City out of Chaos

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City out of Chaos

Urban Self-organization and Sustainability

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Foreword

Vitruvius tells of the architect, Deinocrates, who desired audience before Alexander the Great and came with letters of recommendation to impress the emperor's officials. Tired of the long wait, he attracted Alexander's attention by appearing completely naked, smeared with oil, a lion skin over his left shoulder, a club in his right hand. Received by the emperor, he outlined his proposal to carve Mount Athos into the statue of a man and to build a city in the left hand of the statue. The right hand would hold a basin into which all the streams of the mountain would flow, thence cascading into the sea.

Alexander rejected the proposal with the following words: 'Just as a baby cannot be fed and grow without the nurse's milk, a city without cornfields and their produce cannot develop or grow populous.'

Nothing new under the sun. Architects continue to make bombastic proposals to those in power and acquire credit through the mass media. They continue to consider cities as islands divorced from the surrounding countryside.

One of the great merits of this book is that it demonstrates fully and persuasively that this autonomy does not exist, not even in the age of the global economy, and that recent advances of science provide insights into the complexity of the problems besetting our cities and tools to solve them.

A striking section of the book describes the *ecological footprint*, an indicator that shows the tragic contrast between accelerating consumption and the slow natural regeneration of resources. William Rees and Mathis

Wackernagel introduced this method of environmental accounting in the 1990s. It compares the needs of a population with the area of terrestrial ecosystems required to satisfy them, obtaining a measure of velocity. Applying the indicator to the annual cycles of the planet, Wackernagel proclaimed 6 October 2007 as 'ecological debt day,' because his calculations showed that on that day humans had already consumed the year's resources and begun to erode non-renewable reserves, behaving more or less like the grasshopper in La Fontaine's fable. It is easy to see that this day will come earlier each year if nothing is done, and will soon symbolically mark the beginning of autumn.

This indicator dramatically recalls the second principle of thermodynamics that introduced the concept of entropy as an index of the degradation of physical systems; reversible isothermal variations in entropy are equal to the heat absorbed by the system divided by its absolute temperature. A superficial interpretation of entropy suggests an inexorable process of impoverishment or leveling that evokes pessimism and fatalism: Clausius's thermal death. Taking up the ideas of Prigogine without a trace of pessimism and fatalism, the authors correct this superficial view. Biological evolution demonstrates that biological systems develop in a direction opposite to that of thermal death, far from equilibrium, without contradicting thermodynamics. At equilibrium, matter seems blind and insensitive, whereas far from equilibrium it acquires the mysterious capacity of self-organization. Chaos and order are seen as being in constructive contradiction rather than in opposition.

Here lies the message of hope contained in this book. A physical chemist and an architect reflect on the present and future of cities, with their problems of overcrowding, infrastructural obsolescence, traffic, pollution, wastes, and community breakdown. In a change of method and instruments offered by the new scientific paradigm, they identify a path that could invert some of the processes threatening the human future.

The authors are not falsely optimistic about a happy outcome, nor are they deceived into blind acceptance of the current values created

by the transformation of our cities. The concept of self-organization of matter does not exempt humans from studying the processes that regard them, assessing impact and significance and making decisions. Chaos, its potential revealed by science, is not a cult topic but a dynamic state that can indicate the way to a more subtle and flexible order than simplification and repetition.

Another interesting aspect is a purposeful departure from equilibrium identified in certain works of contemporary architecture. The authors consider Frank Gehry's Guggenheim Museum in Bilbao and Zaha Hadid's Museum of the twenty-first century in Rome. They underline the latter's 'dynamic balance between order and chaos based on the same rules that govern dissipative systems in the universe.' They note the fragmentary character of the Guggenheim: 'a collision of volumes that generates unusual spaces, seemingly by chance, resulting from deformation of concave and convex surfaces, interwoven and suspended: a set of fragments that gravitate around a virtual orbit, resembling a strange attractor.' Their perspicacious and persuasive interpretation of these works identifies what I consider a typical aspect of contemporary art: a faithful reflection of the world and society in which we live, in the most sensitive cases recording the discovery of new perceptive horizons. This reflective capacity makes the architect a 'seismograph' and determines the success of these works that are springing up all over the place, though rarely with the poetic quality of the Guggenheim. However, their relationship with the cities that host them arouses many doubts, seeming resigned to unlimited development for its own sake, rather than committed to the idea of 'sustainable' development based on awareness of individual and collective responsibility towards the environment.

In the transition from *modern* to *contemporary*, artistic research has undergone a radical transformation. If art defined itself as 'modern' last century it was because it aimed not only to reflect society but also to change it by questioning values; today, in defining itself 'contemporary,' art aims for a mere temporal correspondence, unwilling to engage in any

crusade except that of innovation. Van Gogh, Kandinsky, Boccioni, Klee, even Taut, Mies van der Rohe, and Terragni, painted and designed counter-trend to change the prevalent orientation of the world in which they lived, and often their works were only acclaimed by an embattled minority that shared the reasons for their struggle. By choosing a peasant's shoes as a subject to paint, Van Gogh was ignored for years by *experts* but made a statement in favor of a world that wanted to change, providing it with metaphors that would become increasingly eloquent.

