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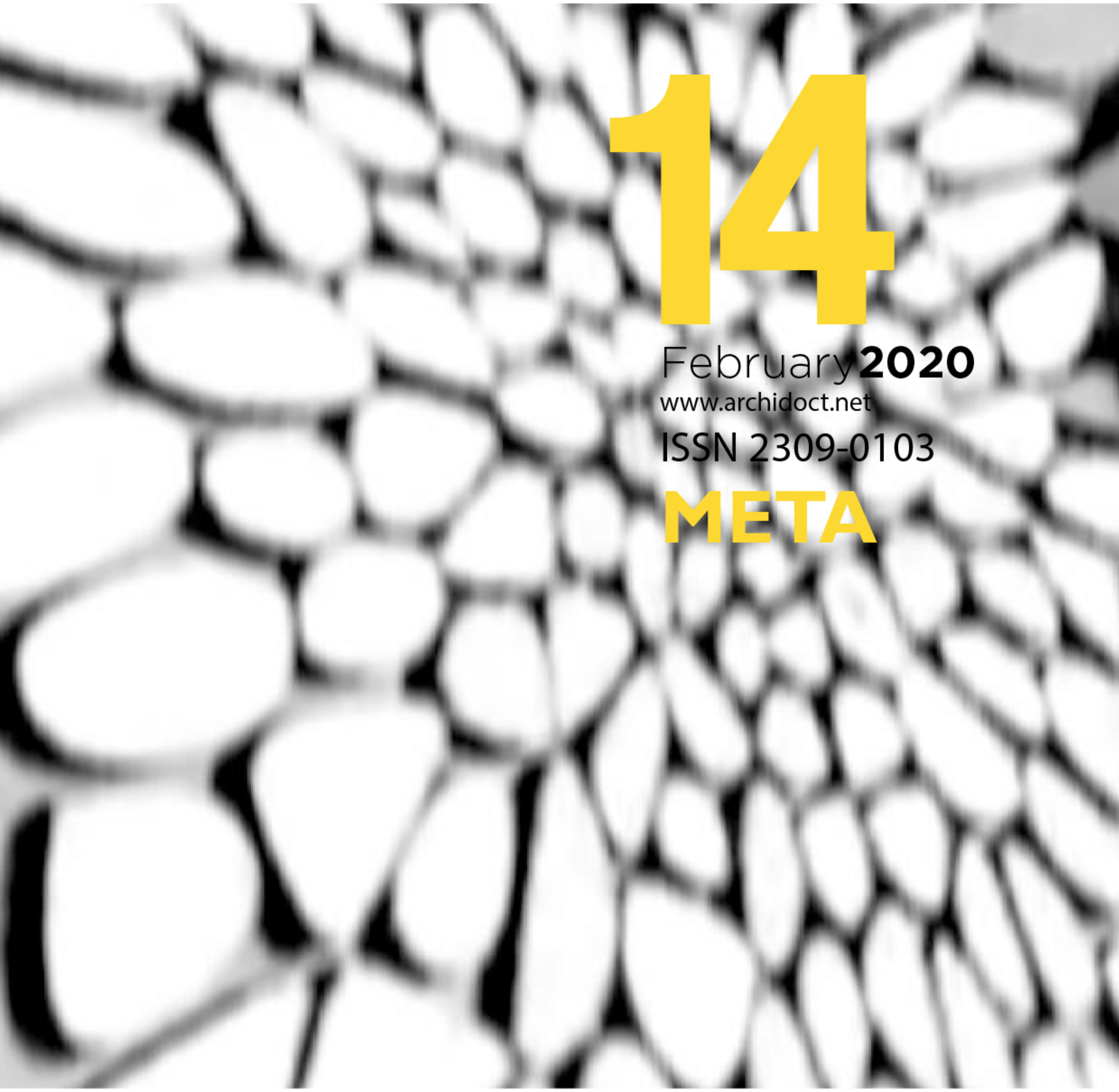

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Systemic Considerations

Regarding the Importance of the Pre- in the Post- on the Path Towards the Meta-system

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Abstract

Historically, systemic considerations adapt their meanings in each era, incorporating progressively new conceptual, methodological and operational advances. Thus, the idea of a system during the Middle Ages, the Renaissance, the Baroque Period and the Contemporary Era has risen and evolved, and linear thinking has first been made possible and then altered and subverted by alternative techniques, leading us towards the meta-system.

