

# Fractal Architecture

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**Abstract** – Research focuses on the recognition of the disposition of natural environment, which serves as an inspiration for cultural creation as it has always been in the history of architecture. Modern mathematical model of fractal geometry has been used to understand patterns occurring in the surrounding. The comparative analysis has been conducted between the abstract mathematical model and architectural composition in the view of contemporary cognitive paradigms. In conclusion, a hypothesis of a new ‘organic’ approach to an architectural elaborate design has been stated.

**Keywords** – Attention, complexity, new detail, perception, self-similarity.

Contemporary architecture is in the process of re-defining the meaning and a role of a detail and ornamentation. Changes in thought and, thus, artistic practice that started at the turn of the 20th century provoked a profound discussion upon human perceptive abilities and the role of attention. It even triggered manifests that regarded detail as crime. However, residues of puristic modernism are very often seen by non-professionals as overwhelming. New architecture, seemingly, seeks a form that has a simple but somehow elaborated structure: defined but not obvious.

## I. THE ROLE OF DETAIL IN THE PAST

It would be very hard to classify most of the buildings from previous centuries without a layer of an ornament, which used to serve as a decoration of few straight and simple planes such as walls, ceilings and floors. Thus, a value of architectural detail in defining an identity of artistic style was predominant. Virtually, “by style people meant ornamentation” [1]. Not only were those details subordinate to existing aesthetic values but also carried a load of re-interpretations of symbolism and affiliations particular to a period.

Huge revolt in the intellectual and artistic life that took place in nineteenth century, “against traditional systems in thought, in politics, and in economics, gave rise to attack upon many beliefs and institutions that had hitherto been regarded as unassailable” [2].

As a result, new stylistic manifestos occurred. In 1908 Adolf Loos presented an essay “Ornament and Crime”, where he repudiated an added ornament in architecture. Was this an aim against detailed elaboration of composition of a building? In the author’s opinion, it was rather against covering it with reliefs that referred to the obsolete cultural and social context.

Anyhow, modernism left us with numerous buildings, which are, in common recognition, better received from distance, or even more so – on an artistic black-and-white photograph rather than in the real life. The clarity and simplicity of a structure are very often regarded as overwhelming. Laymen tend to regard a gothic cathedral or a baroque palace as beautiful rather than a La Tourette Abbey near Lyon or La Cité Radieuse in Marseilles.

Alongside with general audience, the phenomenon mentioned above seems to concern a substantial number of professionals

as well. Moreover, the understanding of subtleness of abstract compositions of modernism is very often insufficient.

To support this anxiety, the author wants to present only one but exemplar case of recent modernization of very sophisticated architectural opus of modernism in Poznan: Collegium Novum of Adam Mickiewicz University. It was erected in 1968 according to the project of L. Sternal, W. Milewski and Z. Skupniewicz, the most recognised modernistic architects of Poznan. For many years it has stood untouched and due to that diminished in external appearance. For that reason, a decision for modernization (due to new climatic regulations) was made in 2011. Even though it can be seen as successful on the face of it, when one deepens the analysis, it is clear that it lacks a sense of the initial composition.

Design from 1968 was strongly vertical, with dispersed horizontal lines due to elaborated rhythm of concrete girders. After renovation dark lines were drawn at a surface to link horizontal lines, which resulted in impression of rectangles standing on one another. Latter composition may be regarded as fine design as the initial, though it is obvious that those two structures are considerably different.

The author proposes a statement that the change of appearance of the facade is a consequence of carelessness rather than consideration and that it shows that purity of modernistic compositions is rarely understood, not to mention the abstract concept of detail as part of a structure, as it can be defined in the given example.

## II. IDIOSYNCRASY OF CONTEMPORARY PERCEPTION

The author thinks that a human being possesses an innate (primordial) inclination towards complexity and details. Notwithstanding, it is not a matter of thought or consciousness, but rather a natural condition of the flow of stimuli that exists in the environment (defined as one that includes all three elements:



Fig. 1. La Tourette by Le Corbusier and Xenakis [9].



Fig. 2. Collegium Novum of AMU in Poznan (project from 1968 – left, renovation from 2011 – right) [10].

a subject, an object and a relation between them). As William James was willing to see it – ‘the stream of thought’ – “constantly changing, but continual flow of images, sensations, fragments of thought, bodily feelings, memories, cravings [3, 85]”.

