DOI: 10.1283/fam/issn2039-0491/n45-2018/163

Ausias Gonzalez Lisorge

Structure Telling. How architectural criticism tells the relationship between Formal structure and Resistant structure

Abstract
It is necessary to situate the gaze in the criticism of architecture to throw a certain light on the issues that this discipline deals with. The story, the logos, fulfills a double function both descriptive and constitutive of the reality. Continuing the way that Panayotis Tournikiotis began in The Historiography of Modern Architecture, the following article tries to highlight how critics of modern architecture have understood the resistant structure in their respective works. Martin Heidegger proposed the tekné as a process to 'bringing-forth' the abstraction. Thus, the technique ceases to have the sense of 'means'. That is, it stands as something necessary to realize an idea. Thus, the study of technology and, therefore, of science turns to be fundamental to understand how architectural projects have been conceived.

Keywords
Historiography — Resistant Structure — Structuralism — Organicism

It is necessary to situate the gaze in the criticism of architecture to throw a certain light on the issues that this discipline deals with. The story, the *logos*, fulfills a double function both descriptive and constitutive of the reality. The historiography of modern architecture played an active role in conformation of styles, focusing its targets. Some of the main architectural tendences of the twentieth century were consolidated through publications and exhibitions. To show this, it is enough to remark the importance of Henry-Russell Hitchcock and Philip Johnson in the developement of the International Style, and the role of latter in the Deconstructivism.
In this sense, Emilia Hernández Pezzi states[1]:

> The written history of the Modern Movement is an exception in its kind because it was not written with the distance that the historian seems to need to interpret or narrate facts from the outside; on the contrary, it was done directly from within. The critics actively participated in the construction of the theoretical framework of this new architecture and promoted their analysis of historical events from contemporary clues that contributed to their programmatic and ideological equipment ...

An important work in this regard is that of Panayotis Tournikiotis *The Historiography of Modern Architecture*. Where the author tries to analyze both illocutionary and perlocutive acts of the texts, that he considered most influential in the evolution of modern architecture. In fact, Zevi in *Profilo della critica Architettonica*, affirms that the text by Tournikiotis is one of the scarce books that deals with this topic.
Following this argumental line, the following article tries to highlight how critics of modern architecture have understood the resistant structure in their respective works. Martin Heidegger proposed the *tekné* as a process

DOI: 10.1283/fam/issn2039-0491/n45-2018/163

to 'bringing-forth' the abstraction. Thus, the technique ceases to have the sense of 'means'. That is, it stands as something necessary to realize an idea. Thus, the study of technology and, therefore, of science turns to be fundamental to understand how architectural projects have been conceived.

This article presents a part of the conclusions of my doctoral thesis[2], *From Empiricism to Invention, Engineering and Design in Modern Architecture,* where the question of the resistant structure is studied more extensively.

The terms used in this article must be defined. According to Paolo Portoghesi[3]:

> In architecture the term s. [Structure] is used with different implications, according to the field to which it refers, according to the general meaning of organization of the parts and the elements in a continuum whose scale is assumed as a unitary reference. Referring to the purely technological field, for s. the static organization of the elements of construction is understood: punctual s., trilitic s. , bridge s., etc. [...] Speaking, instead, of the formal s. or architectural is generally understood as the three-dimensional organization of architectural work, in contrast to a plot [...] that designates certain types of bidimensional orders. The concept of formal s. is, therefore, of fundamental importance for the theory of architecture, since it means the 'form' that represents the solution of the architectural purpose in question. Also the architectural use has its s. (often called 'pattern'). The solution is found, generally, by abstracting from it the spatial consequences and, therefore, translating it into an isomorph formals.

Two concepts are opposed here, formal structure versus structure as something technological. This comes from a historical development, that corresponds to the diffusion of structuralism, after the Second World War. From that time, the term structure is understood, in almost all disciplines, as the internal rules that allow a coherent relationship between the parts and the whole. In this article it was decided to talk about structure (as formal structure) and resistant structure (as technology), that refers to any assembly of materials that resists certain loads.

Once the terms were delimited, an analysis of the texts of architectural criticism proposed by Tournikiotis was carried out. However, due to their heterogeneity, different analyzes were made in order to better study each of them.

On the one hand, there are some books that were analyzed from a qualitative point of view, that happened with *Von Ledoux bis Le Corbusier* by Emil Kaufmann; *Changing Ideals in Modern Architecture (1750-1950)* by Peter Collins; and Manfredo Tafuri's *Teoria e Storia dell'architettura*.

On the other hand there was both a qualitative and a quantitative approach to some of the books. In which it was quantified: the quantity of buildings in which the authors talks about resistant structure, its uses, the architects of those buildings, and also the terms in which critics refers to those questions. Those books are *Modern Architecture: Romanticism and Reintegration* by Henry-Russell Hitchcock. Nikolaus Pevsner's *Pioneers of the Modern Movement from William Morris to Walter Gropius*. *Space, Time and Architecture: The Growth of a New Tradition* by Sigfried Giedion; Bruno Zevi's *Storia dell'architettura moderna*. *Theory and Design in the First Machine Age* by Reyner Banham, and Leonardo Benevolo's *Storia dell'architettura moderna*

In addition, two new books *Modern Architecture: A Critical History*, by Kenneth Frampton. And *The Story of Post-Modernism*, by Charles Jencks,

were added to include opinions on what happened in the last decades of the 20th century and the first decades of the 21st. In the following pages the analyzes of these books and their conclusions are presented.

In the analyzed texts, at least four different critical lines can be found: the mechanist, the structuralist, the organicist and the metacritical. The mechanistic attitude considers that the modern architecture is the logical and universal result of the socioeconomic and intellectual conditions after the Industrial Revolution. Among those who defend this perspective, are: Hitchcock, Pevsner, Benevolo and Giedion. However, the texts studied by the last two authors evolved towards a structuralist attitude, in which Jencks is also situated

In addition, in the analyzed books of Pevsner and Hitchcock, the architecture prior to World War I is studied in one, and World War II in the other. Therefore, they only develop a mechanistic perspective. However, the evolution of these authors deserves a separate treatment.

For Pevsner, technological development was one of the foundations of modern architecture. Although other issues such as aesthetics, etc., were also very important. Therefore, more than mechanist, one could affirm that he was a convinced positivist; that considered that he had to operate through reason. However, in 1973 he published *The Anti-rationalists* where he recognized the value of *art nouveau* and expressionism, not as isolated and marginal styles; but as a case that deserved to be studied. However, in *An Outline of European Architecture* , he affirmed from the experiences of the 1950s[4]:

> …The resurgence of Art Nouveau is not the only response that has been given to criticism against mechanization and the lack of humanity of architecture. There are other buildings of recent construction in which the challenge is accepted and fully overcome without dispensing with the conquests of 1930. They are those that in a future history of twentieth century architecture will represent evolution in the face of the revolution illustrated by Ronchamp ...