This progress towards the meta-systemic derives from ongoing processes anchored in the distant past, finally leading us to a new paradigm.

We aim to trace the evolutionary nature of the systemic character, to clarify its changing notions and its influence on the view of the world and the view of architecture, to gain a better perspective about the present and future: in order to achieve understanding of tools such as computers, we must see that, rather than being the origin of the new paradigm, they are neither the origin nor the product, when the cause-effect dipole is no longer operative.

Therefore, our concept of "meta-" constitutes a hybrid condition that implies an appreciation of the "prior" + the "subsequent", not only in the sense of "post", but also in the sense of "with" and "alongside", based on the intermediate perspective of our time.

And all of this constitutes the starting-point of a future comprehensive research on the origins of the parametric architectural project, based on the hypothetical existence of an equally rich parametric pre-digital theory and history that has been barely explored. In this respect, we should not confuse meta-progress with just digital advance.

Keywords
System; Meta-system; Pre-digital; Parametric Architecture; Zeitgeist.

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Regarding the Importance of the Pre- in the Post-

In recent decades, interest in parametric projects has undoubtedly grown. Their strategies are customary, and based on this, creative and research horizons have increased, and outstanding works have been designed.

We, convinced of the importance of the parametric in architecture, are interested in a different matter from the opportunities provided by the digital tools: the hypothetical consideration of a rich pre-digital parametric theory and historythat has been barely explored.So,we call for a review of everything that is "aside what is well known, and yet constitutes tradition, and also the substance for progress" (Unamuno, 1895/1916).

Parametric thinking in architecture precedes software. This is explained by Mellaartin relation to housing in the first city in history, Çatalhöyük (Mellaart, 1967), or by Gage in relation to Ancient Greek architecture (Gage, 2012). We might also consider Cache on the theme of machines in Vitruvian treatises (Cache, 2003), or Soler when he defines Gaudí as one of the first parametric architects, showing that the traditions underpinning parametric design are veryold (Soler, 2013),and Kontovourkis who confirms that "computational form-finding techniques follow the pioneering work on physical models conducted by Gaudi" (Kontovourkis, 2019).

And for thestarting-point of our exploration, it is important to observe the evolutionary nature of the systemic character. This shall be the focus of this paper:reviewing the process for the preparation of system thinking,which will lead to the contemporary parametric and systemic architecture, to clarify its changing notions and influence on our view of the world and our view of architecture.

We shall start from the moment in which the reductionist models of science defined by Galileo, Descartes orNewton were no longer sufficient, and other forms of complementary thinking were required.

Methodologically, we propose a review of a selection of texts on the evolution of philosophical trends regarding the system. We shall consider the Foucauldian approach, based on two techniques: archaeology and genealogy. The archaeologist is the archivist who builds the memory of previous testimonies with symptoms of present, whilst the genealogist raises questions, seeking to show the conditions (more than just the origin) that madepossible the new discourses(Foucault, 1988).

Our purpose will be to build a new interpretation, aside computers, because without the critical reflections it provides, processes become just another exercise in technological skill.We trust that this awareness will help to place the parametric question within a broader context, to gain a better perspective of the future.

The Meta-systemic Approach

First of all, we must explain what we mean by a "meta-systemic approach".
Unlike the scientific method, which only perceives parts of the world in a decontextualizedmanner, systemic thinking is based on the perception of totalities, to express the

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Figure 1.
Gaudi's catenary model at Casa Milà. EtanTal.