This view is contrasted with an acquired (derivative) intellectual need for synthesis and reduction. That approach is rooted in systematic concepts that appeared in philosophy from Descartes up to Kant, who more or less took into account the dichotomy of subject and object, giving the former a power to perceive the latter using abilities of mind.

The author’s inclination towards the formerly presented view is a result of an observation of the natural environment as well as a result of a simple recognition that the changes that have already taken place in philosophical view, that of subject-object relationship, are irreversible and convert the basis of human creativity.

Since the contemporary notion of attention is defined as “a primary, although fragile tool to impose coherent and explicit forms of the scattered contents of consciousness” [3, 32], after being first regarded as a simple method of memorising information, nature of cultural creation has changed significantly. They are based on strong, though often transient emotions that enable inhibition of environmental stimuli and focus attention on the desired object. However, it is only natural that “attention is diverted from one thing and moved to another (...)If we wish to attract it to the subject, we must constantly seek something new in it, especially if other powerful sensations try to tear it away and distract” [4].

Modernised architecture is subject to the same phenomenon. It needs to be distinctive and eminent to serve as a stimulus that can provoke a discriminating attention. Nevertheless, since “buildings are heavy, expensive, and more or less permanent” [5], there is a justified desire to make them elaborate and complex, i.e., to focus person’s attention for a little longer. Moreover, an urban site is part of nearly everyone’s day-by-day perceptive environments; hence, the responsibility of architects to wisely compose their structures is relatively high. In order to make them more likely to be well-perceived, there is a huge potential in the quest for defined complexity not only in the determined algorithm but also in stochastic one.

It is highly expected that direct inspirations are likely to be found in the natural environment – as it is primal to cultural artifacts. However, the author’s intention is not to praise emulation of organic forms of nature. It is the intricacy of its abstract structure that can be fertile to follow.

### III. NATURE OF ENVIRONMENT

Nature was an inspiration for architectural design from the very beginning. For example, Egyptian columns of hypostyle hall at the temple of Amun in Karnak are in the form of papyrus with closed and open flowers. It was not only the forms that were imitated, but also a rule that open flowers would be in the place where more sunlight was.

Greeks based their orders on motives from the natural world as well: Ionic volutes, egg-and-dart, Corinthian acanthus, etc., became an ornament that was in use from Renaissance to Neo-classicism. Gothic architecture created a separate, very robust language of details inspired by the forms of plants and animals.

All these examples show how organic forms have always been present in the architectural design. Most of them though served as elements of decoration rather than a structure.

Nevertheless, architectural theory and practice is full of analysis of proportions that derived from the environment. The Vitruvian Man by Leonardo da Vinci or the Modulor by Le Corbusier setting standards of architectural harmony for centuries may serve as an example. The fact that the finest artists reached a deeper understanding of the rules of natural environment and were able to incorporate it in their design is a sign that the multidimensional analysis of nature gives a promise of a sense of order.

There is one more aspect that is apparent while analysing the rules of natural world: forms of nature are conducted by certain proportions, indeed, but exhibit a recurrent complexity. Nature usually does not have the simple figures in its structure. Classical (Euclidean) geometry failed to serve as a tool to depict it: “We’ve got nothing to describe this with: clouds are not made with straight edges, trees are not circles, they are not triangles, they are something very very different, indeed, but there is a continual kind of a pattern that I can see as I look at the edge of the rising cumulus cloud” [6].

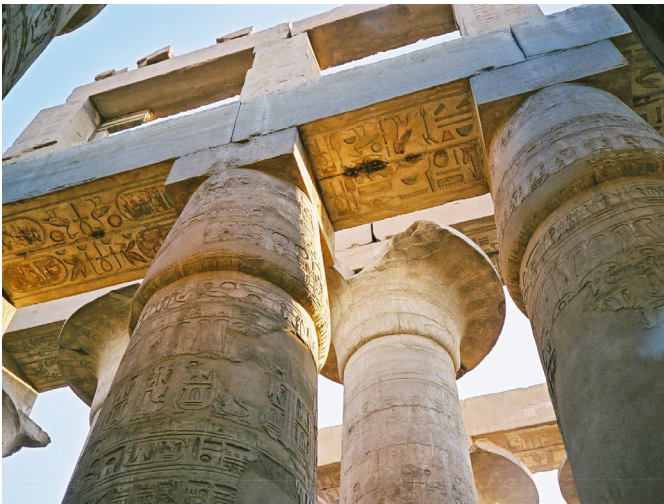


Fig. 3. Great hypostyle hall – Karnak [11].

