The Fatal Birth of Architecture: The Obligation of Order

Renato Saleri

Abstract Creative processes in architecture and design are often accompanied today by a complete set of assistance tools inspired by biomimetic heuristics. Based on processes that took billions of years to set up, some formalisms now allow us to quickly explore vast areas of solutions. For example, they are able to optimize the optimum of a function in a reasonable time when there is no exact method or when the constraints given at an input are antagonistic. When not in a logic of multi-criteria optimization, one can also look for, among the innumerable creative supports offered by geometry or mathematics, those that will be best able to accompany the designer during the initial phases of conceptual exploration. We could of course rely on purely combinatorial logics while being sure to find—among the infinite possibilities offered by a universe number for example (Π, $\sqrt{2}$…)—a solution to our problem but in temporalities that would go far beyond the life of the cosmos itself. Among the experiments conducted by the MAP-Aria laboratory for nearly 20 years, many have relied on bio-inspired heuristics, others have tested combinatorial logic—without much hope—and finally some combined the most recent advances in Computer Vision and shape recognition to try to understand the artist's gesture and the notion of reproducibility or ownership of an artwork. These crucial questions consider the essence of the creative process itself and search the remaining place of the human being in the reduced free space left by the "thinking machines" of today and tomorrow.

Keywords Digital generative tools · Formal grammars · 3D modeling

1 Context

Over the past twenty years, the considerable growth of digital tools has enabled the emergence of technologies capable of imitating and reproducing human behavior in an increasingly autonomous way. Initially conceived as artifacts capable of repeating tedious tasks over and over in order to give humans complete freedom to focus on

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more interesting activities, our contemporary societies are seeing the emergence of a large number of tools capable of assisting us in our daily actions. They are now equipped with behavioral autonomy and are increasingly able to make decisions for us. We've come a long way since the first automatons, designed to reproduce a sequence of predetermined actions, and the devices capable today of potentially replacing humans cognitive faculties. But although the idea of "artificial intelligence" already emerged in the early 1950s in Alan Turing's now famous paper "Computing Machinery and Intelligence" (Turing, 1950), it is certain that—even today—one wonders whether a machine is really capable of thinking.

> Poetry is not only in the verb. The poetry of facts is even stronger. Objects that mean something and are arranged with tact and skill create a poetic fact. [1]

2 The Fatal Birth of Architecture. the Obligation of Order [1]

Architects did not wait for computers to rely on formalisms able to accompany the creative process: "*The regulator layout is an insurance against arbitrariness. It is mind soothing*" [1]. Beyond this assertion, which in our opinion frames the act of thinking a little too closely, it is true that not everyone can or wants to systematically resort to the "*deregulation of the senses to reach the unknown*" (from A. Rimbaud, letter to G. Izambard—1871: in French: "*Il s'agit d'arriver à l'inconnu par le dérèglement de tous les sens*"). "*The regulator layout is a path; it is not a recipe. Its choice and its modalities of expression are an integral part of architectural creation […] by establishing the preeminence of the initiatory trace, bearing the seed of the form and capable of guiding it in its slow maturation towards its finalization*" [1]. The deep harmony of a work cannot, however, be summed up in the beams that seem to fit happily around the guidelines of its composition, and besides "*it would be quite possible, by multiplying the points of reference and without specifying the acceptable margin of error, to always find what one presupposes*" [2].

We must understand that the regulator layout is a mediator between the abstract space of geometry and the concrete space of the project. Set aside the countless contemporary ramblings that force the function within the form, for the sake of the purity of the mathematical or geometrical expression source of its birth. Many of them flourish abundantly on the covers of fashionable magazines, but very few of them delight the users who borrow them. Moreover, one cannot be extremely sure either that the final project—however finite it may be—has reached its full maturity: one could only be happy with a state of "satisfactory incompletion" that best meets the programmatic and functional constraints defined at a given time, but that is another debate…

Thus, if we consider N. Salingaros short essay "*The visceral experience of architecture: object affordance and our need to grasp our surroundings*", we can multiply the geometrical abstractions that will seduce the observer's gaze, but we will have to

look elsewhere for the rules of composition that will allow us to satisfy our need for inner order:

> Human beings respond to spaces, surfaces, detail, and ornament viscerally, which determines how a built structure will actually be used independently of whatever the architect intended. [3]

But how to detach the reasoned perception of the architectural object from what could trigger a most profound accomplishment?