That is to say, Pevsner continued betting on an architecture that started from reason. In this way, his position on the purpose and responsibility of architecture hardly changed during his career. In fact, in the prologue of 1962 to the second Spanish edition of *Pioneers*, he wrote[5]: «…I am convinced as always that the style of the Fagus factory and the Cologne model factory is still valid…»

On the contrary, Hitchcock did evolve from his initial mechanistic stance. Thus, in 1942 he wrote *In the Nature of Materials, 1887-1941: The Buildings of Frank Lloyd Wright*[6]. What led him to recognize the influence and importance of the American master, beyond his role as the father of modern architecture, as he had done in *Modern architecture: Romanticism and Reintegration* and also in *The International Style: Architecture since 1922*[7]. Later, in 1958 he published *Architecture: Nineteenth and Twentieth Centuries*. It is a text that he expanded in 1977 and in which he affirmed[8]:

> …, the historian can only end up wondering if within the confusion of novelties of the 1950s and 60s are the seeds from which the architecture of the late twentieth and twenty-first centuries will be developed; if the stylistic evolution of this quarter of a century corresponds to the mannerism of the central decades of the sixteenth century in Italy, to use another equivocal historical analogy. Can we wait, perhaps by the year 2000, for an immanent movement that is at once a synthesis of the many preceding stylistic and technical innovations and a return to at least some of the principles of

the earlier 'high phase', but above all , a new vital creation with a life expectancy of more than one hundred years as it was in Baroque around 1600? ...

This fragment gives a key to the criticism that Hitchcock developed in that book. The historian based his discourse -as Tounikiotis affirmed- in the idea that[9] «the history of architecture is the great succession of styles.» In this way, Hitchcock tried to maintain a neutral stance. His speech no longer advocated exclusively an architectural style based on the machine; but he described the different tendencies that developed until the middle of the 20th century.

As it has been said, the texts by Benevolo and Giedion were revised and expanded several times. What allows to observe an evolution in the discourse of these authors; from a position that advocated architecture based on reason and industry (and that developed an aesthetic close to cubism); to accept radically different approaches.

Thus, Giedion affirmed that the third generation included in its works: psychological and cultural components, etc. On the other hand, Benevolo maintained that, in the decade of 1990, the invention was reached, thanks to combining the different factors that came together in the buildings. That is, both critics ended up understanding that architecture was a language composed of different signs that could generate a coherent code. What reveals certain points in common with the structuralism. However, unlike Giedion, Benevolo hardly addressed the symbolic component in his text.

Charles Jencks also admits that structuralist interpretation; in fact, he recognizes the influence of Michel Foucault. In this way, the historian understands and reveals that architecture is a code, which must respond to the symbolic needs of a plural society in which minorities have a great importance.

Perhaps, Giedion was the one who best knew how to combine the evolution of the machine with the development of the third generation. Thus, the author accepted the necessity of the monument and the symbol and understood that the architecture was based to achieve it - to a large extent - in the development of the structures towards aerodynamic forms. That is to say, the historian was able to unite an almost mechanistic perspective, with the new concerns of the architects for the psychology, the simbology, and so on.

Kenneth Frampton goes a step further in the integration of mechanistic and structuralist criticism. With a wider historical perspective than the previous authors (except Jencks), Frampton adopts the concept of tectonics as a way to resolve the conflict between both positions. The historian gives a double meaning -constructive and symbolic- to technique and detail.

The critics by Bruno Zevi, were developed according to an organicist perspective. The historian understood that architecture was a complex organism, which evolved according to its internal needs and its boundary conditions. The criticism of this author was not only organicist; it was also organic. That is to say, he did not only present organicism as the most accurate response to architecture, but also his discourse was evolving and adapting itself to each topic that the author dealt with.

In addition, since - as the same historian claimed - Frank Lloyd Wright did not define the concept of organicism, Zevi maintained an open criticism of change. What allowed him to develop a calculated ambiguity with which he could carry out a coherent and quite unitary discourse when analyzing all periods and architectural experiences.

Finally, metacritical perspective is the one that carries out a critique of criticism. In it, it can be inserted the texts by Banham, Collins, Tafuri and Tournikiotis. However, Collins and Banham were not reduced to analyzing exclusively the different criticisms of architecture; but, also, they studied the different aesthetic, philosophical theories, etc. In this way, they did not propose an analysis of architecture through its examples, but -mainly- through its theoretical evolution. This does not mean that Banham did not carry out a review of the characteristics of the most representative buildings.

Curiously, all these critical lines -except the metacriticism- have a parallel with the work of the masters of modern architecture. Thus, Le Corbusier evolved from the mechanism of the Dom-ino system, to the symbolism of Chandigarh. On the other hand, the work of Mies van der Rohe would have inspired Frampton. And Wright would be responsible for the organic criticism. Among these designers should be added the work of Alvar Aalto, who was halfway between organicism, the International Style and constructivism.

Now, what is the role of the resistant structure in each of these types of criticism? As for mechanists, one could say that the text that best answers this question is Banham's; that studies the relationship between the machine and the genesis of modern architecture. In fact, the Dom-ino system created an image of the resistant structure as the key of the *machine à habiter.*

In that sense, the mechanistic critic defends a positivist attitude. According to which, the architecture gives a scientific response to the problems that arise. So the evolution of the technique (which includes the calculation of structures, new materials, etc.) was a very important factor, if not the most transcendental, in the birth and development of modern architecture. Because of this, Hitchcock, Pevsner, Benevolo and Giedion supported the aesthetic derived from Cubism, which was followed by some architects of the modern movement; since industry and abstraction seemed to coincide formally.

However, Banham maintained that, in reality, industry had less influence on the formation of modern architecture than the mechanists claimed. For which, the critic argued that this formal coincidence between cubism and the machine was temporary. So, when the technique evolved, they could not continue to defend a positivist stance - in terms of choosing that aesthetic for scientific reasons.

However, there is a question that the critic did not develop at all; although it is latent in his speech: the machine as a symbol and not as an object. It could be interpreted that, when referring to it, modern architects appealed to the new economic and social order that appeared after the Industrial Revolution. Something that William Morris apparently recognized when, on a theoretical level, he rejected the use of the machine; because it had led to the degradation of artisans into workers. In this way, modern architecture may use the image of the machine as the metaphor of a society polarized into the proletariat and bourgeoisie, as well as the symbol of new technical and scientific developments. So, one could say that industry influenced modern architects beyond the coincidence between science and abstract art.

However, little by little, the evolution of thought since the late nineteenth century influenced architects and critics. So psychoanalysis, the Theory of Relativity, phenomenology, the Frankfurt School, structuralism and semiology, advances in psychology, and so on. Those facts indicated new

perspectives and psychological, cultural and symbolic needs. For all this, positivism - the machine - ceased to be a reference (symbolic and formal) for architects.