Source Fig.1: https://en.wikipedia.org/wiki/Catenary>[consulted: 31st May 2019

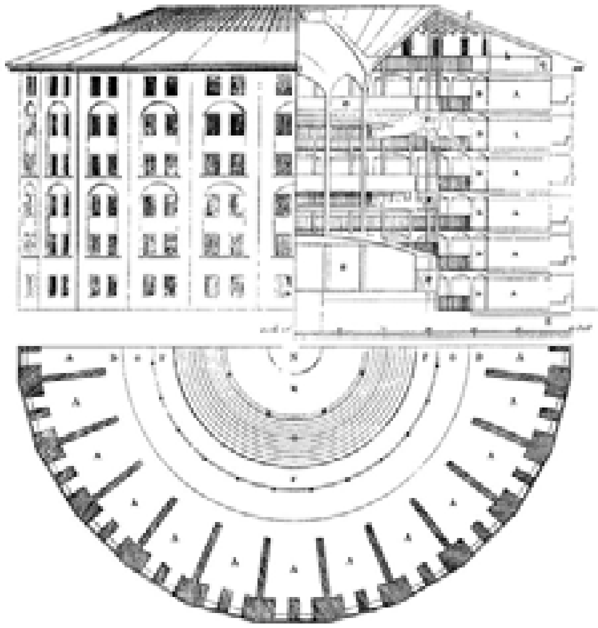

Figure 2.
Plan of panopticon prison, as drawn by Reveley in 1791. The works of Jeremy Bentham Vol. IV, 172-3

Source Fig.2: .<https://en.wikipedia.org/wiki/File:Panopticon.jpg> [25thNovember 2019]

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interconnected aspects that constitute it, and to describe the design through an exploration of relationships.

Etymologically, "1610s, "the whole creation, the universe," from Late Latin systema "an arrangement, system," from Greek systema "organized whole, a whole compounded of parts," from stem of synistanai "to place together, organize, form in order," from syn- "together" (see syn-) + root of histanai "cause to stand," from PIE root *sta- "to stand, make or be firm"(Online Etymology Dictionary, 2019).

And when there is an extension of the limits of a system, we say that we are in the presence of a meta-system: it turns out that a former system is now a more complex one, with new elements and links. Butas we stated above, this implies an appreciation of the "prior" + the "subsequent", not only in the sense of "post", but also in the sense of "with" and "alongside". Bourriaud's (2009, pp.53) 'The Radicant' book talks about a "nomadic" or fluid style of thought that is structured in terms of circuits and experiments rather in terms of perpetuation.

So, to our mind, the meta-system is a hybrid condition between systems and pre-systems: first of allwe are interpreters or architects of a world as a system, and then we go one step further in a new reading that coexists with the previous one, so that we maintain the position of the one who builds and is also built by what surrounds us.

This meta-systemic approach enables rethinking how we analyse and design the world andrespond to previously irresolvable problems. This establishes a new way of dealing with issues, not as part of a new theory[1], as Rosnay explains, but rather based on a different methodology that categorizes information by investigating the interrelationships between the elements in an organization (Rosnay, 1975).

This is closely linked to the meaning of meta-, because revisited systems start withthe deconstruction (in the Derridean sense) of the usual paths. They originate from the incorporation of qualities of tangled reality, intermingling "heterarchical" levels and sublevels, overlapping meanings (McCulloch, [1945/1989), achieved from a modern perspective, even when it has existed since Ancient times.

Rationalism and Scientific Method

Descartes developed his scientific method (1637) based on the logical and experimental study of phenomena, and the irrefut-

1. In this respect, although the first systemic approach dates back to the origins of philosophy, and also way back in science, it wasn't until the second half of the twentieth century that it acquired the guise of formal knowledge.

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able discernment of new mathematics: no longer as a metaphor for the cosmos, but as a scientific instrument for rigorous interpretation, decisively undermining the principles of knowledge until the end of the following century.

Through systematic procedures, new contributions have transformed human knowledge and huge advanceshave been made, accompanied by decisive changes in our view of the world. This is because science is influenced by the social, historical and cultural environment that shapes its methods, theories and contents,in this works in a reciprocal manner(Purves, Sadova, Orians, Hillis and Heller, 2003).

With the advent of Newtonian mechanics, effective machine logic shaped our conception of the universe: now as a regulated and predictable artefact operating through an exact numerical system that can be understood and encoded (Newton, Leseur and Jacquier, 1833).