That might be the reason why a classical geometry is perceived as cold and dry [7, 1]. While there is not only one geometry anymore, and scientists along with artists are not at the exclusive mercy of Euclidean paradigm, it is vital to explore more suitable mathematical concepts that can help in describing the surrounding world.

#### IV. FRACTALS AND CHAOS

Fractals were first fully described in 1975 by a French mathematician Benoit Mandelbrot, though a lot of iterated sets were known before: Cantor set (1883), Koch snowflake (1904), Sierpinski carpet (1915) and others.

Those objects were first “regarded as ‘pathological’... as a ‘gallery of monsters’ kin to the cubist painting and atonal music that were upsetting established standards of taste in the arts at about the same time [7, 3].” While being seen as unnatural, this geometry gave images that showed surprising similarities with elements of nature. Moreover, some physical models are fractal, e.g., the Brownian motion.

Mandelbrot coined a neologism *fractal* for two reasons: to point out its fragmented structure and to put it in opposition with the notion of ‘algebra’ (that derives from the Arabic *jabara* = to bind together) [7, 5]. Fractal is a self-similar geometrical object, whose fractal dimension exceeds its topological dimension. It can be constructed by iterated function systems using affine transformation.

Because of self-similarity fractals are so promising in providing information about the natural world. Self-similarity “often occurs in branching structures in nature” [8]. As long as complexity of the environment was not possible to be described, it was not accessible to a reasonable analysis. When a mathematical model maps that complexity and shows that its beauty may lie in that self-similarity, one can presume that this virtue deserves the analysis of an artist, an architect.

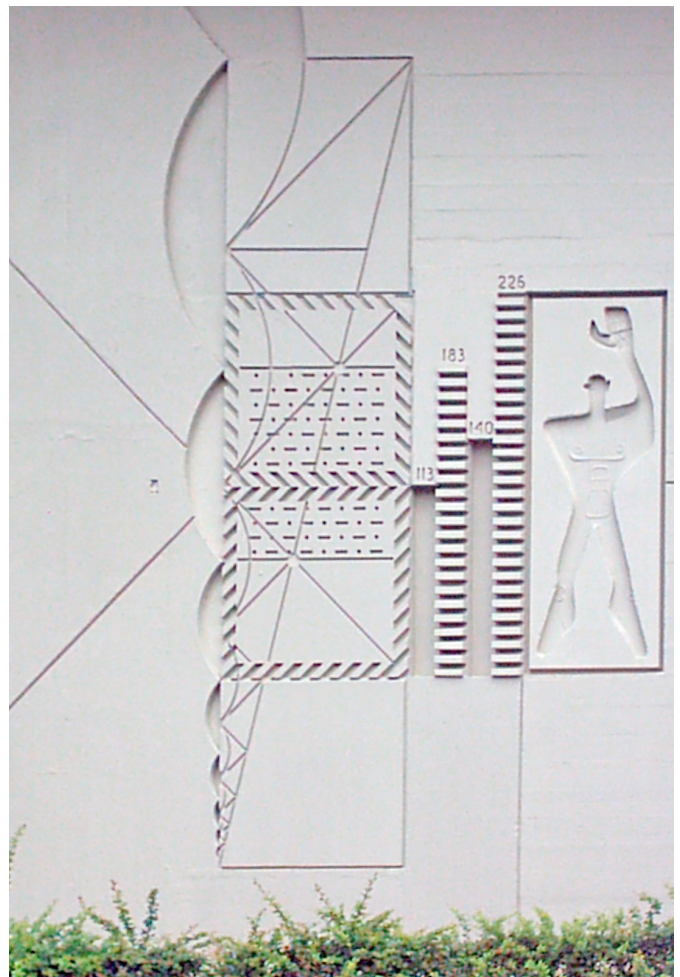


Fig. 4. Le Corbusier's Modulor on Berlin [12].