For this reason, structuralist criticism was developed, which appeals to the possibility of the architect to choose a series of signs to work with. These levels have not an *a priori* hierarchy, but are decided by each designer, at each moment. This caused Benevolo to adapt his criticism to each situation, to each example analyzed after the 1970s. And Giedion, when analyzing the third generation, made a great emphasis on the idea of monumentality. For structuralist criticism, the resistant structure is a significant level; that can have more or less weight when designing a building comparing with other significant levels.

In the organic criticism, we must study the seven invariants of contemporary language to understand the role that the resistant structure has in it. Zevi proposed these invariants in the latest edition of *Storia dell'architettura moderna*; these were: the list of contents and functions, the dissonance, the anti-perspective three-dimensionality, the four-dimensional decomposition, the structural implication, the temporalized space and the environmental continuum. Thus, the author gave a series of examples that represented the structural implication; Among those were: the Federal Reserve Bank in Minneapolis by Gunnar Birkerts, some examples by Norman Foster and Kiyonori Kikutake's projects. That is to say, it seems that Zevi was referring to a series of buildings in which the resistant structure had been fundamental in its conception and that, in addition, the resistant structure was the most important feature in their form.

However, in *Profilo della critica architettonica*, the author used those invariants to expose the characteristics of architecture close to the third millennium. In which the structural implication was placed as one more level with respect to the other six characteristics. Therefore, the author did not refer only to buildings in which the structure had a strong presence. What recalls a comment he made in *Storia dell'architettura moderna*in where he claimed that the development of the structural calculation accredited neoexpressionism.

So for Zevi the technique was one more of those invariants that formed the architecture. So it did not have to be the inspiration of the rest, but it had to corroborate them. As an example of this, the following comment[10] «... Wright penetrates the volumes, the third and fourth dimensions: it is related to spaces, for which it requires structures in cantilever, shells and membranes ..»

On the other hand, it might seem that Zevi had adopted a critique in some way, structuralist, while appealing to language. In fact he wrote[11]: «The new language of the 'seven invariants' has full legitimacy *also* under the semiological profile. It rejects any code based on the past, and any code that intends to determine the future ... »However, that *also* - which in the original is not in italics - gives the key that, rather than language, the author appealed to a series of formal and spatial characteristics of the architecture and not to a set of signs.

Finally, for Frampton, *tectonic* expresses the relationship between the load and the resistant structure. In addition, it also manifests the poetic and the cognitive. Therefore, the structural strategies must be legible and must be an important part in the final configuration of the architecture. Something that could be applied to the architecture by Mies van der Rohe, the Eiffel Tower, Mendes da Rocha or Felix Candela, among a wide range of

DOI: 10.1283/fam/issn2039-0491/n45-2018/163

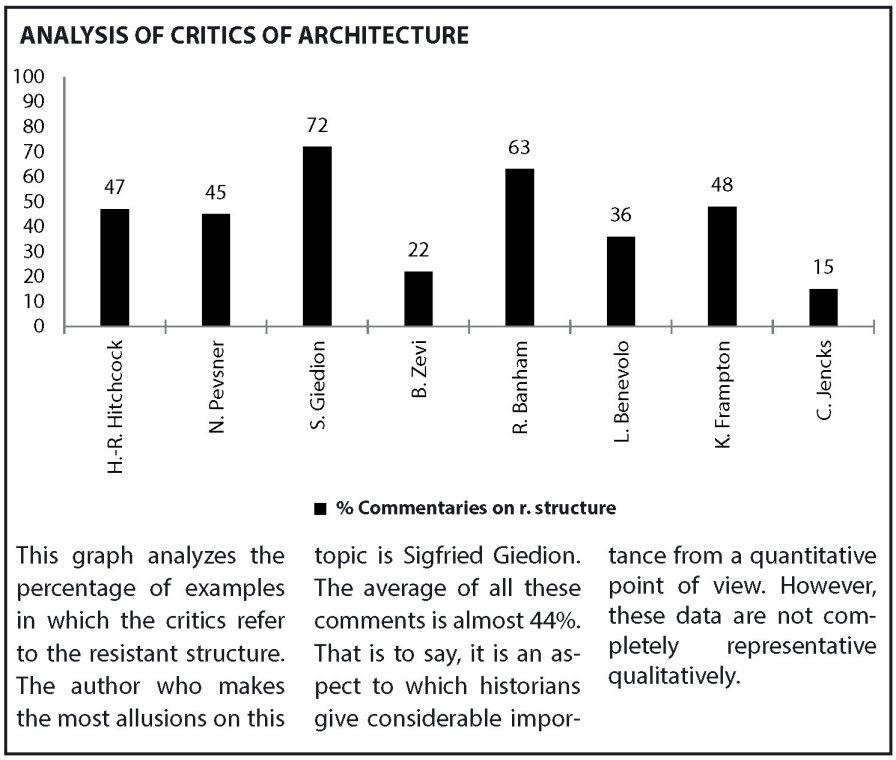
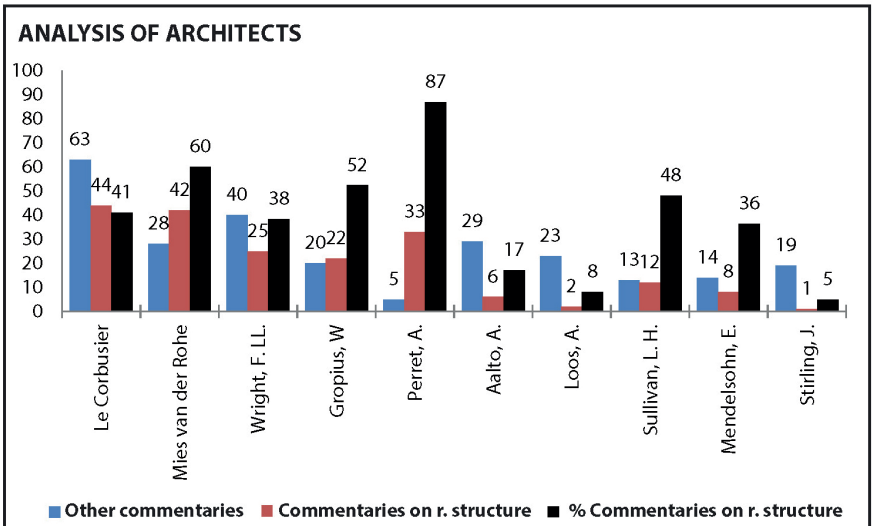


Fig. 1
Analysis of Critics of Architecture.