> By analogy, we can identify primary elements of architecture that are responsible for exerting the strongest influence of form and space on users. What we normally perceive as "architecture" is the surface of nested layers of a complex cognitive/response system. Less obvious but still primary (or primal) aspects of a building or a space influence our physiological and psychological responses: the success of a building or an urban space depends much more on these primal elements than on an intellectual analysis of its visible structure. [3]

And, according to Rudofsky:

> Without mentioning the first fifty centuries of its existence, historians present us with a well-ordered panorama of accepted and recognized architectures, which is as arbitrary a way of conceiving the art of building as if, for example, we were to trace the history of music back to the birth of the symphony orchestra. The forms of certain houses, sometimes handed down through a hundred generations, seem to be eternally valid, as are the forms of the basic tools. [4]

Let us here quote Voltaire who, with his famous sentence: "*Never use a new word unless it has these three qualities: necessary, intelligible, and sonorous*", denounces the gratuitous substitution of a word of use by another word which would have only the merit of novelty: "*it is not enriching the language*," he says, "*it is spoiling it*."

In architectural design, creativity is both a myth and a taboo. For a long time, many researchers have been interested in the inadequacy of design assistance tools in terms of creativity and autonomy. To quote J. P. Chupin who himself invokes the work of D. Shön:

> …architects are far from paying equal attention to process and product. If the introduction of information technology does not certainly increase the architect's creativity in his mission, most CAD software behaves like over-equipped drawing assistants: they presuppose both the maturity of the designer and that of the object of his design. To make full use of the potential of digital tools it is not enough to increase their ability to simulate materiality, but at the same time it is important to take over the relationship with the body they anaesthetize. [5]

The essence of the black box at the origin of the creative process cannot thus be altered other than by the mobilization of "*situations to think*", the only ones capable of stimulating the creative process by "successive jumps of intuition". Again, according to D. Shön:

This does not mean that computers are of no use, no assistance in design. Instead, we suggest that research should focus on computer environments that increase the designer's ability to capture, store, manipulate, organize and reflect on what they see. [5]

Beyond cognitive faculties, a question that arises today concerns precisely the ability of an artificial system to assist us in "creative" disciplines. Without wishing to supplant inspiration, we are now seeing the emergence of many tools capable of accompanying conceptual exploration, a fragile phase if ever there was one, because it comes from a set of cognitive processes that would be able to understand and produce an indefinite number of new processes. Serendipity, which is frequently used in the creative context to designate a form of intellectual availability, fortuitously brings rich teachings from unexpected discoveries or errors. Moravec's paradox establishes that often what is difficult in robotics is easier for man (and inversely, what is difficult for humans seems quite easy to computers…): we enter here into the dark space of a black box in which even the most optimistic predictions do not foresee an artificial intelligence supremacy before many decades. Let us consider instead the phenomena that are still poorly understood concerning the interpretation of intelligible data by the human brain, and in particular those with which, in our field, it is interesting to play. It is not a question of replacing creativity with an artificial cognitive process, but of understanding the levers by which a digital medium is capable of opening the doors of perception.

Malevitch's arkhitectons. From 1923 to the early 1930s, Kasimir Malevich produced several three-dimensional models, assemblages of abstract forms which appear similar to models of skyscrapers, called "arkhitektons". The drawings accompanying the construction of the models are called "planits". The arkhitektons are mostly white plaster models made up by several rectangular blocks added one to another. Usually a central bigger block is the main compositional element and smaller parallelepipeds are progressively added to it. No function is shown or translated into form, the final shape being the pure result of assembling abstract masses vertically or horizontally. With their spatialization of abstraction and their formal non-objectivity, the arkhitektons embody Malevich effort to translate the suprematist principles of composition to three-dimensional forms and architecture.