A renewed design process thus emerged, a modern one, which abandoned formal rules in order to focus on the characteristics of functional organization, materials or on the dimensions of construction elements, etc. In this manner, the reflection on functional organization would lead to the Panopticon-Project, or those related to Galileo's limit(Tzoniset al., 1984).

And, thus, determinism as a doctrine explains that any phenomenonis the consequence of a cause, and in view of that cause, the phenomenon develops without possible variation, denying any possibility of contingency.

Laplace's demon would declare that, if the exact position and momentum of each atom in the universe were known, its past and future values could be accurately calculated (Laplace, 1798). Thus, we move from the observation and study of Ancient man to the precise scientific domain of Modern man.

Crossroads Science

However, exacerbated interest in this type of scientific judgment led to a disintegration in fields of study, in contrast to a more holistic view, which would be called "crossroads science"(Gerardin, 1968): contrary to reductionismof a specialized science, those of a crossroads science grow increasingly wide, contemplating a range of diverse ideas at the same time.

Holism investigates systems by focusing on how the components act within the whole. This is based on the notion of the whole as being more than just the sum of its parts. In order to achieve progress based on synthesis, we mustrevisit and recapitulatematters that were not previously considered together, but that now turn out to represent the reality much better.

TwoLinesofThinkingTowardstheContemporaryAge:Enlightenmentsciencevs.Romantic science

In addition to the above, sceptics with the prevailing logic also emergedwithin the dis-

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Figure 3a.
Perrault's Colonnade, Eastern façade of the Louvre. Jean-Pierre Dalbéra,. Perrault collaborated on it with Le Vau and d'Orbayto solve the engineering problems associated with the construction.

Source Fig.3a :https://www.flickr.com/photos/dalbera/4793076608/

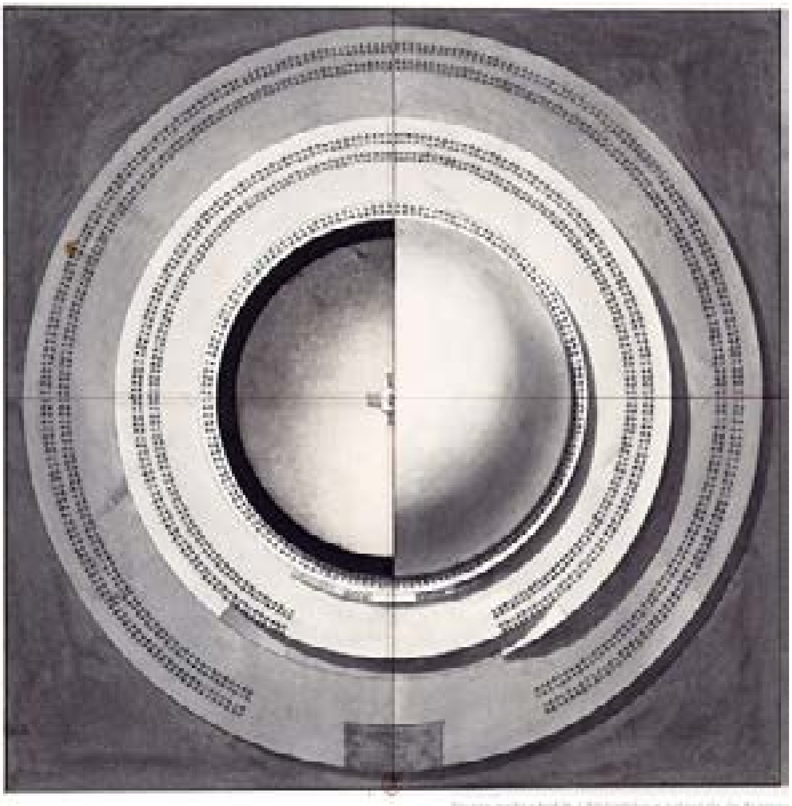

Figure 3b.
Boullée'sCénotaphe_de_Newton. Neoclassical features remain but also geometry and abstraction strongly marked.
Source Fig.3b: https://gallica.bnf.fr/ark:/12148/btv1b7701015b.r=boull%C3%A9e?rk=85837;2>[consulted: 25thNovember 2019

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course in relation to the senses: emotion, opposed to intellection (butequally essential for an understanding of the world and Mankind),also claimed its relevance.