names. Thus, unlike Gottfried Semper, Frampton does not refer to a single type of construction, but to a coincidence between expression and resistant structure. By means of which the material sense of the construction can be transcended to reach a symbolic level, that is, the tectonic can be reached.
Historians do not use the expression 'resistant structure'. Instead of that the main terms that they use to refer to that are: engineering, machine, construction and technique. These words are often used almost as synonyms. They also make references to constructive components such as: pillar, vault, column, slab, etc. And some of them, to the science of structures. In addition, in terms of materials, the main protagonists are reinforced concrete and steel. Likewise, critics refer to the resistant structure through them on many occasions. That is to say, a metonymy is produced in which meronyms (materials) replace holonyms (resistant structure, technique, etc.).
Also the difference between technique and technology is not usually expressed. Something, however, that is worth discussing. According to some philosophers[12], the birth of science points out the difference between these terms. Aft er science the word technology should be used. However, there is no universal consensus on this. In general, historians of modern architecture use both terms synonymously.
Moreover, the word technology can be used in two diff erent ways, either to designate procedures and resources with which to carry out a particular solution, or take a deeper sense. Thus, Martin Heidegger claimed[13]:
«Technology is therefore no mere means. Technology is a way of revealing. If we give heed to this, then another whole realm for the essence of technology will open itself up to us. It is the realm of revealing, i.e., of truth.
This prospect strikes us as strange. Indeed, it should do so, should do so as persistently as possible and with so much urgency that we will finally take seriously the simple question of what the name "technology" means. The Word stems from the Greek Τέχνικοη means that which belongs to τέχνη»
Something that José Ortega y Gasset[14] and Lewis Mumford also defended. In fact, the latter uses the English word *technichs*; however[15], «... is not a

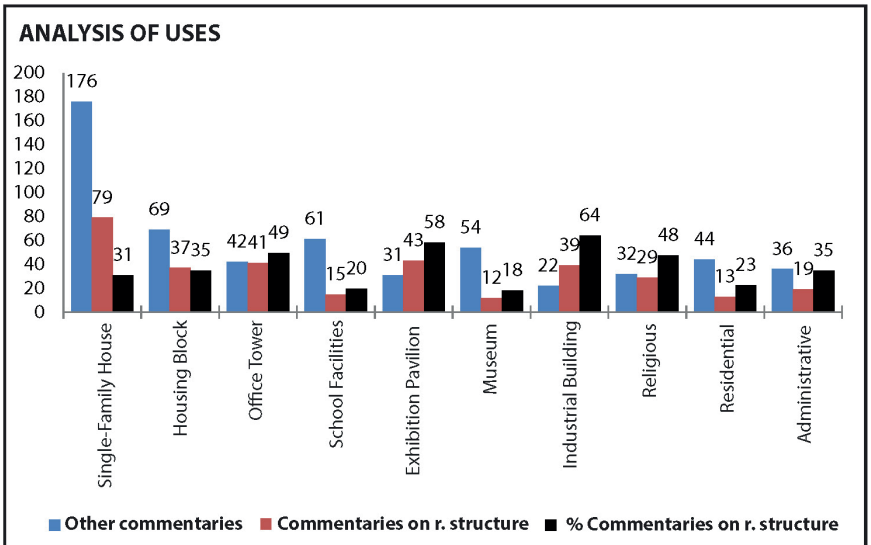
DOI: 10.1283/fam/issn2039-0491/n45-2018/163

Fig. 2
Analysis of Architectis.



The architect with the most comments about the resistant structure is, by far, Auguste Perret, followed by Ludwig Mies van der Rohe. Both integrated construction as part of the expression of architecture. On the other hand, these questions represent relatively high percentages in all masters of modern architecture; except for Alvar Aalto, who was the youngest among them. Precisely, this seems to reflect that, for some of the historians, Le Corbusier, Mies, Gropius and Wright, gave an appropriate language to the new constructive methods.

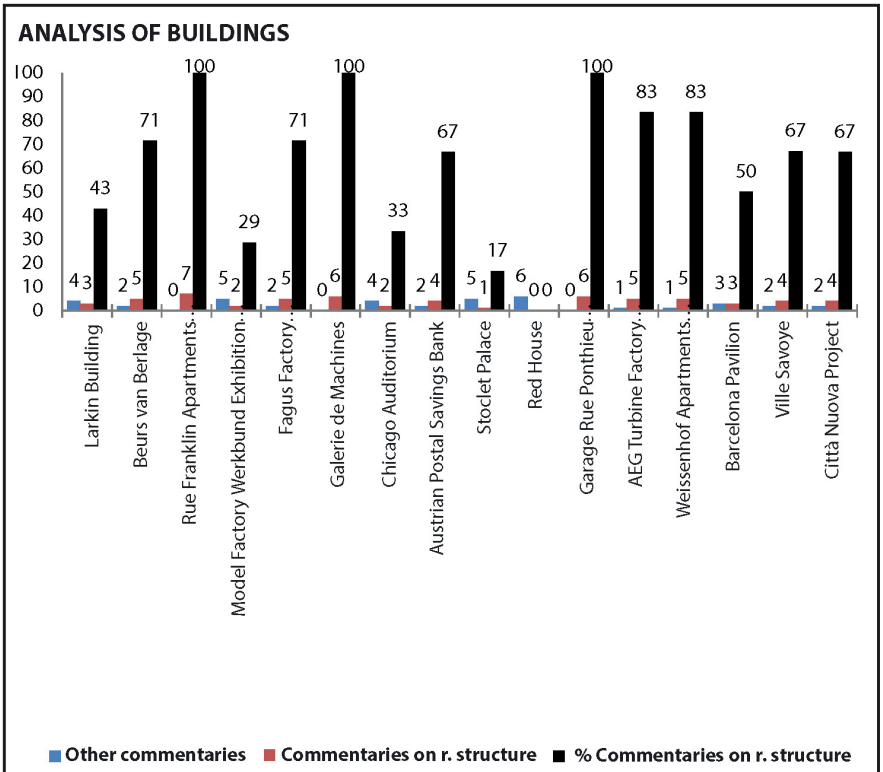
Fig. 3
Analysis of uses.



The two most commented uses are those related to housing. In them, the resistant structure is mentioned between 31% and 35% of the time. This contrasts with the fact that the average of the comments on the authors' graph is 44%. On the other hand, the two uses in which more allusions are made about the technique were designed, at first, by engineers. They are also closely followed by the office towers and religious buildings. That is to say, historians usually focus their attention on technical questions when referring to examples in which an important structural effort is usually made, either because of their height or because of the need to save large spans. In addition, these buildings were among the first to incorporate metal and reinforced concrete.

DOI: 10.1283/fam/issn2039-0491/n45-2018/163

Fig. 4
Analysis of Buildings.



To a large extent, this graph corroborates the analysis of the architects. Thus, here are buildings by: Mies van der Rohe, Le Corbusier, Frank Ll. Wright, W. Gropius, etc. The works in which more aspects of the resistant structure are commented on are due to Auguste Perret and to Contamin and Dutert. And they are, followed, by examples by Mies and Behrens. On the other hand, the average of the comments of these questions is 66%, which far exceeds that of the historians of architecture. This seems to indicate that there is a certain unanimity in emphasizing this topic in some examples. Thus, critics often incorporate such buildings in their discourse, due to their importance in the formation of modern architecture.

