ARCHITECTURE AND SYSTEMICS – AN OUTLINE AND AN OUTLOOK

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1. THE POWER OF METAPHORS

Systemic thought has often crossed the path of architectural culture along the XX Century.

A significant part of architectural thought is about the connection between people and places. For this reason, the complex nature of architectural phenomena, which shape the built environment where people live, has frequently appealed to architecture theorists.

In 1968, American designers Roy and Charles Eames produced a film for IBM: *Powers of Ten: A Film Dealing with the Relative Size of Things in the Universe and the Effect of Adding Another Zero.* The film begins showing a couple picnicking at the Chicago lakefront, framed inside a one- square-meter field. Then the viewpoint zooms out to a view encompassing a square field with a ten-meter side, then it continues zooming out at a rate of one power of ten every 10 seconds, reaching a field of 1024 meters, that is, the size of the observable universe. The camera then zooms back in to the picnic couple, and then it "plunges" into the man's body showing views of negative powers of ten down to 10−16meter, that is the shortest measurable distance inside the proton of a carbon atom. This representation of the human scale and its interconnections to the greater and the smaller environment was the work of architects and designers, as the Eames were.

In the last 50 years, research improved the understanding of how complex settlements work (Batty, 2005), and relevant advances in systemic thought about the built environment have been made. Recently, a very interesting line of thought has emerged: *Complexity Theories of Cities (CTC)* (Portugali, 2011). Overviews took place in Delft in 2009 and 2013 (Potugali *et al*., 2011). CTC is based on the ideas of self-organization and synergetic, entailing questions about pattern configuration and order parameters.

I will start tracing the path of systemic thought in architecture following the fruitful idea of *metaphor*.

Architectural thought is very fond of metaphors: actually, in many fields in science as in culture, we often use metaphors. A metaphor is a figure of speech in which a word or phrase, literally denoting one kind of object or idea, is used in place of another to suggest a likeness, an analogy between them – in this way making a clearer idea of something that is particularly difficult to describe and to define.

Since the late XIX Century, when the traditional architectural theories proved inadequate to the increasing complexity and the new challenges of mass-production, architectural thought has often looked for inspiration at sciences adequate to research into complex fields – such as physics and biology – and, more recently, to human sciences such as psychology, anthropology, sociology (Broadbent, 1973 ; Zeisel, 1981).

I would rather say "looked for *inspiration*" than *for methods or tools*, because the power of metaphors lies in giving light to new and dark fields, in helping to recognize paths. Along such paths, the quest for methods and tools remains a difficult challenge anyway, especially in those fields where quantitative validation methods are not customary, and speculative assumptions prevail.

At the beginning of the XX Century, and even more after WWI, industrialization turned the mass production of housing into a widely renowned architectural question, something that had never occurred before, and challenged the architectural thought in a radical way.

So, when *mechanization took command,* at the height of the Machine Age, the mechanic metaphor became popular. It conceptualized the idea of a building – as well as of a city – as an artifact with a primary functional character. A machine, a machinery, whose component parts and overall arrangements had to be specifically designed to maximize functionality. The house could be seen as *La Machine à habiter*, according to Le Corbusier’s famous statement. Such metaphor strengthened between the two World Wars, and thrived well into the 1970’s.

In *Vers une Architecture* (1923), Le Corbusier, again, famously claimed, "All men have the same organism and the same functions. All men have the same needs." Thus prompting the rationalist idea of *standard*. Standards, established by “logic controlled by analysis and experiment”, are based upon the idea of users being a homogeneous public, with homogeneous needs, desires, ways of life and so on.

Many years later, in the second half of the XX Century, such functionalist theories were considered responsible for many dysfunctional outputs of city design and construction. Apart from their practical results, they also suggest a mechanical idea of human life and human needs, which greatly helped making contemporary architecture *ideology* quite unpopular among the public opinion[1].

During and after WW2, driven by the military industry in the USA and UK, much research focused on problem-solving activities, which could account for the increasing complexity of industrial production and the need to increase speed and reduce uncertainty in the production process. The aim was to establish a rational sequence going from the problem definition to its solution. Research developed techniques of analysis, prevision and control, and defined processes for activities, and for each process phase, in terms of *plan, program, design, production*.

Design theories assumed a specific "industrial systemic outlook", generating "tools" for problem solving, which resorted to the mathematics of probability. Such were the Operational Research (O.R.) methods, developed during wartime with the aim of tracking down enemy submarines.