In this sense, discourses arose in Europe, such as Condillac'sTraité des systems (1798), or Berkeley or Hume's ideas, and, at the end of the century, there was shift in interest towards sensory dominance, which can be perceived in Locke's ideas.

So we can witness two parallel visions: an enlightened science, and another more romantic science of expressive capacity, which travelled on different paths but were also interlinked, because although they may have seemed antagonistic, they didshare, as Tarnas explains,goalswith regard to questions such as the appreciation of the potential of Man within his context, forms of individualism, criticism of habit or an exploration of hidden structures in nature (Tarnas, 1991).

And between these two poles, architecture also progressed, so that while it stayed in touch with aesthetic aspects, it gradually granted more attention to questions such as ways of building; thus, for example, the tectonic approach of Perrault and, later on, that of Laugier.

It come across an assumption of the laws of mechanics and, later, an interest for living forms, as well as inherited visions of nature that are more poetic, leading to somewhat entangled step-by-step developments. As an example of the miscellaneous of these two visions, we might mention Blondel: a superlative example of academic rationalism, but also a thinker who revealed echoes of the expressive traditions of Ancient cosmic harmony. And what aboutBoullé, with his appreciation of architecture that is endowed with a capacity to move us, as reflected in Essai sur l'Art.

The Contemporary Era: Natural Science and Major Advances in Engineering

The Contemporary Era revealed, through the auspices of engineering, some extraordinary advances regarding new calculation procedures applied to fields such as geometry, mechanicsor construction, based on numerous theoretical and practical writings that brought descriptions of new technical approaches. For example, the famous Encyclopédieby Diderot and d'Alembert (1780), orDurand'sPrécis des leconsd'architecture(1802), presentedthe earliest formulations of the standardization of architecture.

Similarly, this was also a period of progress regarding the natural sciences. Lamarck defined biology as the study of living beings, and he explained evolution as a tendency towards complexity and progressive refinement, based on the inheritance of acquired characteristics and environmental adaptation,as well as the concept of use and disuse (Lamarck and Martins, 1873).

This is described by Collins,in the same sense as Sullivan's functionalist expression in the twentieth century, as "form follows function" (Collins, 1998, pp. 188): in our matter referring to formal aspects (Labrouste, Viollet-le-Duc or Gaudí, etc.), and to structural aspects (Sullivan, Wright, etc.).Later on, Thompson would also contribute to the idea that this inheritance is not exclusively responsible for morphology, given that it also depends on the forces exercised and the optimization of energy (Thompson, 1968).

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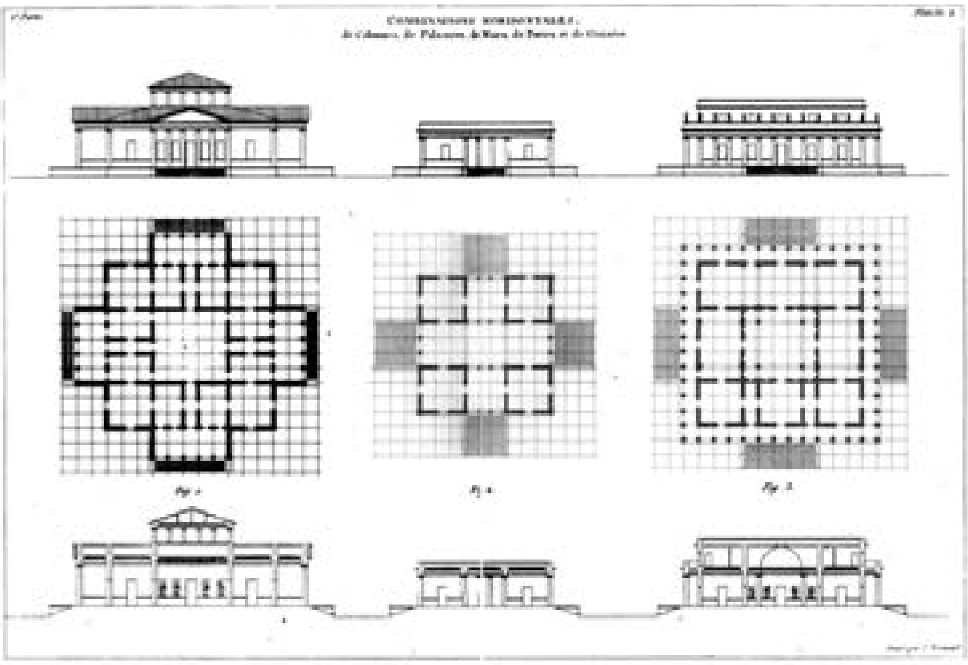