DOI: 10.1283/fam/issn2039-0491/n45-2018/163

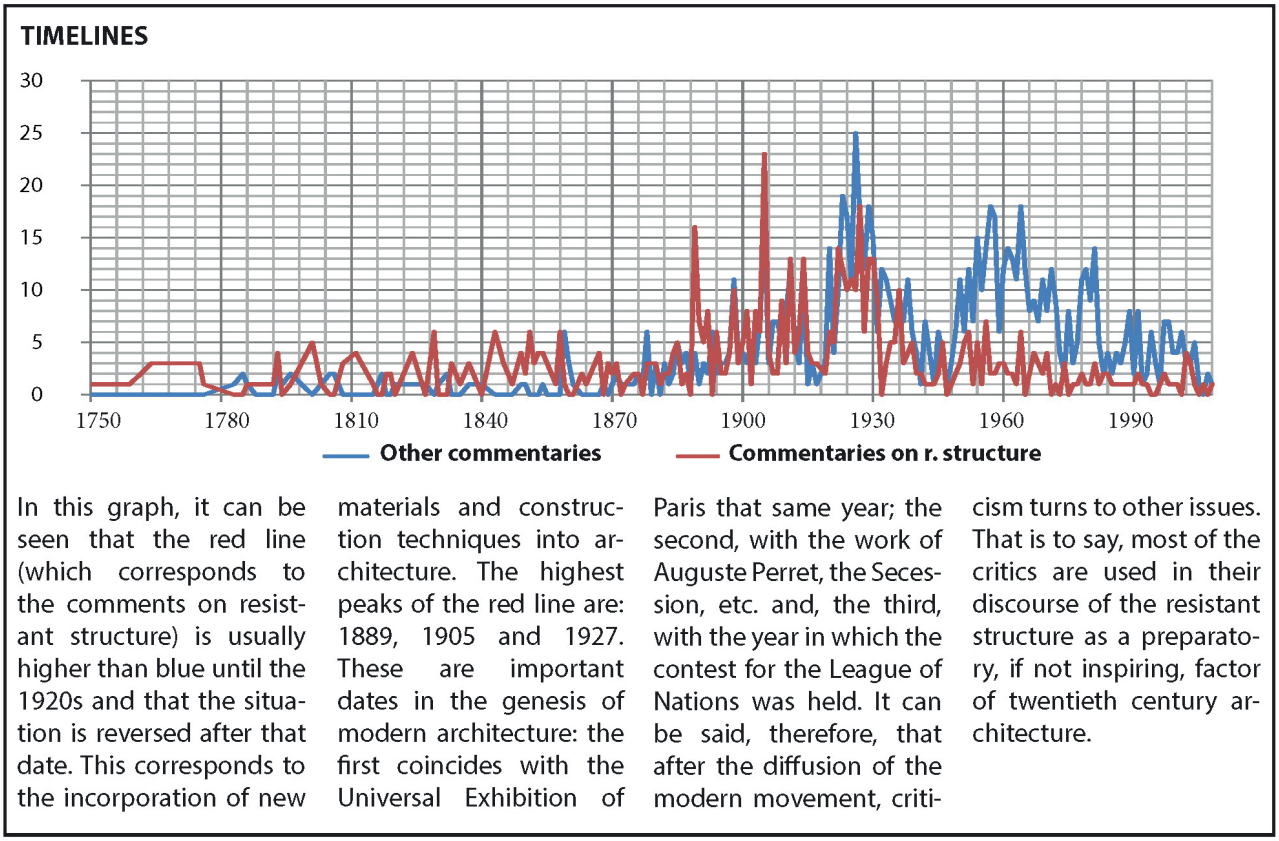


Fig. 5
Timelines.

common word in [that language], and Mumford uses it deliberately as a synonym of the Greek *tekné* (Τέχνη), a term that refers not only to technology in a narrow sense, but also to art and craftsmanship , and by extension to the interaction between the social environment and technological innovation. »

Thus, most critics of architecture, which have been studied, refer to technique as a means. However, Frampton adopts the Heideggerian sense of the word. In fact, it integrates it within the concept of tectonics, but giving it a constructive reality.

If the graphics of all the books are studied, (see figures: Analysis of critics of architecture/Analysis of architects/Analysis of uses/Analysis of buildings/Timelines) it can be seen that among architects and engineers quoted by historians, Auguste Perret is by far, the architect who is proportionately most quoted regarding this resistant structure. Moreover, within uses, industrial and exhibition pavilions are the highest percentage in this regard. On the contrary, the use of single-family homes (which is where the most comments are made) only appeals to this issue in 30% of cases.

As for the most talked about buildings, three in which the resistant structure is mentioned in 100% of cases are Rue Franklin Apartments and Garage Ponthieu by Auguste Perret and the Galerie des Machines. These are followed by the AEG Turbine Factory by Peter Behrens and block houses for the Weissenhof by Mies. Also, if we look at time lines, it is noted that before 1920, commentaries on structures (in red) exceed or equal the rest of the commentaries; but since then the red line decrease with respect to the blue line. In addition, there are three highest peaks; 1889, 1905 and 1927. So, roughly speaking, it can be affirmed that the resistant structure seems to be important for historians -fundamentally- before the 1930s; and very especially before the 20th century.

If the quantitative and qualitative data are compared, several conclusions

DOI: 10.1283/fam/issn2039-0491/n45-2018/163

Fig. 6
From left: H. R. Hitchcock; Pevsner.; S. Giedion; B. Zevi; R. Banham; K. Frampton; C. Jencks; P. Tournikiotis.

are obtained. Critics often make two types of analysis of the technology: as an isolated or integrated object in their speech. As to the first, all the critics that address the evolution of the technology, carry out a review of the evolution of metal since the beginning of the Industrial Revolution to the Exposition Universelle of 1889. Thus, the authors usually talk about the production of iron and its first examples in: bridges, greenhouses, exhibition halls, and so on.

That is why one of the peaks that appears is 1889. Which, in addition, underlines that the Galerie des Machines of Contamin and Dutert is one of the buildings in which this topic is always discussed. Also in that year, they mention: the Eiffel Tower, buildings of the Chicago School as the Tacoma Building, and so on. Precisely, when refering tho the construction of the towers of the Chicago School, critics usually speak of the use of the typical structural system of the factory buildings.

Once this tour is complete, historians addressing these dates propose a review of the development and evolution of reinforced concrete, from Paul Cottancin to François Hennebique. This tour is usually finished by explaining some of the bridges and slabs by Robert Maillart, as well as historian give examples of Eugène Freyssinet's work. In fact, at the peak of 1905 there are works such as: the bridge over the river Rinn in Tavanasa by Robert Maillart and the garage of Rue Ponthieu by Perret. In addition to other experiences in metal; among which the transporter bridge in Marseille by Arnodin and the building of the Sammaritaine stand out. Therefore the numbers underline thet the uses in which the resistant structure is usually commented are those uses referring to industry and exhibition halls.

