Aesthetica Preprint, n. 117, maggio-agosto 2021 ISSN 0393-8522 DOI: 10.7413/0393-8522064

Beyond the Organic Paradigm Biomorphic Digital Architecture

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ABSTRACT
This paper aims at a definition of the biomorphic paradigm that characterizes a significant part of contemporary architecture. This paradigm is clearly distinguished from the classical organic paradigm as it was initially outlined by F. L. Wright and represents a considerable development that must therefore be addressed in a specific way.
The paper will be structured in three distinct sections, organized as follows:
1. Conceptual definition of the organic paradigm, with main focus on the work of Frank Lloyd Wright.
2. Conceptual definition of the biomorphic paradigm in light of the overcoming of the classic organic model, in order to set a clear distinction between the idea, typical of the organic model, of integrating architecture and the natural environment, and that, here presented moving from a reference to Niemeyer's work, of an architecture capable in itself to expresses a natural morphology.
3. Contemporary developments in biomorphic natural architecture, demonstrating how the reproduction of natural morphology in the construction sector has undergone an extraordinary increase with the development of modern digital technologies.

KEYWORDS
Architecture, Organic, Frank Lloyd Wright, Oscar Niemeyer, Biomorphism

1. *The Organic Paradigm*

As much as the title of a famous writing by Sergei Eisenstein (2004), *Non-Indifferent Nature*[1], could be coherently understood as the enunciation, in the cinematographic field, of a Hegelian declaration, and in fact the dialectical nature of his theory of montage would confirm the hypothesis, so, if we were to summarize the conception underlying the model of organic architecture developed by Frank Lloyd Wright, we could resort to the label, anti-Newtonian and therefore, architecturally, anti-classical: *the non-indifferent space*.

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[1] See Ėjzenštejn S.M., *La natura non indifferente*, P. Montani (ed.), Marsilio, Venezia 2001.

What this means is made explicit in a sharp intuition of Bruno Zevi – not only the first, but probably also the greatest Italian interpreter of Wright's work – who, while presenting dodecaphonically (so he oddly states) a possible periodization of the architect's work based on a sequence of dynamic invariants, concludes his introduction with a paragraph entitled *Space-time of Einsteinian mark*, where he – directly quoting the German physicist – writes:

> Even space-time is likely to be turned into a dogma and a fetish. It must be understood that "space-time is not necessarily something to which a separate existence can be attributed, regardless of the actual objects of physical reality. Physical objects are not in space, but spatially extended. In this way, the concept of 'empty space' loses its meaning." Wright seems to translate literally, and confirms.[2]

A description of the cardinal principle that defines the metrics of organic architecture, from which all its other structural characteristics derive, is contained here in a nutshell. Only an incorporeal and abstract space, understood as the empty container in which things and phenomena are placed, can be governed by a rational conception that divides it according to a Euclidean-type[3] division where geometric forms, immaterial in themselves, become simple logical structures of composition that neither modify themselves together with the material development of the building nor evolve according to its perceptive dynamics.[4]

[2] Zevi B. (ed.), *Frank Lloyd Wright*, Zanichelli, Bologna 1979, p. 16. Einstein's excerpt reported by Zevi clearly sets out one of the cornerstones of modern physics. On the same length, the observations to be found in Heisenberg W., *Indeterminazione e realtà*, G. Gembillo (ed.), Guida, Napoli 1991, p. 100; my translation: "Newtonian theory renounces from the beginning the idea, obvious from Greek philosophy onwards, that space and matter can be connected to each other, for example in the sense that space is supported, so to speak, by matter, or that matter must be considered as the structure of space."

[3] Although it starts from a very debatable premise, the following Pierantoni's observation is an excellent synthesis of the static and at the same time abstract character of Euclidean metrics: "The remarkable indifference of Greek thought towards everything concerning dynamics is a proven fact. The masterpiece of Greek scientific thought are Euclid's *Elements*, in which only static and massless entities are articulated with each other by means of a complex hierarchical logical scaffolding that starts from the famous postulates" (Pierantoni R., *Forma fluens. Il movimento e la sua rappresentazione nella scienza, nell'arte e nella tecnica*, Boringhieri, Torino 1986, p. 141; traduzione mia).