> In a series of prismatic, quasi architectural sculptures (which he called 'Arkhitektons') [he] sought to demonstrate the timeless laws of architecture underlying the ever changing demands of function. (…) Malevich's Arkhitektons resemble early De Stijl compositions in which ornament is non-figural and 'form' and 'ornament' are differentiated only by scale. These studies are purely experimental and the buildings have no function and no internal organization. [6]

Responding to the issues stated by Malevitch in his supremacist manifesto, these formal games not only appeal to interpretative shifts due to their plastic ambiguity but also herald—perhaps unintentionally—the rise of those recursive formalisms that today are called "fractals".

> At the same time, we are discovering that traditional wisdom embedded in the built environment contains many of the design answers we now seek. Our ancestors who built towns and cities had an intuitive idea of which environments were more accommodating emotionally, and more healing (Alexander, 1979; Alexander et al., 1977). The tools they used to evaluate them were their own direct senses. [3]

The tools we manipulate for conceptual support should therefore be more attuned to the deep resonances of our sensory biology. We can sense that juxtaposed relative quantities or judiciously superimposed tracings are at the origin of unexpected perceptive phenomena—such as optical illusions for example—or visually satisfying phenomena; this perception seems to be universally shared by all observers since time immemorial. Certain harmonic relationships, whether musical or geometric, arouse common feelings in most human beings and it has been shown that certain sensory stimuli seem to favor the development of plant species.

The observation of the growth phenomena of living organisms can thus largely inspire generative processes designed to be attuned to their ecosystem, whether natural or artificial. In this, we can draw on the cumulative experience of thousands of generations that have succeeded in adapting their evolution to the constraints of the environment in which they evolved. Is it not a universal mechanism to be able to adapt to the environment around us? Bjarke Ingels, from the BIG agency, sees the possibility of a kind of "**architectural Darwinism**" emerging within the decision-making groups that bring the idea to its concrete conclusion. Let us broaden the field of application of this fundamental notion and imagine that all the solutions generated by humanity to respond to the constraints linked to its evolution are evaluated, cross-referenced, hybridized or discarded before being adopted and put to the test of time.

> Long before the advent of architects, architecture emerged from the place, the time and what you have on hand to build it. It is more a form of community production, not the product of a few intellectuals or specialists, but of the spontaneous and continuous activity of a whole people, custodian of a common heritage and obedient to the lessons of a common experience. [7]

More interestingly, the survival of an idea will depend on its capacity to undergo during its existence a set of transformations likely to harmonize its functioning with the transformation of uses. If we want to generalize this concept, we could say that this is valid with regard to the "phenotype"—an object, a form or a building capable of surviving and "reproducing" (being imitated, or even copied)—as much as the "genotype" that is at the origin of it: an idea, a function or a path of thought or debate that remains and remains applicable whatever the circumstances. The very persistence of an aesthetic expression—a baroque and emergent expression of form—may even be at the origin of its survival when its functional support has disappeared. All this generates an infinity of persistent figures and signs that in turn shape our predisposition to find in them a subjectively personal and familiar meaning.

3 Bio-Mimetic Processes and Optimization of Generative Strategies

Combinatorial strategies, although capable of creating an infinity of formal solutions, are not able to produce interesting solutions in a temporality compatible with human existence. According to this point, current research focuses on those mechanisms

that have regulated the generative processes of our biosphere for billions of years. Some of them were theoretically described several decades ago and still constitute today a solid exploratory basis for the ongoing investigations in this very field. For example, L-systems—described during the early 60' by the Hungarian biologist, Aristide Lindenmayer—make it possible to model in space and time some growth phenomena that mimic the growth dynamics involved, e.g., in plants evolution.