The main goal of Operational Research was to establish a decision sequence, in order to obtain an improvement both in the performance of a process and in the performance of the final product of the process itself. Thus, it is possible to synthesize the solution – that is, the decision sequence itself – by means of a mathematical model.

After WW2, in industrial countries the building industry developed prefabricated reinforced concrete techniques, which required increasing mechanization in the building process – both in factories and on the construction site. The building industry soon adopted P.E.R.T. (Project Evaluation and Review Technique), a well-known Operational Research technique, which is still widely used to establish activities in the building process. P.E.R.T. was mostly developed in the 1950’s by the USA and British Navies to design nuclear powered submarines armed with Polaris missiles (Broadbent, 1973). The first step in P.E.R.T. design is to define a sequence of activities, which allows the underpinning of critical paths: that is, the time path connecting each activity, which must not exceed their allowed time, not to affect the completion date for the project.

In 1965, RIBA – the Royal Institution of British Architect – defined and published, in its "Handbook for Architects", the sequence of activities involved in building a house. It allowed professionals to draw a complete network diagram and timeline for each design phase (Broadbent, 1973).

[1] One for all, in general literature, see: T. Wolfe, From Bauhaus to Our House, 1981.

In those days, many authors worked along this line of thought, developing rational design theories and methodologies: Asimow, Jones, Gregory, Archers, to name just the most famous. Their works deeply influenced a large part of the design culture, both in Europe and in the USA (Asimow, 1962 ; Jones, 1963 ; Jones, 1970 ; Gregory, 1964 ; Archer, 1965).

In Morris Asimow's seminal work *Introduction to design* (1962), the author defines the 7 phases of Design Morphology:

1. Feasibility Study;
2. Preliminary Design;
3. Detailed Design;
4. Planning the Production Process;
5. Planning for Distribution;
6. Planning for Consumption;
7. Planning for the Retirement of the Product.

Each phase in the Design Morphology contains the same sequence of events, which represent the Design Process: 1. Analysis; 2. Synthesis; 3. Evaluation and Decision; 4. Optimization; 5. Revision; 6. Implementation.

Such systemic analysis of the building construction process draws inspiration from the industrial production ratio, referring mainly to functional criteria to describe its internal relationships. Its main objective is to provide the building sector with a systematic tool, devised to achieve the best quality of a building and of its parts.

The question asks how can architects define *quality*. The answer lies in defining and stating the characteristics that each element and space in the building must possess. Thus, quality can be defined in terms of the requirements which meet the needs expressed by the user, who shall be satisfied by the actual performance of the building systems and of its elements.

Optimization was the main keyword in this need/performance-based design idea.

All along the 1950s, 1970s and 1970s, the quest for optimization in architecture led, quite often, from Utopia to dystopia, as represented by such famous cases as:

- The Corviale, at the outskirts of Rome. A council housing project built in 1972, it was conceived, and also saluted at the time, as a successful manifesto of rational design. During time, it proved quite uncomfortable and unpopular among its tenants, and underwent a series of disputable refurbishing attempts.
- The Pruitt Igoe Housing Estate, St. Louis, 1951-1955. Designed by Architect Minoru Yamasaki, it won the American Institute of Architects Award in 1951. It was demolished in 1971, after proving absolutely dysfunctional, and having been heavily damaged, beyond any possible rehabilitation, by generations of unhappy inhabitants. The demolition of Pruitt-Igoe features in the opening sequence of the American environmental movie "Koyaanisqatsi" (1982); the event was labelled *an icon of post-industrialization* by geographer and anthropologist David Harvey (1989).

The mechanic metaphor generated the idea of a DESIGN METHOD, that is: the idea that design can be treated like a process, divided into phases, all of them aimed at controlling a stated quality of the output. The contributions of operational research, the increasing development of computing devices and the contemporary development of disciplines dealing with complexity in production, were well available to design theorist in the early 1960's. Rational design methods represented the architectural output as a flow, which proceeds from plan to program to design to production.

The ideas of *input*, *output*, *feedback*, as well as flowcharts, became familiar to architects.

In the words of one of these authors, Welsh designer John Chris Jones, "The method is primarily a means of resolving a conflict that exists between logical analysis and creative thought" (Broadbent, 1973, p.257). As Broadbent noted, "In his method, Jones suggested that the designer should separate imaginative ideas and designs from logical statements of information and requirements during the design process, trying to put them together again at some point 'along the way'" (p.257).