[4] We first mentioned the fact that the dialectical approach of Eisenstein's montage is linearly Hegelian, implicitly believing that *non-indifferent* is only the *nature* whose process and whose concreteness depends on a spiritual act of the subject who poses and fulfills it; then it would be equally opportune to probe the relationship between the *non-indifferent space* of F. L. Wright and the Kantian space as pure intuition. If on the one hand it is true that Kant also subjects the Newtonian theory of absolute space to harsh criticism (space is transcendently understood as an *a priori* form of subjectivity, which is why spatiality is the subjective dimension of the constitution of phenomena, not an external extension of them, independent and therefore dogmatically indemonstrable), he nonetheless never abandons the formal purity of the Euclidean perspective: space is expressed in rational forms and does not coincide in any way with the material process of its own articulation,

The space of organic architecture, in other words, is not a mental space but a living space. In his famous lectures dedicated to the topic, Wright, not by chance taking up Lao Tze (together with the *I Ching*, the place that perhaps more than any other thinks in unity terms that the West tends instead to consider as incompatible, that is form *and* movement), conceives a critique of the concept of classic that goes hand in hand with a reformulation of architectural practice on a completely different basis: "The 'Classic' was more a mask for life to wear than an expression of life itself [...] Modern architecture– let us now say *organic* architecture – is a natural architecture – the architecture of nature, for Nature."[5] Consequently to this definition, the classical style is accused of being one "imposition upon our life" – "something *on* life"[6] – something therefore imposed from the outside in a false manner and therefore unsuitable for grasping the movement of life (which it would only aspire to stiffen in fixed and therefore unnatural forms). While classical architecture would obtain to bind the building to a specific function by formally disciplining it, that is, subjecting it to the rigor of a rational form, in the organic model "*Form and Function are One*"[7]: like a plant, whose existence coincides with the expression of its own form, the organic building is also a form of *con-crescence* whose formal development is as such an expression of a specific vital function (in the strict sense because each type of building is suitable for accommodating a specific human activity: work, education, recreation, housing, etc.).

The conception of the spatial dynamics of the building as a con-crescence that is both formal and material, could easily be connected to all those attempts which, at least from Goethe's *Metamorphosis of Plants*[8] onwards, have undertaken to theorize morphogenesis as expressive process (exempt from the need to go through negation and therefore not dialectical), assuming that the determining individualization does not arise from the action, on matter, of a logical-abstract moment, but is vice versa an expression of its own intrinsic forming energy. Examples of this approach, which could provide a coherent theoretical 'framework' to the or-

at the same time real and perceptive–what happens instead in the organic model which for this reason seems to me to recall, in a constructive sense, a metaphysically Aristotelian approach for which the form of phenomena does not lie in the mind that senses them but, as μορφή, is immanent in the becoming materiality of the thing essentially 'being.'

[5] Wright F.L., *Organic Architecture*, MIT Press, Cambridge, MA 1970, p. 3.

[6] Ivi, p. 4.

[7] *Ibid.*

[8] Goethe J.W., *La metamorfosi delle piante e altri scritti sulla scienza della natura*, S. Zecchi (ed.), Guanda, Milano 2008.

ganic model, are the distinction, made by Paul Klee, between *Form* and *Formung*[9], the pareysonian concept of *forming form*[10] and that, developed by Ruggiero Pierantoni, of *forma fluens*.[11]

Once the general characteristics of the organic model have been outlined, it is a question of going into more detail, specifying, in a more analytical way, at least those, among its most peculiar features, useful to indicate how, in Wright's architecture and in its many 'offshots[12],' the morphological dynamics and structure of the constructed object are conceived.

It is still Bruno Zevi, in a particularly relevant page of his pioneering *Towards an organic architecture* (1945), to enumerate, by compiling a highly effective scheme, the most salient features of the organic 'project.' Opposing it to the inorganic model of functionalism, Zevi argues[13] that the classical organic paradigm is characterized by (I summarize his position in the following points):

1. Advocating for intuitive rather than rigidly constructive works;
2. Preferring the naturalism of irregular forms to the abstract stylism of regular ones;

[9] "The formation (*Formung*) determines the form (*Form*) and therefore transcends it. / The form is then never to be considered as a conclusion, a result, an ultimate end; it is instead genesis, becoming, essence [...] / Good is the form as a movement, as deed: good is the active form, whereas bad is the form as rest, as an end. Bad is the form that you are subjected to, the finished form. Good is the formation, bad is the form, because the form is just an end, it implies death" (Klee P., *Teoria della forma e della figurazione*, M. Barison (ed.), Mimesis, Milano-Udine 2011, p. 169; my translation).

[10] "If this is the nature of the artistic process, we must say that the form, in addition to existing as formed at the end of production, already acts as forming in the course of it. The form is active even before existing; impelling and propulsive even before conclusive and satisfying; all moving before leaning on itself and gathering around its center. During the production process the form, therefore, is and is not there: there is not, because as formed it will only exist once the process is concluded; there is, because as forming it already acts once the process starts. Nor the forming form is something different from the formed form, because his presence in the process is not like the presence of the aim of an action which wants to reach a goal: if the value of such action lies in its adaptation to a predetermined goal, the value of the form lies instead in its adaptation to itself" (Pareyson L., *Estetica. Teoria della formatività* (1950-1954), Bompiani, Milano 2005, pp. 75-76; my translation).