> Designers long have dreamed of buildings that behave like living things. Frank Lloyd Wright defined "organic architecture" as "building the way nature builds." In 1963, Archigram envisioned a "Living City"—community as organism. And now the Cascadia Green Building Council has issued a Living Building Challenge as the next stage of evolution toward "true sustainability." The challenge: "Imagine a building designed and constructed to operate as elegantly and efficiently as a flower." [8]

The recursive and auto-similar properties of their structure will allow them to be displayed with incremental levels of detail able to produce evolutionary shapes that model, for example, the transformation of an architectural ensemble built over time. L-systems are based on axioms and rule mechanisms whose formal expression is easily applicable to constructed elements with redundant and self-mimetic characteristics that actually imitates evolutionary process with a recursive regeneration of auto-similar patterns (Fig. 1).

Experience shows that the structured use of shape variables with a proper set of geometric transformations make it a very efficient 2D and 3D generator. Applied to topological germs specific to architecture, an infinite number of formal varieties can be obtained. Ongoing experiments aim to demonstrate the formal versatility of this model in generating the most disparate morpho stylistic varieties.

> But how does a flower grow? It might be time to shift the conversation from product to process. What if buildings could be created in the same way a cell develops into a plant—from the bottom up instead of the top down? Technology may point the way. Automated processes are changing every aspect of design and construction, and it's only a matter of time before self-assembly completely takes over. [8]

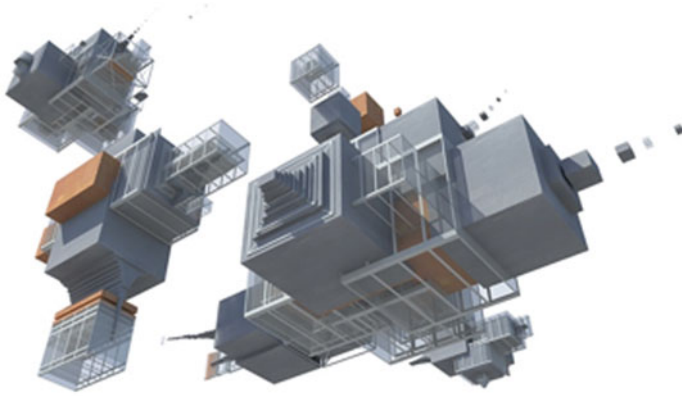

Fig. 1 Author's early L-System generator (2008)

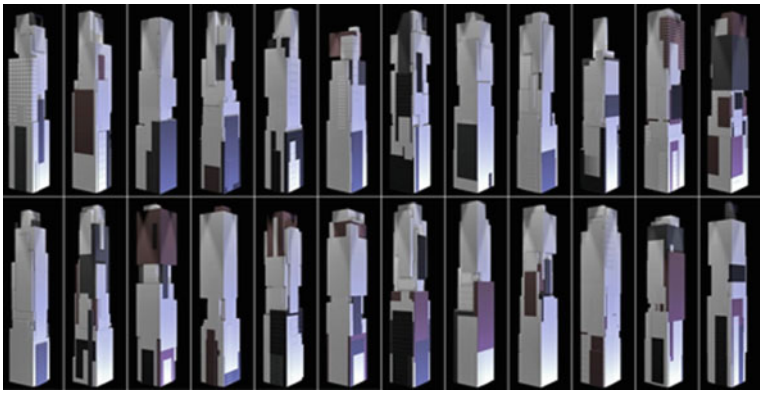

Fig. 2 The Arkhology generator – Biennale d'architecture de Lyon (2017)

This formal distopia resonates with the issues related to the use of combinatorial formalisms that have interested our research since the beginning. Following the chimera described by Borges in his famous account "The Library of Babel", it is tempting to imagine a device capable—in the field of architecture—of sweeping away, according to a combinatorial logic, all past, present and future architectural production of mankind. Of course, we are not at all in the same generative paradigm and it is highly likely that the vocabulary elements involved in such a generator would exceed the 24 characters used to populate the Borges library (Fig. 2).