The ideas of feedback and feedback loops comes, of course, from *Cybernetics***:** the science that studies the structure of regulatory systems.

Basically, Cybernetics deal with the structure of language-based systems: a set of signals connecting a system with its environment. All changes in the system cause some change in the environment; such change is conveyed to the system via information, or *feedback.* Feedback is, a flux, a flow of signals that cause the system to adapt to new conditions: feedback allows the system to change its behavior to meet the new environmental situation. Thus, Cybernetics provide powerful tools to study both informational and social systems, as both of them are based on *language*: that is, the exchange of signals which can change the behavior of a system.

Cybernetics and Information sciences bring in another metaphor, which relates to computer science, Artificial Intelligence and the regulatory systems in complex structures.

2. BETWEEN ART AND SCIENCE, UNDERSTANDING NATURE

In the 1970s, The Architects' Journal British cartoonist Louis Hellman depicted an architect engaged in the difficult task of "taming" two wild horses: Art and Science, trying to make them work together. A telling metaphor, once more.

Without any doubt, architecture *is* an art in many ways: it is the art of representing civilization and power, as well as the art of according people, their needs and aspirations, to the "mineral substance" of the material world.

Now, let's take a step back and track down another path in systemic references, that runs into the architectural thought.

Christopher Alexander (1964), in his *Notes on the Synthesis of Form*, wrote that "[…] every design problem begins with an effort to achieve fitness between two entities: the form in question and its context. The form is the solution to the problem; the context defines the problem.

In other words, when we speak of design, the real object of discussion is not the form alone, but the ensemble comprising the form and its context. […] The ultimate object of design is form. The reason that iron filings placed in a magnetic field exhibit a pattern - or have form, as we say - is that the field they are in is not homogeneous. If the world were totally regular and homogeneous, there would be no forces, and no forms. Everything would be amorphous. But an irregular world tries to compensate for its own irregularities by fitting itself to them, and thereby takes on form."

At the beginning of the 1960s, Alexander was committed to the scientific approach to architectural form, going back to the studies of Scottish biologist and mathematician D'Arcy Wentworth Thompson. Thompson (1917), in his capital work *On Growth and Form*, stated that the form and structure of living organisms depend mainly from physical laws and mechanics. Cities had often been compared to living organisms in the XIX Century. Victorian poets and writers, such as Wordsworth and Dickens, often recurred to an organic metaphor in describing London as an ant-hill, or a "monster-city" with a will of its own (Johnson, 2001). A peer and compatriot of Thompson's, geographer and biologist Patrick Geddes, further developed the organic metaphor. In his book *City in Evolution* (1915), he introduced the idea of "evolutionary planning", in order to better describe and understand the way human settlements behave and grow during time, and properly approach planning tasks. As Michael Batty and Stephen Marshall write, "In planning terms, this meant that a town was not a purely manufactured artefact that could be arbitrarily imposed on a particular location, like the design of a building, but was a product of its environment, to be studied as part of that environment, and to be planned in sympathy with it" (Batty & Marshall, 2009).

Through metaphor, we approach the ecological paradigm of our days.

In fact, as many other animal species do, humans shape their own settlements through artifacts. The buildings and other artifacts, deposited on the earth surface during time, form what we call the built environment. The human species has a powerful capacity of modifying its own environment. We can define architecture, "the set of human artefacts and signs that establish and denote mankind's settlements", following what William Morris wrote almost 150 years ago[2]. Thus, the built environment and architecture represent a complex social product as well as the peculiar, artificial main part of the eco-system where the human species lives and develops.

The organic metaphor helps in establishing an ecological paradigm in architecture and urban design: "Cities are emergent and adaptive […] we cannot expect them to exist in a state of equilibrium, as they are intrinsically unstable, always in flux and thus far from equilibrium" (Batty & Marshall, 2009).

Stephen Marshall further introduces the idea of co-evolution in the process of the built environment growth: "In the evolutionary paradigm, the city is not a designed object (or a series of created objects); nor it is a developing organism composed of parts that are functionally interlinked, supporting and subordinate to the whole. Instead, the city is a collective entity like a forest or an eco-system, a population of coevolving things, partly in cooperation, partly in competition. It is the very interactions of the cooperating and competing parts that gives rise to to the complex collective product. In the evolutionary paradigm, above all, there is no optimal target form. It may be possible to identify potential improvements as immediate targets, but there is unlikely to be a single optimal target form and certainly no long-term knowable optimal form" (Marshall, 2009).