[11] See Pierantoni R., *Forma fluens. Il movimento e la sua rappresentazione nella scienza, nell'arte e nella tecnica*, cit., pp. 124-158.

[12] Among the architects adhering to the organic model are, *entre autres*, Alvar Aalto (see Zevi R., *Storia dell'architettura moderna* (2 voll.) *Da william Morris ad Alvar Aalto: la ricerca spazio-temporale*, Einaudi, Torino 2004, pp. 221-232; Menin S., Samuel F., *Nature and Space. Aalto and Le Corbusier*, Routledge, London 2002; F. Moschini, *Alvar Aalto. Tra naturalismo nordico e razionalismo europeo*, in "Costruire", No. 100 (1977), pp. 1-8), Soleri P., *Itinerario di Architettura. Antologia dagli scritti di Paolo Soleri*, K. Ryan (ed.), Jaca Book, Milano 2003, pp. 43-73 e pp. 110-111), and Aaron Green (Henning R.C., *Aaron G. Green: Organic Architecture Beyond Frank Lloyd Wright*, Oro, San Francisco 2017). For a general account of the role of the organic paradigm and its proponents within the modernist movement, see Hess A., *Organic Architecture. The Other Modernism*, Gibbs Smith, Layton 2006.

[13] See Zevi B., *Verso un'architettura organica*, Einaudi, Torino 1945, pp. 66-67.

3. Being a growing organism rather than a mechanism structured according to an immutable order;

4. Preferring dynamic forms over static ones.

As clearly emerges from the set of references recalled and from the conceptual elaboration derived from them, also in the light of what emerges from the scheme proposed by Bruno Zevi, organic architecture is characterized by the fact that it conceives its own formal articulation not as an abstract stylization, geometrically purified and therefore independent from the forms of nature, but, on the contrary, as a mimetic morphology with respect to the living and therefore capable of maintaining, in the architectural field, both the polymorphic irregularity and the intrinsic dynamism of natural evolving shapes.

2. *The Biomorphic Paradigm*

A yet implicit – but unavoidable – question is the epistemological ground of the connection between organic model and natural forms: the relationship, mediated by science, between architecture and technology. There is no doubt, in fact, that a conception of architecture as formally and functionally mimetic to nature requires the ability, both in terms of design and construction, to know how to actually reproduce the natural morphology artificially, or, alternatively – and this is perhaps even more interesting – to know how to propose built entities which, while not directly imitating natural examples, are, so to speak, capable of posing themselves as natural: a new artificial form of nature made up of buildings whose function, whose morphology and structural 'metabolism', are able, having overcome the abstract rigidity of classical models (purely artificial in themselves), to express an autonomous vital tension.

This point becomes immediately palpable as soon as one compares the relationship with the natural world entertained, respectively, by an example of Frank Lloyd Wright's architecture and by a case of natural anti-Euclidean morphologism in the contemporary avant-gardes, such as, for example, in a canvas by Max Ernst.[14] It is clear that while painting, thanks to the ductility of the medium, can easily be-

[14] For a general overview of the relationship between nature and non-Euclidean forms in the context of abstract art, see Crowther P., Wünsche I. (eds), *Meanings of Abstract Art. Between Nature and Theory*, Routledge, London 2012. Specifically dedicated to Max Ernst and to the way in which he introjects in his work examples of natural geometry in direct relation to the way in which the sciences deal with it, see Stokes Ch., *The Scientific Methods of Max Ernst: His Use of Scientific Subjects from "La Nature"*, in "The Art Bulletin", 62/3 (1980), pp. 453-465.

come mimetic with respect to natural forms – which is why we have the recourse to arborescent textures, fungal porosity, alveolar cavities, leafy profiles, etc. – this is in no way true for architecture. Even in its best known and celebrated example, the so-called *Fallingwater* created by Wright in the Laurel Highlands region, near Pittsburgh, we are not witnessing a naturalization of drawing: on the one hand, nature is assimilated without intervention (exemplary, in this regard, the boulder on which the fireplace rests), on the other hand an admirable interplay of volumes, with floors that intersect in an irregular manner and which, projecting, penetrate the surrounding environment to extend the building beyond its constructive boundaries, abolishes any separation between building and natural context; but, in fact, it is an organic integration between architecture and nature, not yet an architecture truly capable of being formally and functionally nature – and this, in all evidence, not only for programmatic or poetic reasons, but because the materials of architecture at Wright's time, and the techniques for using them, did not make possible their completely anti-Euclidean remodeling. Hence, it is possible to observe that Wright resorted to a still essentially Euclidean drawing to obtain, in terms of the interaction between building and environment, and with regard to the internal movement of the volumes, the dynamics, as fluid and natural as possible, which he could not yet technically impose on the inherent rigidity of building materials.