Figure 4.
Combinaisonshorisontales de colonnes, pilastres, mursportes et croisées
Source 4 in Durand's Précis des leconsd'architecture, 1802.

Figure 5.
Louis Sullivan's Wainwright Building, St. Louis, Missouri, emblematic for its famous maxim, "form follows function".
Source Fig.5: https://commons.wikimedia.org/wiki/File:Wainwright_building_st_louis_USA.jpg>[25thNovember 2019

Figure 6.
David's Charge to Solomon (1882), a stained-glass window by Burne-Jones and Morris, at Trinity Church, Boston.Morris explained that the 'diligent study of Nature' was significant, as nature was the example of God's design. He saw this as the spiritual remedy to the decay in social, moral and artistic standards during the Industrial Revolution.
Source Fig.6 https://en.wikipedia.org/wiki/File:David%27s_Charge_to_Solomon,_by_Burne-Jones_and_Morris,_Trinity_Church,_Boston,_Massachusetts.JPG

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In a similar manner to the developments that took place in the 17th century regardingmechanics, biology now reinforced a systemic view based on theconcept of the organicas opposed to the machine, and the question was transposed intophilosophy, art and architecture.

As of 1750 until 1900 and beyond, biological concepts became capital tools for interpretation and creation (Collins, 1998), and multiple perspectives developed from their notions,based on the empowerment of tectonic aspects and, simultaneously, the persistent discourse of the organism. In this regard, the first major contributions emerged around 1800, with Goethe or Schlegel's nature and architecture approaches, although they never explicitly used the term 'organic' to designate any kind of architecture. They were followed by Hirt, Morris or Ruskin.

Renewal of Architectural Concepts

So, the main architectural concepts were revised, now with afocus on logical structure and unitary attributes. The question would arise recurrently, even though the theory was still missing, and the discussion still took place within the framework of existing styles, based on an organicism that was non-stylistic at first and then, later on, one that expressed an analogy of form that reflected a certain style.

Consequently, after a certain point, Euclid's geometryand Newton's mechanics were called into question, based on a wider-ranging reflection that brought together previously dispersed disciplines that were now articulated.

Uncertainties that were previously ignored began to be explored, whilst the dualist, reductionist and mechanistic foundations were challenged, leading us towards the approaches ofSaccherius, Cantoror, later on,Poincaré. Any former predictability turned out to be false, and thus, mathematics and physics first, followed by biology, the social sciences and psychology, etc., made a stand against the Laplacian demon who ignored the emerging. Based on rigorous but freer interconnections, featuring precision but also leaving space for eventuality, the history of science was identified with the history of thought itself, because even when mathematical results were presented as eternal, they were understood and conveyed in cultural contexts (O'Shea, 2007, pp. 74).

Nonlinear Dynamics and the Impact on Architecture

And, in this manner, at the end of the 18th century, interest in non-linear questions arose: within a deterministic world, when all the details regarding the state of an event are known, things are predictable,but when the number of elements makes the equation more complex, the calculations become unattainable, and then it is essential to make estimations based on statistical methods, taking into account both chance and admissibility.

Society must continue to be founded on reason, but now must "not only deal with what actually occurs, but with the possibility of things happening in thismanner or

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otherwise"(Cruz Roche, 2012). And based on this possibility of a huge disparity in results, all obeying rigorous laws, anew conception of the relationship between calculus and geometry was proclaimed between the 18th and 19th centuries.

This was based on the idea of a mathematical function as an analytical expression consisting of certainties but also of possibilities, with the development of systems of equations and series theory, leading towards theThree-Body Problem, etc. Through this maze of chance, a series of possible regularities replace exact laws.