In the peak of 1927, works of modern architecture are discussed: the building of the Weissenhof by Mies van der Rohe, the Villa Stein by Le Corbus-

ier, some projects for the League of Nations, the Lovell House by Richard Neutra, etc. Unlike the previous peaks, in this case the structure is usually a part of the discourse of the authors.

These data corroborate that there are two attitudes with respect to the development of new techniques. Thus, for some historians, it had a fundamental role in the birth of modern architecture (Hitchcock, Pevsner, Giedion, Benevolo, Frampton) and for others, it was just a factor (Zevi and Banham).

The majority of the comments that the authors make of the evolution of the technique are almost identical. What indicates that, as an isolated object of study, technology is seen as a block. Critics do not produce a critique of science, nor their motives, nor its successes and its failures Thus, the architects are impelled to be either passive users, or instigators of the technique. But it seems that architects can't have a decisive role in the evolution of technology that is relegated to engineering and industry.

Moreover, since 1920 the weight of the technique goes down considerably, with respect to other issues, and one could argue that the technology has become an element of the discourse of authors. It is indicating that the mechanistic positions were abandoned, giving way to a structuralist critique.

Notes

[1] TOURNIKIOTIS P (1999)— *The Historiography of Modern Architecture,* Cambridge, Mass., Massachussets Institute of Technology (Spanish translation by Jorge Sainz, *La historiografía de la arquitectura moderna*, Madrid, Librería Mairea y Celeste Ediciones SA, 2001) p. 7 [Translation by the author]

[2] GONZALEZ L. AUSIAS (2016)— *Del Empirismo a la invención, cálculo y proyecto en la arquitectura moderna,* PhD presented in Escuela Técnica Superior de Arquitectura de Madrid, Madrid

[3] PORTOGHESI P. (director) (1969)— *Dizionario Enciclopedico di Architettura e Urbanistica, Roma, Volumen VI*, Istituto Editoriale Romano, 1969 [translation by the author]

[4] PEVSNER N. (1943)— *An Outline of European Architecture*, Harmondsworth, Penguin Books (Spanish translation by María Corniero y Fabián Chueca, *Breve historia de la arquitectura europea*, Madrid, Alianza Editorial, 1994), p. 366 [Translation by the author]

[5] PEVSNER N. (1936)— *Pioneers of the Modern Movement from William Morris to Walter Gropius,*1ªed., Londres, Faber & Faber (Spanish translation by Odilia Suárez and Emma Grefores, *Pioneros del diseño moderno: de William Morris a Walter Gropius*, 1ªed., Buenos Aires, Infinito, 1958, (5ª edición, 2011))..., *op. cit.*, p 14 [Translation by the author]

[6] HITCHCOCK H.-R. (1942)— *In the Nature of Materials, 1887-1941: The Buildings of Frank Lloyd Wright*, Nueva York, Duel, Sloan and Pearce

[7] HITCHCOCK H.-R. (1932)— *The International Style: Architecture since 1922*, Nueva York, W.W. Norton (Spanish translation by Carlos Albisu, El Estilo Internacional; arquitectura desde 1922, Murcia, COAT, 1984)

[8] HITCHCOCK H.-R. (1958)— *Architecture: Nineteenth and Twentieth Centuries*, Harmondsworth, Penguin Books (ed. of 1968) (Spanish translation by Luis E. Santiago, *Arquitectura de los siglos XIX y XX*, Madrid, Ediciones Cátedra, 1981) pp 626-627 [Translation by the author]

[9] TOURNIKIOTIS P. (1999)— *The Historiography of Modern Architecture,* Cambridge, Mass., Massachussets Institute of Technology, 1999 (Spanish translation by Jorge Sainz, *La historiografía de la arquitectura moderna*, Madrid, Librería Mairea y Celeste Ediciones SA, 2001)Panayotis, *op. cit.*, p 127 [Translation by the author]

[10] ZEVI B. (1950)— *Storia dell'architettura moderna*, 1ª ed, Torino, Einaudi (Spanish translation of the 5th Italian ed by Roser Berdagué, *Historia de la arquitectura*

moderna, Barcelona, Poseidón, 1980), p 322 [translation by the author]
[11] ZEVI B. (2001) — *Profilo della critica architettonica*, Roma, Newton & Compton Editori, p 105 [translation by the author]
[12] This difference is found in: GARCÍA SIERRA P. «Diccionario filosófico» En: «http://www.filosofia.org/filomat/df177.htm» (26/03/2015)
[13] HEIDEGGER M. (1954)— *Vorträge und Aufsätze*, Pfullingen, Verlag Günther Neske (English translation *The question concerning Technology* Garland Pub 1977 p 3-35)
[14] ORTEGA Y GASSET J. (1982)— *Meditación de la técnica y otros ensayos sobre filosofía*, Madrid, Revista de Occidente en Alianza Editorial, 1982 (ed of 2004). [It is a course that Ortega y Gasset gave in Universidad de Verano de Santander in 1933]
[15] MUMFORD L. (1952)— *Art and Technics*, New York, Columbia University Press, (ed. year 2000) (Spanish Translation by Julián Lacalle, *Arte y técnica*, La Rioja, Pepitas de la calabaza, 2014), p 49 [This is a note from the spanish translator, who continues saying: «Given the alternative of translating it as tekné or as a" technique ", we have preferred this second option ...»] [Translation by the author].

References

ADDIS B. (1994)— *The Art of the Structural Engineer*, Londres, Artemis.

ADDIS B. (2007) —*Building: 3000 Years of Design*, Engineering and Construction, Londres, Phaidon Press

BANHAM R. (1960) — *Theory and Design in the First Machine Age*, Londres, The Architectural Press, (reprinting de 1982)

BANHAM R. (1960) — *Theory and Design in the First Machine Age,* Londres, The Architectural Press, (Spanish Translation by Luis Fabricant, *Teoría y diseño arquitectónico en la era de la máquina*, Buenos Aires, Ediciones Nueva Visión, 1965)

BANHAM R. (1960) —*Theory and Design in the First Machine Age*, Londres, The Architectural Press, (Spanish Translation by Luis Fabricant, *Teoría y diseño arquitectónico en la primera era de la máquina,* Barcelona, Ediciones Paidós, 1985)

BANHAM R. (1966) — *The New Brutalism, Ethic or Aesthetic?*, Londres, The Architectural Press, 1966

BANHAM R. (1976) — *Megastructure: Urban Futures for the Recent Past*, Londres, Thames and Hudson, (Italian translation by Renato Pedio, *Le tentazioni dell'architettura. Megastrutture*, Roma-Bari, Laterza, 1980)

BASTIDE R., et al. (1962) — *Sens et usages du terme structure dans les ciences humaines et sociales*, La Haya, Mouton & Co., (Spanish Translation by Beatriz Dorriots, *Sentido y usos del término estructura en las ciencias del hombre*, Buenos Aires, Editorial Paidós, 1971)