Once the limits of Wright's approach and of the classical organic paradigm have been highlighted, given that, as we have seen, they aim more at integrating architectural forms into nature than at conceiving a real biomorphic architecture that expresses in itself forms equivalent to natural ones, it will be necessary to ask: When and how did architecture prove itself capable of taking the organic paradigm into something different and more radical? When and how, that is, we begin to glimpse the attempt to technologically free architecture from the Euclidean rationalism of classical forms to produce a movement that is effectively dynamic and polymorphic like that which characterizes the life and growth of natural entities?

A first example in this regard – and particularly significant because it implies a real change of perspective, which is reflected in a change of fundamental principles – is offered by the work of Oscar Niemeyer, and specifically by what he himself enunciates in his famous *Poema da curva*[15] that intends to act as a counterpart to what Corbusier wrote in his *Le poème de l'angle droit*.[16] As Paolo

[15] Niemeyer O., *O ser e a* vida, Editora Revan, Rio de Janeiro 2007, pp. 4-5.

[16] Le Corbusier (Jeanneret-Gris, Ch.-É.), *Le poème de l'angle droit*, Éditions Connivences Fondation Le Corbusier, Paris 1989.

Portoghesi brilliantly summarizes in his profiles of the Brazilian architect, "[...] Niemeyer will develop his language by identifying in the curved line its main qualifying element [...] In Niemeyer's architecture [...] the curves become essential, they are the way of reflecting the fluences of a boundless landscape, the taste for bodily and carnal beauty and the way of taking into account a tradition, that of the Baroque, to which we owe the extraordinary spatial qualities of the buildings in Ouro Preto".[17]

The association of the reference to the Baroque (more understandable if one thinks of the direct interests of Portoghesi as a theorist[18]) to the morphology of the landscape, makes us clearly understand how with the work of Niemeyer we are witnessing the ability, on the part of architecture, to express the whole variety – therefore also the dynamic irregularity – of natural forms without the need to simplify them into a rational order of Euclidean character based on the synthesis of the right angle. The "curve," in fact, in all its evolutions, is the element that, in the Brazilian's work, is delegated to this task: to acknowledge the morphology of nature even at the cost of incurring into a Baroque complication.

But precisely a complication of this kind is possible only on the basis of new technologies which, gradually – and Niemeyer represents a pioneering starting point in this regard – make it possible to model the materials of architecture on the basis of expressive needs that go beyond the capabilities of the classical-rational style that still governed the formal setting of the Modern Movement, especially if we refer to its more 'industrial' component, developed along the line that from the Deutscher Werkbund leads first to the Bauhaus and then to the American functional 'experiments' of Mies van der Rohe.

The technology we are talking about is obviously *reinforced concrete*, of which Niemeyer repeatedly praises[19] the plastic capabilities, apt to materially incorporating the sensuality of the curved shapes that generate its architecture. It is true, however, that the history of reinforced concrete[20] begins well before Niemeyer's work, first of all

[17] Portoghesi P., *Editoriale. Oscar Niemeyer*, in "Abitare la Terra", XI/32 (2012), p. 31; my translation. On the great Brazilian architect's predilection for curved shapes, see also at least Pagliano A., *Oscar Niemeyer. La geometria della forma*, FrancoAngeli, Milano 2011.

[18] Among all it is worth mentioning his two fundamental contributions to the history of Roman Baroque architecture: Portoghesi P., *Roma barocca*, Laterza, Roma-Bari 1973 and *Borromini*, Electa, Milano 1990.

[19] See for example the passages in Niemeyer where he expressly speaks of "a beautiful concrete curve" (Niemeyer O., *The Curves of Time. The Memoirs of Oscar Niemeyer*, Phaidon Press, New York 2000, p. 21), mentioning also "[...] the plastic freedom that reinforced concrete introduced. I was attracted by the curve–the liberated, sensual curve suggested by the possibilities of new technology" (ivi, p. 62).

[20] For a history of the evolution of concrete as a construction material, from antiquity to recent times, see at least Jahren P., Sui T., *History Of Concrete. A Very Old And*

with the engineering intuitions of the Perret Brothers and then with the revolutionary use that Corbusier was the first to make of this technology (a real 'manifesto' in this regard are two famous constructions: the first residential building built in 1903 with this innovative construction technique, in rue Franklin in Paris, followed in importance by the Garage Ponthieu of 1905, again by the same 'structural' engineer: Auguste Perret; Corbusier in fact will resort to reinforced concrete in a definitive way only for the project of the Maison Dom-ino, the 'scaffold-house', with slab ceilings suspended on the pillars – but we are already in 1914, therefore more than ten years after the Perrets' works).

But if reinforced concrete is already largely employed by Le Corbusier, and if even the aforementioned *Fallingwater* makes use of it, how does Niemeyer's accentuation of its 'curved manipulation' differ from these previous examples – a manipulation to which we could add a series of other consonant cases, from the anticipatory – and less known – Zarzuela Hippodrome designed in 1935 by Eduardo Torroja, to the famous Eero Saarinen's TWA Terminal at JFK New York Airport, recently converted into a hotel lobby (*sic*)?