A very modest attempt was made by the MAP on the occasion of the first Lyon Architecture Biennale in 2017, during which we left a machine running for only 5 days during the event and which was responsible for randomly producing a mapped projection on the two pillars surrounding the reception area. During the exhibition, nearly 300,000 digital arkhitektons were produced in pairs, most of which went unnoticed, either because of the inattention of the spectators or because the projection took place at night during the closing of the venue.

> The 'un-authored' object idea; objects formed out of chance and accident, that are then noticed and valued in equivalent ways to the art object is theoretically interesting because it questions the technical relationship between seeing and creating, and more broadly the dynamic of the viewer and the artist. [9]

We like the idea of these machines working tirelessly to produce images that no one will be able to see. A little in this logic, we have reproduced an artistic online installation that already dates back about ten years: a matrix of pixels turned on or off according to a binary logic; when a pixel has finished its cycle (turned on and off) the adjacent pixel changes state. For practical reasons all pixels are disposed in a square matrix, the logic remaining the same for the "line" pixel as for the adjacent pixel. According to this very simple rule, the occurrence of the state change for each pixel of the matrix will depend on its position in the row and will follow an exponential temporality. Nevertheless, left alone, this system will sweep away all existing binary

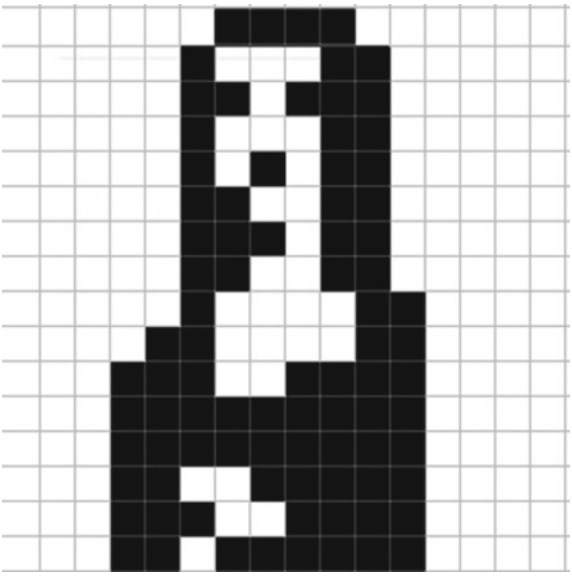

Fig. 3 One amongst the 2^{256} display possibilities of a 16×16 b&w px matrix

possibilities and will eventually produce some happier solutions beyond a universe of meaningless configurations (Fig. 3).

Following the same logic, we have developed and experimented with a tool displaying a numerical sequence in the form of grey pixels distributed on a matrix whose l/h ratio can be modified. This tool makes it possible to easily highlight the periodicity of a real number: the sensitivity of the eye to moiré phenomena makes it possible in this precise case to appreciate the repetition of the decimals by simply observing the image produced. By modifying the l/h ratio it is even possible to vary the aspect of the display and thus to look for more interesting configurations. Is there however a hidden order in the series of decimals that make up the substance of irrational numbers? We could certainly find, following the example of the quest of the Aleph according to Borges, the sequence of numbers forming any past, present and future Instagram© picture but still it would be necessary to locate it in the infinite sequence of PI decimals: we would not have more probabilities to find its location than to find the novel "Les Misérables" by Victor Hugo in the famous library mentioned previously.