As we can see, references to Systemics have travelled a long way from the early, industrial stage of performance-based design.

Like any other living species, humans are organisms that adjust to a dynamic, ever-changing environment shaping it according to their own purposes. The very nature of the relationships between organisms and their environment is systemic.

The systemic approach to environmental research focuses on the impact of human actions on the physical environment, both built and natural, and entails the idea of a regulatory system: homeostasis. Homeostasis is a self-regulating process which allows living systems to find their own right balance in a changing environment and to reach an equilibrium point despite unpredictable and external conditions.

From the the ecological realm, we draw another fruitful concept: affordance.

According to environmental psychologist J.J. Gibson, affordance is a property of the environment relative to an animal, allowing a certain kind of mutual relationship between them. Affordance represent a property of the environment which allows a specific kind of animal to afford a specific behavior. In Gibson's words (1979), "affordances are facts of the environments and do not depend on the needs of the observer". If we translate the notion of affordance into the realm of architecture and urban design, we find that it could help updating the old, worn-out rationalist notion of performance, without losing the necessary link to the centre of design process: people. "Affordance" is a concept far more open than "performance", which is strictly based upon the users' needs. It is more about a range of offered possibilities than of specific satisfied needs. It allows more opportunities for change in time, thus it is more helpful in the strive for harmonizing our design behaviour to the definition of sustainability given by the Bruntland Report: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). It represents a fascinating field for research.

[2] According to William Morris (1881), the idea of Architecture could not be restricted to the realm of the Arts, because "*Architecture regards all the signs that mankind leaves on Earth, except pure desert*".

3. LANDSCAPE: SYSTEMICS MADE VISIBLE

The European Landscape Convention defines landscape as "an area, as perceived by people, whose character is the result of the action and interaction of natural and human factors"[3].

The definition puts the inhabitants' perception at the core of any protection and planning action, and people's partecipation becomes a fundamental issue.

In Ambrogio Lorenzetti's "Allegoria del buon governo" (1338 – 1339) in the Palazzo pubblico at Siena, we can see the effects of good, moral government resulting in the ordered behaviour of citizens and peasants, and in the flow of thriving activities between the lively, peaceful city and the quiet, productive country. Centuries of such activities shaped the productive Tuscan landscape, giving it the character that the whole world knows and perceives in terms of *delight.*

"Delight" is one of the three Vitruvian precepts for good architecture, together with soundness and function. In Latin, the word for delight is *venustas*, the main attribute of Venus, goddess of physical pleasure. Delight is for sure one of the characters that should be preserved, though preservation seems to be a difficult goal in an ever-changing environment, where valuable site resources are in constant danger of being swept away by careless exploitation.

Inhabitants have great responsibilities; local communities often find it difficult to make decisions and to balance between useful development and careful protection of landscape resources. In fact, both big and small decisions give the environment its shape. The construction of a highway promotes great change, as well as a body of planning regulations or the poor maintenance of country lanes. Such activities all rely upon the culture of populations and communities: both the high, institutional culture generating planning regulations and the widespread, commonplace culture defining how people keep their own garden fence.

Christopher Alexander (1964), again, wrote: "Architects are responsible for no more than perhaps 5 percent of all the buildings in the world. Most buildings [...] which give the world its form [...] come from the work of thousands of housewives, the officials in the building department, local bankers, carpenters, public works departments, gardeners, painters, city councils, families...".

In 1974, Eugenio Turri, a great Italian geographer, wrote: "As a biological eco-system breaks down when its utilization by the inhabiting organism destroys the conditions for the survival of the organism itself, so its anthropological equivalent – the built environment – breaks down when the balance between its natural and human resources and the requirements of its inhabitants has been upset. [...] In this case, culture fails to play its role in mediating between society and environment, not being able to direct social behaviours as well as the actions of the political and administrative institutions" (Turri, 1974).

Indeed, *culture* should be considered the main systemic regulator.

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[3] The European Landscape Convention is an international treaty aimed at the protection, management and planning of all landscapes. Is was adopted in 2000 and it was subscribed in Florence by 27 European countries. See: European Landscape Convention (2000), www.coe.int/t/dg4/cultureheritage

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