The decisive difference is that while the ductility of concrete is used by Corbusier (at least up to Ronchamp, which however represents a turning point in his production) in accordance with the purist needs of the modern rational spirit, and in Wright it serves to operate a dynamic integration of the built body in the natural environment, only with the exasperation of the curvilinear performance of the material does the organic impulse turn into a *real biomorphic gesture* – and this is exactly what begins with Niemeyer and in parallel with the so-called 'jet age' aesthetics.[21]

Hence the classical organic paradigm cannot be extended to some of the most relevant innovations proposed by later architecture for at least two reasons:

1. Twentieth-century biomorphic architecture does not imitate natural forms, but aims to artificially produce constructions whose forms express in themselves an autonomous living quality: that is, biomorphic architecture is an autonomous, not imitative, technologically enhanced form of '*post-natural* nature;'

Modern Material, Chemical Industry Press, Beijing 2017. Exhaustive, in this regard, also the chapter *Constructive and Structural Elements in Reinforced and Prestressed Concrete* in Sestini V., *Architettura e tecnologia. Materiali ed elementi dell'organismo architettonico*, Alinea Firenze 2008, pp. 79-96.

[21] See Schwartz V.R., *Jet Age Aesthetic. The Glamour of Media in Motion*, Yale University Press, Yale 2020.

2. Natural are also inorganic forms: including mineral architecture, natural architecture develops the organic paradigm beyond the distinction between organic and inorganic.

This last point becomes decisive because it leads the organic model far beyond the naturalist approach that still characterized it in Wright's original version. In support of this reading, widely attested in the main examples of biomorphic architecture after the 1960s – and incomprehensible if not in relation to their antecedents, such as Niemeyer and Saarinen – it is possible to list the following particular cases (each of which would deserve an analytical treatment that here however it is not possible to carry out):

– Catalogs by Serrats[22], Rocca[23], and Tartarella[24] confirm the thesis, since the examples of natural architecture they collect include different projects inspired by inorganic entities.

– Otto Frei is known for his contributions to biomorphic architecture, which, as he himself argues[25] and as shown by the extraordinary contribution of Agkathidis[26], draw on natural architecture without distinguishing between organic and inorganic forms.

– Similarly, Herzog & de Meuron, in their *Histoire Naturelle*[27], refer not only to mineral models, but also to plant models, such as those portrayed in Karl Blossfeldt's photographs, as shows Ulrike Meyer Stump, *Modèles d'une géometrie cachée de la nature*.[28]

– Agkathidis' theoretical work is here of primary importance, because it unifies, in the category of biomorphic architecture, both mineral and generally inorganic morphology (chapter: *Water, Earth and Geological Formations*)[29], vegetal morphology (chapter: *Plants and Branching Systems*)[30], and animal morphology (chapter: *Animal Structures and Properties*).[31]

[22] Serrats M. (ed.) *Organic Architecture. Inspired by Nature*, Loft Publications, New York 2010.

[23] Rocca A. (ed.), *Natural Architecture*, Princeton Architectural Press, New York 2007.

[24] Tatarella F. (ed.), *Natural Architecture Now. New Projects from Outside the Boundaries of Design*, Princeton Architectural Press, New York 2014.

[25] See Barthel R., Burkhardt B., Frei O., *Natürliche Konstruktionen. Formen und Konstruktionen in Natur und Technik und Prozesse ihrer Entstehung*, DVA, Stuttgart 1982; Frei O., *Architecture et Bionique. Constructions naturelles*, Éditions Delta et Spes, Lausanne 1984; Frei O., *Gestaltwerdung. Zur Formentstehung in Natur, Technik und Baukunst*, Müller, Köln 1988.

[26] Agkathidis A., *Biomorphic Structures. Architecture Inspired by Nature*, Laurence King Publishing, London 2017.

[27] De Meuron P., Herzog J. (eds.), *Histoire naturelle*, Ph. Ursprung, Lars Müller Publishers, Zürich 2002.

[28] Cf. *ibid*., pp. 312-319.

[29] Agkathidis A., *Biomorphic Structures. Architecture Inspired by Nature*, cit., pp. 26-69.

[30] Ivi, pp. 70-107.

[31] Ivi, pp. 108-151.