Without looking so far, it is possible to find in the already mentioned L-Systems harmonic phenomena that occur after a large number of iterations. Are they due to the particular recursive properties of these formalisms on which all types of rules can be applied? (Fig. 4)

To do this, it is necessary to act with great finesse on the factors applied recursively in order to observe unexpected alignments when the major axes of composition approach particular angular ratios: it is fascinating to note to what extent the recursive functions applied to geometry are capable of modelling the formal expression of a large number of more primitive plant and animal species. Is the initial search for

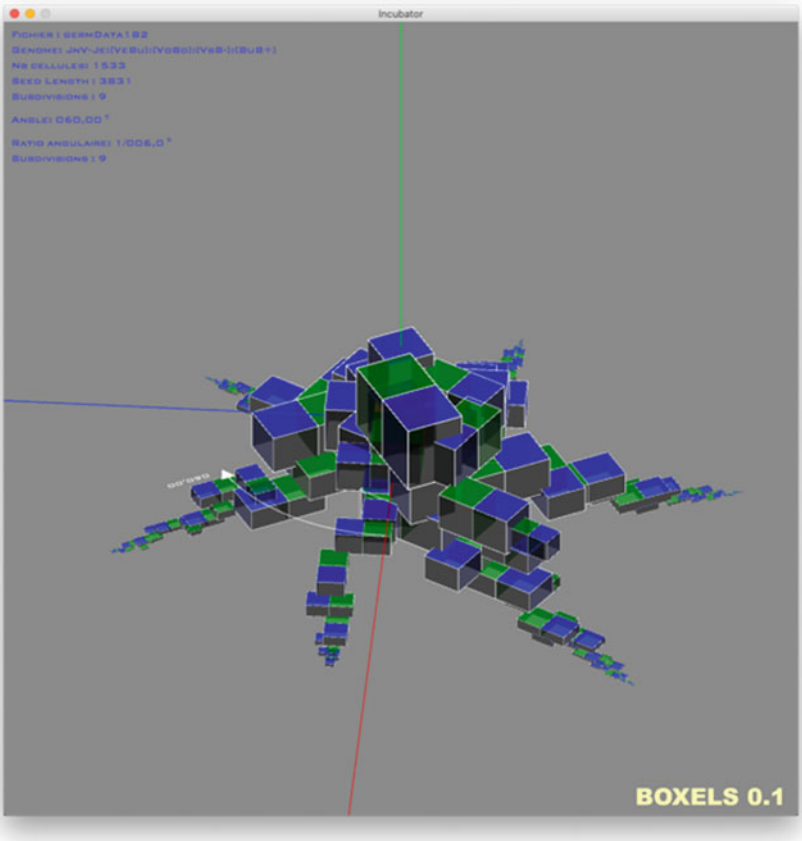

Fig. 4 Combining a GA approach with a L-System generator (2020)

adaptation to an unfamiliar environment simpler when one adopts star-shaped or symmetrical forms? This is an interesting avenue for architecture. Ernst Haeckel's plates artfully illustrate the impressive beauty of the biological world, a beauty that expresses itself in our eyes but which has no other reason in the end than to offer species the tools to survive and procreate.

4 Conclusion

Recalling Nature with efficient generative paradigms seems to be relevant to discriminate the exponential spread-out of possible solutions of un-controlled growth approaches. However, the drawback of such processes is in its unpredictability or its poor response to domains where it is hard or impossible to define a computational fitness function. Interactive Genetic Algorithms (IGA) or Aesthetic Selection

uses human evaluation for the fitness function, typically when the form of fitness function is not known, such as visual appearance or aesthetics evaluation. It is so possible to use well-established mechanisms that have been experimented by nature for billions of years and that have produced—needless to say—workable results in many areas. Well implemented in today's 3D tools, some inspired organic formalisms are now used in many fields: although they certainly do not deploy the same functional complexity as their living counterparts, they are extremely gifted at optimizing multi-criteria problems, supervising monitoring operations or assisting in operational decision-making. As said before, it is no longer necessary to go through the tree of possibilities in its entirety, we will be able to make drastic shortcuts in the production of optimal solutions considering a set of constraints placed at the beginning and according to a time span more compatible with the duration of our own existence.

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