It was soon accepted that determinism only had a partial role to play in the modelling of reality, since different scenarios can emerge based on processes that are not entirely predictable.

The reductionism became too limiting to describe phenomena, and so work began on recognizing nonlinear patterns that focused on the exploration of interactions that led to the emergence of unwonted characteristics. Emergentists admit the existence of a single physical substance,but this is organized through processes at successive levels that emerge from one other, characterized by properties that cannot be reduced.
In the 19th century, geometry was considered the science of space, and arithmetic the science of pure time. Furthermore, the first non-Euclidean geometry was developed,building on the work initiated by Saccherius: this asserted the plurality of parallel lines that passed through a point outside a straight line, and then, subsequently, proclaimed the non-existence of these parallels (Saccherius, 1733). Thus, Euclidean geometry was reduced to the status of a special case within a more general repertoire, with a consequent weakening of the intuitionist view of mathematics.

The new geometries, which at first seemed outlandish to the real world, were those that best described the true architecture of the cosmos, and generated the idea that there is an irreducible uncertainty linked to probabilistics, quantum mechanics or Heisenberg's UncertaintyPrinciple (1927), etc. It was definitively concluded that determinism constitutedan incomplete picture, as would be demonstratedby Minkowskior Einstein.

And new science, which means that some complex phenomenon that was invisible to the science comes into its view now, and consequently, people's view of the world become to change,will lead to new architecture (Li, 2015).

The Path Followed by the Meta-systemic vision

Nevertheless, in 1917Thompson,in his work "On Growth and Form", addressingthe study of nature based on physical and mathematical tools for the first time, pointed once again towards the ideals of Euclidean geometry as being predominant in natural forms created by physical forces, because their laws favour simplicity as an optimal representation of those forces, he explained(Thompson, 1917).

Therefore: first, Euclidean geometry was considered by Kant as a form of pure a prioriintuition (Kant, 1781); and then by Russell as also a product of experience (Rus-

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sell, 1973); but then later, the concept was called into question by Gauss's multiplicity (Gauss, 2005);in which respect Poincarédeclared that there is no truer geometry, but only that which is more or less convenient for the world (Poincaré, 1905); and then Einstein dealt a definitive blow to Euclidean-Newtonian absolute space (Einstein and Lawson, 1920); and, yet, Thompson's biomathematics took up the ideals of Euclidean geometryagain (Thompson, 1968).And thus, as Spiridonidis explains, also the link between architecture and geometry transverses centuries and places and maps diverse forms of trust, dependenceor enquiring (Spiridonidis, 2019).

So, we come across avaried set of approaches that come and go, moving beyond the reductionist idea of orthodoxy. These areopen to an approach adapted to complexity, as part of an experimental search that analyses the conditions of possibility. They arenot certainties, but make up, rather, a huge debate, annulling those doctrines that seek any kind of discursive determinism or the imposition of certain propositions over others.

But in any case, there is always room for a renewed meta-systemic vision.

Conclusions and future work

Our review has enabled us to reach some significant conclusions, which reveal the significance of the knowledge of the pre- to gain a better perspective about the present and future, and also the early signs on the existence of a parametric pre-digital history which concerns us.

We can see that, although it is true thatsystemic concept has been incorporated into science in more recent times, they are not that recent in philosophical thinking, having been tackled since Ancient times.Starting with the earliest philosophers (aspects that Aristotle and Heraclitus had already sensed), andeven within the old reductionist debate on the foundations of modern science, we can find traces of new forms of reconsidered causality.

And so,the incipient definition, which is to sayan initial state or law that makes it possible to deduce future circumstances with certainty, has given way to a more liquid consideration, a meta-approach, departing from gradually obsolete positivist perspectives and moving towards holism and complexity theories, common in philosophy, science and architecture.

In architecture, the concept is also ongoing, understood from the beginning as a structure of interconnected formal relations: starting with the order of the Greek temple, to the patterns of each style within its corresponding time. However, within the field that interests us, we consider it to be more closely related to the concept of code. With ideas involving architectural space which more frequently distance themselves from long lasting materials and forms, or permanent definitions. In a scenario which progressivelyplaces architecture in a new pathos far from the old Vitruvian firmitas.