3. *Biomorphism and Digital Technologies*

A few years ago a documentary by Sidney Pollack, *Sketches of Frank Gehry* (2006), got some success. In the scenes shot in the studio, it is clearly seen that the American architect's working method consists in outlining with a pencil, or sometimes even only sketching in a still very rudimentary way, wrinkling or folding the paper, highly irregular profiles that his collaborators, helped by specific computer technologies, are called to transform into complete architectural structures that can be viewed on a screen in all their details. Shortly before, in 2005, in a famous episode of "The Simpsons" called *The Seven-Beer Snitch*, where Frank Gehry appears, voiced by himself, he designs a concert hall for the city of Springfield ("the first city in America to abandon the metric system"!) from the re-elaboration of a sheet of paper randomly balled up and thrown on the ground. The example, of course, is ironic and paradoxical, but no less significant, because it directly highlights how modern digital technology makes it possible to develop, in the design field, forms and structures that would simply have been inconceivable – and therefore unattainable – with the tools of classical Euclidean design. It is no coincidence that Gehry himself created a company in 2002, Gehry Technologies, which optimized innovative tools in the field of digital architectural design (later also extended to manufacturing and aerospace industry), among whose commercial products should be mentioned the development of extremely functional software, so much so that over the years some of the largest architectural firms (including Diller Scofidio + Renfro, Herzog & de Meuron, Jean Nouvel, Coop Himmelb(l)au, and Zaha Hadid) have become his customers.

Although unsophisticated, the example allows you to quickly focus on how, in recent decades, the reproduction of natural morphology in the construction sector has undergone an extraordinary increase with the development of modern digital technologies. Biomorphisms, reticular structures, tensostructures, and fractal geometries can be planned in an exact and functional way only using modern digital design systems. The scientific contributions in this regard are innumerable: in addition to Agkathidis, for fractal architecture refer to the chapter *Nature's Order and Its Architectural Embodiment* in Harris' *Fractal Architecture*.[32] As for an analytical report on digital models for natural architecture, the contribution

[32] Harris J., *Fractal Architecture. Organic Design Philosophy in Theory and Practice*, University of New Mexico Press, Albuquerque 2012, pp. 53-80.

of Buratti and Rossi[33] appears also to be essential. Regarding the geometric-mathematical approach to natural architecture, refer instead to Thompson[34]; Ball[35]; Costes, Godin, and Sinoquet[36]; Bucksch and Chitwood.[37]

This series of references thus demonstrates there is a peculiar link between digital technology and natural architecture, which makes clear how the construction of the post-natural anthropocenic environment[38] depends on the architectural implementation of a specific form of digital design. If the architecture after the Second World War was conceivable, using the famous category of Reiner Banham, in the framework of the *second machine age*[39], I here propose to think about the relationship between technology and architecture in the *third machine age*: the age of *digital device*.

An idea of this kind naturally allows for a series of criticisms, centered on the fact that an architecture whose design and construction forms are to the greatest extent dependent on the level of current technologies, therefore on digital ontology, risks flattening precisely architecture on the technical element alone, forgetting that architectural practice accomplishes the intersection of multiple factors – social, moral, conceptual – some of which are indeed in radical countertrend to its pure subjection to what, from time to time, one specific historical context can offer as the apex of the development of its scientific knowledge, *therefore*, consequently, of the technologies that derive from these. The references, in this regard, would be manifold, starting from a retracement of that dense series of works[40] that since the early decades of

[33] Buratti G., Rossi M., *Computational Morphologies: Design Rules Between Organic Models and Responsive Architecture*, Springer, Berlin-Heidelberg 2018.

[34] Thompson W., *On Growth and Form*, Dover Publications, New York 1992, pp. 912-933.

[35] Ball Ph., *Branches. Nature's Patterns: A Tapestry in Three Parts*, Oxford University Press, Oxford 2009, pp. 131-149.

[36] Costes E., Godin C., Sinoquet H., *A Method for Describing Plant Architecture Which Integrates Topology and Geometry*, in "Annals of Botany", No. 84 (1999), pp. 343-357.

[37] Bucksch A., Chitwood D. (eds.), *Morphological Plant Modeling: Unleashing Geometric and Topological Potential within the Plant Sciences*, Frontiers Media, Lausanne 2017.

[38] For a discussion of the modern concept of the anthropic environment, within which, as strongly emphasized by the theory of the Anthropocene, every possible distinction between nature and culture falls away, see the classic observations of Latour B., *Nous n'avons jamais* été *modernes. Essai d'anthropologie symétrique*, Éditions La Découverte, Paris 1991.

[39] Banham R., *Architettura della Seconda Età della Macchina*, M. Biraghi (ed.), Mondadori Electa, Milano 2004.

[40] Among others, an unavoidable set of references would be: Anders G., *Die Antiquiertheit des Menschen* (2 voll.), Beck C.H., München 2018; Heidegger M., *Die Frage nach der Technik*, in Id., *Vorträge und Aufsätze*, F.-W. von Herrmann (ed.), Vittorio Klostermann, Frankfurt am Main 2000, pp. 5-36; Jünger F.G., *Die Perfektion der Technik*, Vittorio Klostermann, Frankfurt am Main 2010. More recently, the following approaches deal critically with the relationship between architecture and technology, highlighting the

the twentieth century have critically addressed the alienating and dehumanizing impact entailed by integral adherence to processes of technological elaboration of the 'being'. From this point of view, the thematization of the concept of *Ort* by Heidegger in the famous *Bauen Wohnen Denken*[41] remains a sure point of reference, which attempts to release the making of architecture from the set of techniques supervising its realization.