BENEVOLO L. (1960) — *Storia dell'architettura moderna*, Bari, Casa Editrice Gius. Laterza & Figli

BENEVOLO L. (1960) — *Storia dell'architettura moderna*, Bari, Casa Editrice Gius. Laterza & Figli, (last edition 2003) (Spanish Translation by Mariuccia Galfetti, Juan Díaz de Atauri, Anna María Pujol i Puighvehí, Joan Giner y Carmen Artal, *Historia de la arquitectura moderna*, 8ª edición (tercera tirada), Barcelona, Editorial Gustavo Gili S.A., 2005)

BOUDON R. (1968) — *À quoi sert la notion de "structure"? Essai sur la signification de la notion de structure dan les ciences humaines*, París, Éditions Gallimard (Spanish version, *Para qué sirve la noción de "estructura": ensayo sobre la significación de la noción de estructura en las ciencias humanas*, Madrid, Aguilar, 1972)

CHOISY A. (1899) — *Histoire de l'architecture*, Paris, Gauthier-Villars

COLLINS P. (1965) — *Changing Ideals in Modern Architecture (1750-1950)*, Londres, Faber & Faber (Spanish Translation by Ignasi de Solá-Morales, *Los ideales de la arquitectura moderna; su evolución (1750-1950)*, Barcelona, Editorial Gustavo

Gili, 1970 (5ªed., 1998)

DELACAMPAGNE CH. (1995)— *Histoire de la philosophie au XXe siècle*, París, Éditions de Seuil (Spanish Translation by Gonçal Mayos Solsona, *Historia de la filosofía en el siglo XX*, Barcelona, RBA Libros, 2011)

FORD EDWARD R. (1990)— *The Details of Modern Architecture*, Cambridge (Mass.) y Londres, The MIT Press

FORD EDWARD R. (1996) — *The Details of Modern Architecture*, Volume 2, 1928 to 1988, Cambridge (Mass.) y Londres, The MIT Press

FRAMPTON K. (1980) — *Modern Architecture: A Critical History*, Londres, Thames and Hudson (edition of 1992) (Spanish Translation by Jorge Sainz, *Historia crítica de la arquitectura moderna*, Barcelona, Gustavo Gili, 1998 (10ª ed. 2000))

FRAMPTON K. (1980)— *Modern Architecture: A Critical History*, Londres, Thames and Hudson (4ª ed. ampliada 2007)) (Spanish Translation by Jorge Sainz, *Historia crítica de la arquitectura moderna*, Barcelona, Gustavo Gili, 1998 (4ª ed. ampliada 2010))

FRAMPTON K. (1995)— *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century in Architecture*, Chicago, Cambridge, Londres, Graham Foundation for Advanced Studies in Fine Arts, The MIT Press, (second reprint 1996)

GARCÍA SIERRA P.— «Diccionario filosófico» In: «http://www.filosofia.org/filomat/df177.htm» (26/03/2015)

GIEDION S. (1941)— *Space, Time and Architecture, The Growth of a New Tradition*, 1st ed., Cambridge (Mass.), Harvard University Press, (6ª ed., 1946)

GIEDION S. (1941) — *Space, Time and Architecture, The Growth of a New Tradition*, Cambridge (Mass.), Harvard University Press, (Spanish Translation by Isidro Puig Boada, *Espacio, tiempo y arquitectura, el futuro de una nueva tradición*, [with the new chapters that appear in the first italian edition, *Spazio, tempo ed architettura*] Barcelona, Hoepli S.L., 1958)

GIEDION S. (1941)— *Space,Time and Architecture*, The Growth of a New Tradition, Cambridge (Mass.), Harvard University Press, (5th ed. of 1967) (Spanish Translation by Jorge Sainz, *Espacio, tiempo y arquitectura: origen y desarrollo de una nueva tradición*, Barcelona, Editorial Reverté, 2009)

GONZÁLEZ L. AUSÍAS (2016) — *Del Empirismo a la invención, cálculo y proyecto en la arquitectura moderna*, PhD presented in Escuela Técnica Superior de Arquitectura de Madrid, Madrid, 2016

GONZÁLEZ L. AUSÍAS (2017)— «Del empirismo a la invención, cálculo y proyecto en la arquitectura moderna / Fom Empiricism to Invention, Calculation and Design in Modern Architecture», Proyecto y Ciudad, 08, pp. 111-122

GONZÁLEZ L. AUSÍAS (2013)— «Hábitats de tierra: Paolo Soleri, Last Interview», Arquitectura Viva, 152, may, pp. 60-63

GONZÁLEZ L. AUSÍAS (2015)— «De lo ligero a lo expresivo, Mobile Roofs and Structures», Arquitectura Viva, 157, september, pp. 63-65

GONZÁLEZ L. AUSÍAS (2017)— «Ma Yansong: An intervew», Arquitectura Viva, (pending of publishing)

GORDON J. E. (1978)— *Structures or why Things don't Fall Down*, London, Pelican Books (reprint in London, Penguin Books, 1991)

HEIDEGGER M. (1954)— *Vorträge und Aufsätze*, Pfullingen, Verlag Günther Neske (Spanish Translation by Eustaquio Barjau, *Conferencias y artículos*, Barcelona, Ediciones del Serbal, 1994)

HEYMAN J. (1998)— *Structural Analysis: a Historical Approach*, Cambridge, Cambridge University Press (Spanish Translation by Santiago Huerta, *Análisis de Estructuras: un estudio histórico*, Madrid, Instituto Juan de Herrera, 2004)

HEYMAN J. (1999) — *The Science of Structural Engineering*, Londres, Imperial College Press (reimpresión de 2006)

HEYMAN J. (1999)— *The Science of structural engineering*, London, Imperial College Press (Spanish Translation by Gema M. López Manzanares, *La ciencia de las estructuras*, Madrid, Instituto Juan de Herrera, 2001)

HITCHCOCK JR. H.R. (1929) — *Modern Architecture: Romanticism and Reintegration*, 1ªed, New York, Payson & Clarke (reprint 1st ed., New York, Da Capo Press, 1993)

HITCHCOCK JR. H.R. (1942)— *In the Nature of Materials, 1887-1941: The Buildings of Frank Lloyd Wright,* New York, Duell, Sloan and Pearce

HITCHCOCK JR. H.R. (1958)— *Architecture: Nineteenth and Twentieth Centuries, Harmondsworth*, Penguin Books, (ed. of 1968) (Spanish Translation by Luis E. Santiago, *Arquitectura de los siglos XIX y XX*, Madrid, Ediciones Cátedra, 1981)

HITCHCOCK JR. H.R.; JOHNSON P. (1932)— *The International Style: Architecture since 1922, Nueva York, WW. Norton* (ed. of 1966) (Spanish Translation by Carlos Albisu, Murcia, COATT, 1984)

HUERTA S. (2004)— *Arcos, Bóvedas y cúpulas, geometría y equilibrio en el cálculo de estructuras de fábrica*, Madrid, Instituto Juan de Herrera.