One may well ask whether the art we see today, that represses work and effort as useless and seeks success by satisfying the desire for 'distraction, like a consumer good on display in a supermarket, is worthy to accompany scientists' attempts to lead the city 'out of chaos.' From what was probably an excess of ideology spurring architects and artists to oppose the eclectic bourgeois consumerism of the time, we have gone to a form of art that cultivates deresponsibilization, making a show of its lack of ideology and sinking passively into overwhelming 'reality.' Is it legitimate to raise the problem of a type of innovation that recognizes the value of commitment without betraying the need for freedom and autonomy that asks how it can contribute to the struggle for environmental awareness? Past misunderstandings created by foolish ambitions of political commitment justify diffidence and doubts about art, but as far as I am concerned, not about architecture, which does not enjoy the privileges of other arts. If you want to see a picture, a happening, an event, you go to a gallery or a museum, or you can ignore it. The same is not true of cities and landscape. Even if you do not wish to see them, they enter your life and affect it, influencing your being and how you live. Even those who do not see are citizens and enjoy or suffer what architects and governors build. Before it is too late, we need a 'geoarchitecture,' an architecture that starts from the principle that we are inhabitants of the Earth, we are part of the Earth and therefore responsible for what happens on the planet, not only for what happens in our 'developed' corner where the vast majority of the Earth's resources are consumed, but also for what happens in the rest, in the *desolate land*

inhabited in want, suffering, and grief. And 'geoarchitecture' would not be enough without 'geo-planning' understood as the discipline of complexity, concerned with regional systems and capable of producing maps that are increasingly sensitive to the rhythms and needs of life, capable of suggesting choices that differentiate good from bad government.

The title of Pulselli and Tiezzi's book leaves no doubts. Chaos is not to wallow in with decadent complacency, but must be studied to discover the seeds of change through movement and metamorphosis, a principle of order to cultivate, not in the immobility of equilibrium but in the mobility of evolution.

This book does not merely divulge methods of knowing and controlling urban phenomena, but offers examples of the application of these methods to urban systems like Siena, Cagliari, Pescara, and Milan. To analyze relations between the city and its surroundings, Odum's concept of emergy (with an M instead of an N) is introduced. Emergy quantifies the memory of all the energy necessary to support a process or system. Applied to an urban system, emergy analysis makes it possible to identify and measure the relations that a local setting establishes with other systems on a local or global scale. Emergy flows offer a key for more correct and efficient government. In the case of Pescara and the nearby Adriatic coast, the tool used was mobile phone traffic, the only field in which Italy is world leader. Use of base station data to map mobility and relations provides an image of significant aspects of individual and social behavior, a sort of X-ray that renders visible the hitherto invisible fabric of immaterial relations animating a region.

Besides its usefulness in proposing new ways of observing urban phenomena, the book is of humanistic inspiration, revealing the special sensitivity of authors who have uprooted the palisades traditionally separating the two cultures. Chapter 7 began analyzing Jochem Hendricks's work *Newspaper of 1994* that shows a newspaper in which the text has been replaced by the scan of the reader's eyes. It ends on

this note: 'We concluded this chapter with a visit to an art gallery because we liked to think that art and science share romantic passion and that *cartography is the most scientific art and the most artistic science*.'

Paolo Portoghesi

Rome, 2008

Prologue

The title of this book, *City out of Chaos*, pays homage to Ilya Prigogine. *Order out of chaos* is an expression coined by the father of evolutionary physics, winner of the Nobel Prize in Chemistry (1977), to express a key concept of complexity theory. For scholars of chaos, it is an idiom loaded with meaning distilled in a handful of *bits*. Indeed, it condenses a vast scientific theory which has enormous implications for contemporary thought.

Order out of chaos implies an event, a novelty emerging from a circumstance, from a combination of facts in a favourable context, from a choice, a collision or a chance encounter. Atoms form a molecule. Molecules form cells. Organisms form an ecosystem. Persons form a society. Words express a thought.

Evolutionary physics is the science of emergence of novelty, the narrative elements of nature, the formation of living structures and their evolution in a dynamic and variable world. The city, immersed in this dynamic world, is the subject of our research. To our eyes, the city is a living organism, a system that breathes, feeds, takes on an identity and communicates. We believe that certain theories of evolutionary thermodynamics, environmental physical chemistry, and ecology, elaborated in order to understand biological and living systems, can be extended to the study of social and urban systems and can provide new elements for interpreting their function. The concepts of dissipative structure, complexity, and self-organization have in our opinion such pertinence to the complex world and current problems as to change our

view of the development and growth of contemporary cities. Faced with the global environmental crisis, the greenhouse effect, climate change and resource depletion, the need to change the paradigm of town planning and urban systems is increasingly evident, and receives impulse from the evolutionary sciences. The search for a new alliance between humans and nature proposed by Prigogine and Stengers[1] calls for a new view of human systems and of the relations they establish with the environment, with sustainability as an aim, as well as defending the opportunities for present and future generations.