How to answer to this criticism? It is believed that this would be valid only when an architecture conceived on an exquisitely technical basis would be opposed to nature according to the distinction between organic and artificial, therefore between biological (or natural) and technological. But this is not what is being theorized here. The reference to the possibility of post-natural architecture should in fact indicate another perspective: post-natural is that architecture that *no longer* materializes in the epistemological context of a distinction between nature and artifact.

The role of modern technologies, in fact, is not to produce apparatuses or forms of existence that oppose natural entities, supplant them or nihilistically intend to threaten their survival (this, if it was ever true, happened when technology went through its analog and mechanical phase). Digital technology, on the other hand – and this is what clearly emerges in the context of the development of artificial intelligence – aims to incorporate life into a hybrid form of a technologically enhanced organism, capable of making use of a highly technological performativity without rejecting its own characteristics of a living being.

Everything that has been said has very impactful repercussions on the ecological discourse, which go well beyond the architectural sphere. Ecology does not exclusively envisage the design of environmentally-friendly buildings based on sustainability. If, as it happens with the Anthropocene, the threshold of distinction between natural and artificial is lost and if, in the model of natural architecture I propose, it is no longer possible to speak of a clear demarcation line between organic and inorganic, it will then be necessary to begin to think of the architecture of the future as a practice capable of producing nature itself[42]; or, better: capable of producing world beyond the distinction between nature

nihilistic implications, on the ethical and social level (La Cecla) and on the metaphysical one (Severino), of an integrally technical twist of architectural epistemology: La Cecla F., *Contro l'architettura*, Bollati Boringhieri, Torino 2008; Severino E., *Tecnica e architettura*, Raffaello Cortina, Milano 2003.

[41] Heidegger M., *Bauen Wohnen Denken*, in *Vorträge und Aufsätze*, cit., pp. 145-164.

[42] See, on this regard, Chiambaretta P., Huyghe P., Sassen S. (eds.), *Stream 03. Habiter l'Anthropocène*, Art Book Magazine, Paris 2015, p. 116.

and culture. Natural architecture is not only integrated within the environment, as in the classical organic paradigm, but – by operating a paradigm shift of the greatest extent – it is also capable of producing real natural environments. To do this, architecture uses, as we have seen, a specific digital technology. It is a planning form of digital ecology aimed at world-production, therefore at environment-design.

Bibliography

Agkathidis, A., *Biomorphic Structures. Architecture Inspired by Nature*, Laurence King Publishing, London 2017.

Anders, G., *Die Antiquiertheit des Menschen* (2 voll.), C. H. Beck, München 2018.

Ball, Ph., *Branches. Nature's Patterns: A Tapestry in Three Parts*, Oxford University Press, Oxford 2009.

Banham, R., *Architettura della Seconda Età della Macchina*, M. Biraghi (ed.), Mondadori Electa, Milano 2004.

Barthel, R., Burkhardt, B., Frei, O., *Natürliche Konstruktionen. Formen und Konstruktionen in Natur und Technik und Prozesse ihrer Entstehung*, DVA, Stuttgart 1982.

Bucksch, A., Chitwood, D. (eds.), *Morphological Plant Modeling: Unleashing Geometric and Topological Potential within the Plant Sciences*, Frontiers Media, Lausanne 2017.

Buratti, G., Rossi, M., *Computational Morphologies: Design Rules Between Organic Models and Responsive Architecture*, Springer, Berlin-Heidelberg 2018.

Chiambaretta, P., Huyghe, P., Sassen, S. (eds.), *Stream 03. Habiter l'Anthropocène*, Art Book Magazine, Paris 2015.

Corbusier, Le (Jeanneret-Gris, Ch.-É.), *Le poème de l'angle droit*, Éditions Connivences Fondation Le Corbusier, Paris 1989.

Costes, E., Godin, C., Sinoquet, H., *A Method for Describing Plant Architecture Which Integrates Topology and Geometry*, in "Annals of Botany", No. 84 (1999), pp. 343-357.

Crowther, P., Wünsche, I. (eds.), *Meanings of Abstract Art. Between Nature and Theory*, Routledge, London 2012.

De Meuron, P., Herzog, J., *Histoire naturelle*, Ph. Ursprung (ed.), Lars Müller Publishers, Zürich 2002.

Ėjzenštejn, S. M., *La natura non indifferente*, P. Montani (ed.), Marsilio, Venezia 2001.

Frei, O., *Architecture et Bionique. Constructions naturelles*, Éditions Delta et Spes, Lausanne 1984.