The evolutionary process does not play itself outin an invariably rectilinear manner,on the contrary, it passes through moments of agreement and negation, and then agree-

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ment again, moving backwards and forwards. Certain deviations are pursued in order to explore essential ideas, justifying the abandonment ofany discourse of origin-development-effect.

And thus, in an attempt to represent and explore this complex ambiguity, diverse approaches have emerged such as structuralism, logic and other branches that operate signs such as linguistics or semiotics, etc. We have moved from the machine to the biosphere, from causality to evolving contingency, from category to the pattern.

And even dating from long before the last unconditional confidence in linear approaches, even before computers, ourhistory is weaved with a confluence of pioneering attitudes, all of which added new knowledge and resulted in revelations leading to the pre-systemic era/ the systemic era/ and the meta-systemic path.

All this has had an influence on technology, with discourses being refined to introduce new symbolic languages that serve to create revolutionary artificial languages and algorithmic codes, granting absolute importance to the new digital architecture era.

However, as Lacasta explains, we should take into account the fact that although cutting-edge technological advances acquire importance when it comes to writing the history of the world, it seems legitimate to think that such advances are the product of a profound transformation in culture, and not the opposite.Thus, "if society makes so much effort to develop a tool as powerful as the computer, this would surely be the result of a prior need, because an awareness of change already exists. That is to say, wouldn'tthe personal computer be more a product of that new paradigm than the origin of it?" (Lacasta, 2010, pp. 7).So, he explained, in order to achieve understanding of tools of the present age such as computers, we must see that, rather than being the origin of this new paradigm, they are, in fact, one of its products.

Now, we add, they are neither the origin, nor the product at the end, when, as we explained, the cause-effect dipole is no longer operative at all.

And, although we have fully assumed the consequences of the revolution, we do not know in depth the conceptual path traversed of these transformations.In an uncommon scenario, ambiguous (a non-deterministic reading of the element, advanced (Albers, 1935)), today unthinkable, where the computer did not exist. Recognizing the object as a powerful cultural fact also aside the digital fascination.

This discourse featuring a parametric panorama weakened by an excessively digital affectation, arises as something of a problem when studying the matter at hand, andcould be the subject of a next paper.

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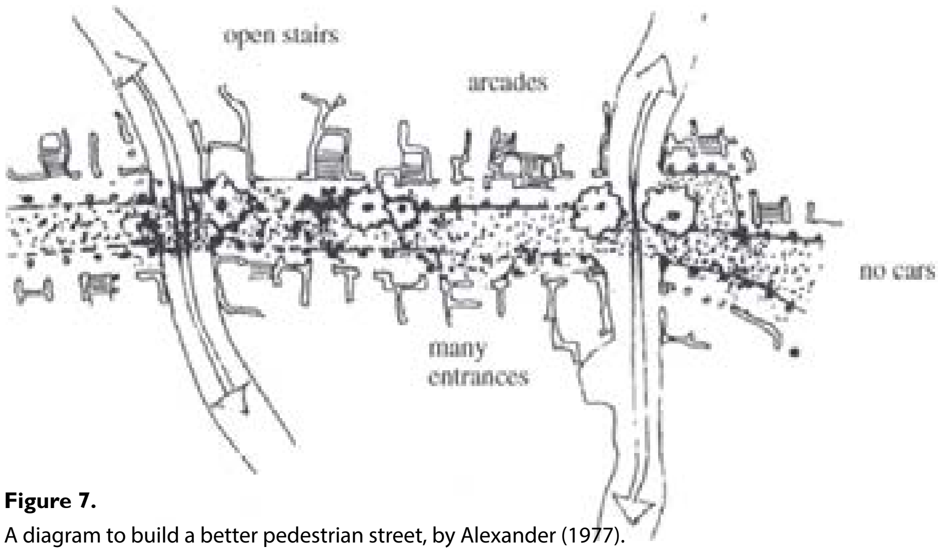

Figure 7.
A diagram to build a better pedestrian street, by Alexander (1977).

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