JENCKS CH. (1977)— *The Language of Post-Modern Architecture, Londres y Nueva York*, Academy Editions y Rizzoli (Spanish Translation by Pérdigo Nárdiz y Antonia Kerrigan Guravich, *El lenguaje de la arquitectura posmoderna*, Gustavo Gili, 1980)

JENCKS CH. (2011)— *The Story of Post-Modernism: Five Decades of the Ironic, Iconic and Critical in Architecture*, Chichester, John Wiley & Sons Ltd.

JOHNSON P.; WIGLEY M. (1988)— *Deconstructivist Architecture*, New York, MOMA.

KAUFMANN M. E. (1933)— *Von Ledoux bis Le Corbusier, Ursprung und Entwicklung Der Autonomen Architektur*, Viena, R. Passer (Spanish Translation by Reinald Bernet, De Ledoux a Le Corbusier, origen y desarrollo de la arquitectura autónoma, Barcelona, Gustavo Gili, 1982 (2ª ed. 1985))

KURRER K.-E. (2008)— The History of the Theory of Structures, From Arch Analysis to Computational Mechanics, Berlin, Ernst & Sohn Verlag für Architektur und technische Wissenschaften GmbH & Co. KG.

LACLAU E.; MOUFFE CH. (1985)— Hegemony and socialist strategy. Towards a radical democratic politics, Londres, Verso (New Left Books), (Spanish version , Hegemonía y estrategia socialista. Hacia una radicalización de la democracia, Madrid, Siglo XXI, 1987)

MANTEROLA J. (1984)— «Evolución de los puentes en la historia reciente», Informes de la Construcción, vol. 36, nº 359-360, abril-mayo

MANTEROLA J. (1985)— «La estructura resistente de los edificios altos», Informes de la Construcción, vol. 37, nº371, junio, pp 5-30

MANTEROLA J. (1998)— «La estructura resistente en la arquitectura actual», Informes de la Construcción, Volumen 50, nos 456-457, julio/agosto-septiembre/octubre

MANTEROLA J. (2005)— «La estructura resistente en la arquitectura actual (continuación)», Informes de la Construcción, Volumen 57, nos 499-500, septiembre-octubre/ noviembre-diciembre

MUMFORD L. (1952)— Art and Technics, New York, Columbia University Press, (ed. year 2000) (Spanish Translation by Julián Lacalle, Arte y técnica, La Rioja, Pepitas de la calabaza, 2014)

MUMFORD L. (1967)— Technics and Human Development: the Myth of the Machine (Volume One), San Diego, Harcourt Brace & World (ed. year 1995) (Spanish Translation by Arcadio Rigodón, El mito de la máquina: Técnica y evolución humana, La Rioja, Pepitas de la calabaza, 2010 (2ª ed., 2014))

MUMFORD L. (1970)— The Pentagon of Power: The Myth of the Machine (Volume Two), San Diego, Harcourt Brace Jovanovich (ed. year 1998) (Spanish Translation by Javier Rodríguez Hidalgo, El pentágono del poder: el mito de la máquina (dos), La Rioja, Pepitas de la calabaza, 2011)

ORTEGA Y GASSET J. (1982)— Meditación de la técnica y otros ensayos sobre filosofía, Madrid, Revista de Occidente en Alianza Editoria (edición de 2004)

PEVSNER N. (1936)— Pioneers of the Modern Movement from William Morris to Walter Gropius,1ªed., Londres, Faber & Faber, 1936

PEVSNER N. (1936)— Pioneers of the Modern Movement from William Morris to Walter Gropius,1ªed., Londres, Faber & Faber (Spanish Translation by Odilia Suárez y Emma Grefores, Pioneros del diseño moderno: de William Morris a Walter Gropius, 1st ed., Buenos Aires, Infinito, 1958, (5th edition, 2011))

PEVSNER N. (1973)— The Anti-rationalists, Londres, Architectural Press

PICON A. (2010)— Digital Culture in Architecture, Basel, Birkhäuser

PORTOGHESI P. (director) (1969)— Dizionario Enciclopedico di Architettura e Urbanistica, Volumen VI, Roma, Istituto Editoriale Romano

PORTOGHESI P. (1964)— «La Chiesa dell'Autostrada del Sole», L'Architettura Cronache e storia, number 101, march, pp 798-809

QUIRÓS FERNÁNDEZ F— «El concepto de estructura». En: « https://www.academia.edu/7652176/CONCEPTOS_ELEMENTALES_I_ESTRUCTURA_ » (30/03/2015)

ROSSI A. (1973) — *L'architettura della città*, Padova, Marsilio

SCHULZ N. (1967)— *Intensjoner i arkitekturen*, Oslo, Universitetsforlaget (Spanish Translation by Jorge Sanz Avia y Fernando González Fernández Valderrama, *Intenciones en arquitectura*, («GG Reprints»), Barcelona, Gustavo Gili, 1998)

STRAUB H. (1949)— *Die Gesichte der Bauingenieurkunst*, Basel, Verlag Birkhäuser (English translation by E. Rockwell, *A History of Civil Engineering, An Outline from Ancient to Modern Times*, London, Leonard Hill Limited, 1952)

TAFURI M. (1968)— *Teoria e Storia dell'architettura,* 1ª ed., Roma-Bari, Gius. Laterza & Figli Spa (4th ed., 1976) (Spanish Translation by Martí Capdevilla, *Teorías e Historia de la Arquitectura*, Madrid, Celeste Ediciones, 1997)

TOURNIKIOTIS P. (1999)— *The Historiography of Modern Architecture, Cambridge, Mass., Massachussets Institute of Technology*, (Spanish Translation by Jorge Sainz, *La historiografía de la arquitectura moderna*, Madrid, Librería Mairea y Celeste Ediciones SA, 2001)

VENTURI R. (1966)— *Complexity and Contradiction in Architecture*, New York, The Museum of Modern Art Press, 1966

ZEVI B. (1950)— *Storia dell'architettura moderna*, 1st ed, Torino, Einaudi Editore

ZEVI B. (1973)— *Spazi dell'architettura moderna*, Torino, G. Enaudi (Spanish Translation by Roser Berdagué from the 2d Italian ed., *Espacios de la arquitectura moderna*, Barcelona, Poseidón, 1980)

ZEVI B. (2001) — *Profilo della critica architettonica*, Roma, Newton & Compton Editori, 2001

Ausías González Lisorge was born in Murcia (Spain) in 1985. He holds the title of Doctor Internacional en arquitectura in 2016, at the ETSAM (Escuela Técnica Superior de Arquitectura de Madrid) with the thesis entitled:*Del empirismo a la invención, cálculo y proyecto en la arquitectura moderna*. During his doctorate he spent a year in Venice, doing research at the IUAV (Istituto Universitario di Architettura di Venezia), as well as at the Università degli Studi di Trieste. His thesis develops the relationship between resistant and formal structure in architecture.