Frei, O., *Gestaltwerdung. Zur Formentstehung in Natur, Technik und Baukunst*, Müller, Köln 1988.
Goethe, J. W., *La metamorfosi delle piante e altri scritti sulla scienza della natura*, S. Zecchi (ed.), Guanda, Milano 2008.
Green, A. G., *Wright's Organic Architecture*, Frank Lloyd Wright Foundation, Scottsdale 2001.
Harris, J., *Fractal Architecture. Organic Design Philosophy in Theory and Practice*, University of New Mexico Press, Albuquerque 2012.
Heidegger, M., *Die Frage nach der Technik*, in *Vorträge und Aufsatze*, F.-W. von Herrmann (ed.), Vittorio Klostermann, Frankfurt am Main 2000, pp. 5-36.
Heidegger, M., *Bauen Wohnen Denken*, in Id., *Vorträge und Aufsätze*, F.-W. von Herrmann (ed.), Vittorio Klostermann, Frankfurt am Main 2000, pp. 145-164.
Heisenberg, W., *Indeterminazione e realtà*, G. Gembillo (ed.), Guida, Napoli 1991.
Henning, R. C., *Aaron G. Green: Organic Architecture Beyond Frank Lloyd Wright*, Oro, San Francisco 2017.
Hess, A., *Organic Architecture. The Other Modernism*, Gibbs Smith, Layton 2006.
Jahren, P., Sui, T., *History Of Concrete. A Very Old And Modern Material*, Chemical Industry Press, Beijing 2017.
Jünger, F. G., *Die Perfektion der Technik*, Vittorio Klostermann, Frankfurt am Main 2010.
Klee, P., *Teoria della forma e della figurazione*, M. Barison (ed.), Mimesis, Milano-Udine 2011.
La Cecla, F., *Contro l'architettura*, Bollati Boringhieri, Torino 2008.
Latour, B., *Nous n'avons jamais été modernes. Essai d'anthropologie symétrique*, Éditions La Découverte, Paris 1991.
Menin, S., Samuel, F., *Nature and Space. Aalto and Le Corbusier*, Routledge, London 2002.
Moschini, F., *Alvar Aalto. Tra naturalismo nordico e razionalismo europeo*, in "Costruire", No. 100 (1977), pp. 1-8.
Niemeyer, O., *The Curves of Time. The Memoirs of Oscar Niemeyer*, Phaidon Press, New York 2000.
Niemeyer, O., *O ser e a* vida, Editora Revan, Rio de Janeiro 2007.
Pagliano, A., *Oscar Niemeyer. La geometria della forma*, FrancoAngeli, Milano 2011.
Pareyson, L., *Estetica. Teoria della formatività* (1950-1954), Bompiani, Milano 2005.
Pierantoni, R., *Forma fluens. Il movimento e la sua rappresentazione nella scienza, nell'arte e nella tecnica*, Boringhieri, Torino 1986.
Portoghesi, P., *Roma barocca*, Laterza, Roma-Bari 1973.

Portoghesi, P., *Borromini*, Electa, Milano 1990.
Portoghesi, P., *Editoriale. Oscar Niemeyer*, in "Abitare la Terra", XI/32 (2012), pp. 30-33.
Rocca, A. (ed.), *Natural Architecture*, Princeton Architectural Press, New York 2007.
Schwartz, V. R., *Jet Age Aesthetic. The Glamour of Media in Motion*, Yale University Press, Yale 2020.
Serrats, M. (ed.), *Organic Architecture. Inspired by Nature*, Loft Publications, New York 2010.
Sestini, V., *Architettura e tecnologia. Materiali ed elementi dell'organismo architettonico*, Alinea Firenze 2008.
Severino, E., *Tecnica e architettura*, Raffaello Cortina, Milano 2003.
Soleri, P., *Itinerario di Architettura. Antologia dagli scritti di Paolo Soleri*, K. Ryan (ed.), Jaca Book, Milano 2003.
Stokes, Ch., *The Scientific Methods of Max Ernst: His Use of Scientific Subjects from "La Nature"*, in "The Art Bulletin", 62/3 (1980), pp. 453-465.
Tatarella, F. (ed.), *Natural Architecture Now. New Projects from Outside the Boundaries of Design*, Princeton Architectural Press, New York 2014.
Thompson, D'Ar. W., *On Growth and Form*, Dover Publications, New York 1992.
Wright, F. L., *Organic Architecture*, MIT Press, Cambridge, MA 1970.
Zevi, B., *Verso un'architettura organica*, Einaudi, Torino 1945.
Zevi, B. (ed.), *Frank Lloyd Wright*, Zanichelli, Bologna 1979.
Zevi, B., *Storia dell'architettura moderna* (2 voll.), *I. Da william Morris ad Alvar Aalto: la ricerca spazio-temporale*, Einaudi, Torino 2004.