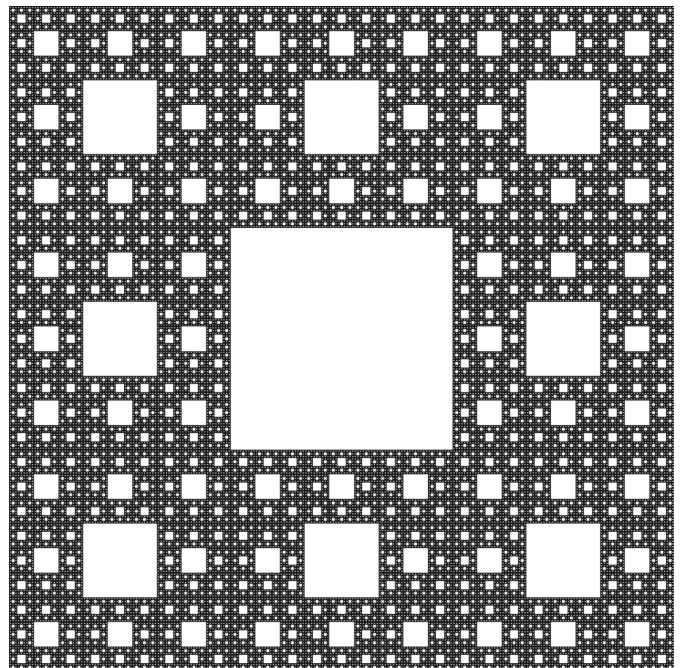


Fig. 5. Sierpinski carpet [13].

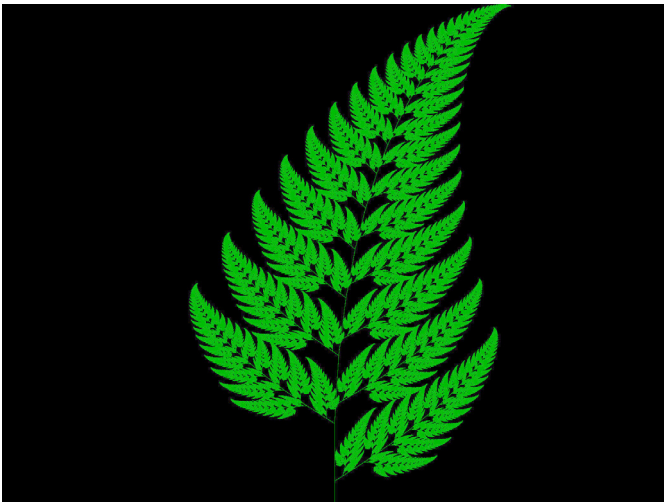


Fig. 6. Barnsley Fern [14].

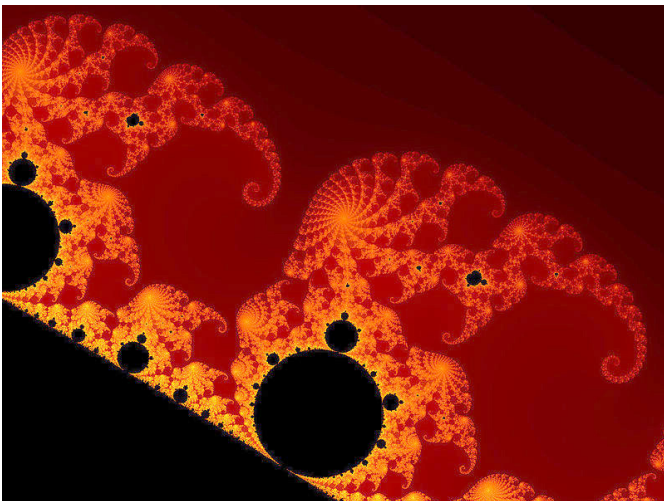


Fig. 7. Mandelbrot set [15].

### CONCLUSIONS

Contemporary architecture is conducted by a need for self-justification. There is no singular model of proportion, symbolism or pattern that can serve as a module for composition. Although polymorphy of patterns (notions), as Derrida proposed, is a consequence of deconstruction made within an existing structure of patterns given as a common belief, it is now architect's interpretation or even independent construct that is a base for a composition.

Self-justification, a primary rule of a composition of a building, can be very simple. Nevertheless, there is a very high potential when the rule generates a complex structure that is self-similar and somehow infinite. All these characteristics are immanent for fractals, which are not only another shapes in classical geometry, but are distinguished phenomena that open one's mind to nonlinear (chaotic, but non-random) complexity and new abstract modules for compositions.

Moreover, a fractal approach can help in re-defining a role of detail in architecture. This model shows how 'organic' is to treat particular elements of architectural composition on a different

scale as an integral entirety that can follow the same idea, same principles.

This is presumably a way to construct a building that is elaborated and simply coherent with itself and, thus, presenting a sense of order that can attract the attention of a modernized observant for longer than an instant.

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