In this book, we deal with many topics and will not be able to provide complete answers to all the questions we raise. We endeavour to coordinate many thoughts, reflections, and suggestions, and to forge a coherent, discernible link between chapters. If we were asked what was the thread of this book, we would probably say it was *creativity*, meaning the *creativity of nature*, a red thread that runs through the fabric of our work, more or less explicitly. Through theories and practical examples, we endeavour to demonstrate that we and our ideas, projects, and desires are an integral part of this creativity. The creative power of nature cannot be eluded. We cannot plan an artificial world that completely excludes it or isolate ourselves in a cocoon designed to fit our model, but we can choose to live in harmony with nature and its laws. We can plan a way of interacting with the innate creativity of the systems of which we are part. We can even decide whether or not we agree with those laws and act to save natural cycles or to irreversibly impair them. We can choose order or chaos.

To define chaos, it is customary to call on daily experience. A practical example comes to mind now as we write. The first draft of this book was very close to the idea we have of chaos. Several months ago, we began writing all the topics we wanted to include on a clean sheet of paper. Each topic had direct and indirect links to other topics. Many were linked together. Lines crisscrossed the page. In a corner, there

[1] Prigogine, I. & Stengers, I., *La Nouvelle Alliance. Métamorphose de la Science.* Gallimard: Paris, 1979.

were words written sideways for lack of space, sentences in capitals, and others in running writing, without any rhyme or reason. For several days we continued adding references to the page. In the end, besides a triumph of key words, names of persons and things, words scattered in a tangle of ink, there appeared the moist outline of a coffee cup and the date of a seminar scribbled absent-mindedly in pencil.

Our notes did not bear any evident trace of a structure that could guide the pen. At a certain stage, the sheet of paper was no longer coherent and no principle of order could be discerned. The many thoughts jotted on the page seemed to form a homogeneous whole and could no longer be distinguished. It was as if one had entered a city, or urban outskirts, for the first time. All directions were the same and it was impossible to get one's bearings. It engendered a disquieting feeling, but was fascinating to think about. The initial scheme was more like a hypertext, an open structure that we could follow in many directions. Since then, we put much energy into defining a structure. It was necessary to make order out of chaos.

The reader can judge our results. We will only say that although this book observes a criterion of continuity, it contains fractures, requires jumps, and indicates connections. While the chapters took form according to a general scheme we had agreed upon, incidents in daily life, such as a conversation, a phrase heard at a seminar, a photo in a newspaper, or a scientific news item, influenced the scheme and suggested path variations. We sometimes referred to literary passages, contemporary art installations, oscillating chemical reactions, striking architecture, stories, invisible cities, imaginary characters, snow flakes, and tropical storms to describe a scientific theory. This book arose out of a description of a set of concepts and endeavours to at least partly reflect the formation of a thought or the birth of a system of relations, and hopefully a logical conclusion.

The authors are an architect and a physical chemist, student and teacher. The topics include physical chemistry, evolutionary thermodynamics, ecology, complexity, aspects of town planning,

environmental assessment, and architecture. It may seem directed to architects and town planners, to whom it communicates notions of thermodynamics, or it may seem directed to scholars of environmental, chemical, and natural sciences, to whom it espouses concepts of regional planning and architecture.

We knowingly drew from different disciplines because transdisciplinarity has something to do with complexity theory. Transdisciplinarity indicates a fusion between disciplines that destroys academic barriers and creates new disciplines in which everything is more than the sum of the parts. We also believe that one of the main points of transdisciplinarity is the opportunity of going beyond the science-humanity dichotomy, as observed by Prigogine when he stated that scientists do not read Shakespeare and humanists are insensitive to the beauty of mathematics.

Clearly transdisciplinarity must go beyond something. Its essence lies in fusing pre-existing elements to create something new. In their manual of ecological economics, Herman Daly, a founder of sustainable development, and Joshua Farley[2] give a good description of the concept of transdisciplinarity:

> *… the disciplinary structure of knowledge is a problem of fragmentation, a difficulty to be overcome rather than a criterion to be met. Real problems do not observe academic boundaries. We certainly believe that thinking should be 'disciplined' in the sense of observing logic and facts, but not 'disciplinary' in the sense of limiting itself to traditional methodologies and tools that have become enshrined in the academic departments of neoclassical economics.*

The aim of this text is therefore not to fully expound all our arguments, many of which have been analyzed by Ilya Prigogine, Fritjof Capra, Enzo Tiezzi, and others, but to introduce them synthetically and make them collide, so that something new emerges.

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[2] Daly, H.E. & Farley, J., *Ecological Economics. Principles and Applications*. Island Press: Washington, 2004.