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**Harmony in the City: Towards A Cyber Ecology**

According to the Cambridge Dictionary, the word harmony refers to *“a situation in which people are peaceful and agree with each other, or when things seem right or suitable together.*” (The Cambridge Dictionary).

In fact, beyond this relatively straightforward definition, there lies a multifaceted debate that stretches across history. In Western philosophy, the term *harmony* is not used very often per se. Yet, it still can be found playing a substantial part in the writings of both ancient and modern thinkers. This essay aims to explore the concept in relation to architecture – by seeing the built environment as a site where the two poles of natural and artificial should find ways to reinforce one another. However, a few preliminary notes should be provided to elucidate how the idea of harmony analyzed here hinges upon a wider philosophical conceptualization.

Ever since Greek and Roman times, harmony has often been discussed as the outcome of conflict. For pre-Socratic philosopher Empedocles, for instance, the variety of natural phenomena, including the regular succession of the seasons during the year, are the result of two opposing forces: Love and Strife. In Roman times, Horace described the harmonic balance that arises from the contrast between the four elements in nature (air, earth, fire and water) with the expression *concordia discors*– a jarring unity.

While originally, the term *harmony* was used as part of a discussion on cosmology, it later became integral in the debate on political philosophy. Since the settlement of the European wars of religion in the seventeenth century, a principle has been permanently established: a plurality of opposing and irreconcilable positions can run within the same society. Such plurality does not rule out the possibility of harmonic coexistence among citizens.

Harmony in society does not mandate individuals to drop their conflicting opinions. Rather, it is achieved, to borrow the words of twentieth-century American philosopher John Rawls’ *Political Liberalism*, as an *overlapping consensus* between overall conceptions of the good (moral or religious conceptions, for example) that acknowledge a principle of reciprocity. In turn, this establishes the foundation of the constitutional principles that lead to liberal democracies, where a dynamic harmony exists between political forces fighting to gain the electoral majority.

As harmony can be understood as a dynamic, conflict-driven concept, this applies also to the realm of urbanism and architecture. The city, the ultimate man-made creation, can be seen as the site where two opposite forces clash and compete – the natural (biological) and the artificial (technical).

For centuries, western thinkers saw little room for reconciling the two forces. In Eighteenth century’s Europe, two opposing beliefs coexisted. For some, like the Italian writer Giacomo Leopardi, nature is essentially hostile to man, who must fight it and eventually tame it. For others, notably the Swiss-born philosopher Jean-Jacques Rousseau, the source of all our ills is exclusively human. However, this does not equate to claiming a return to an original “state of nature”: Rousseau claimed that the inequality that plights human society must be fixed by reforming the State and the social contract that underpins its foundation.

What is common between both positions is the idea that there is very little to learn from nature. Even in the myth of the noble savage, the primitive man was constructed to only possess the ability to cast a naive and uncorrupted gaze over our civilization, not a wisdom that is worth applying to the modern world. Similarly, the Europeans considered the indigenous populations of America, Asia, or Africa inferior because their way of living was closer to a “natural” state – and this often ended up justifying the colonial enterprises.

The attitude towards nature gradually changed over the course of the twentieth century. Nature was ultimately recognized to be (almost) on equal footing as its artificial counterpart. This became the impetus for the society to revise the historical imbalance and seek harmony between the two elements.

This process occurred under the pressure of numerous parallel forces. Some of them will be discussed later, such as an increasing awareness in climate change, or the emergence of digital technologies and cybernetic thinking. However, at the end of this introductory section, it is worth quickly mentioning the role played by ethology, a discipline whose birth follows the formulation of Charles Darwin's theory of evolution in the second half of the nineteenth century. Figures as different as [Nikolaas Tinbergen](https://en.wikipedia.org/wiki/Nikolaas_Tinbergen%22%20%5Ct%20%22_blank), Konrad Lorentz, [Karl von Frisch](https://en.wikipedia.org/wiki/Karl_von_Frisch), or in more recent times, Edward O. Wilson or Stefano Mancuso, have studied the behavior of animals, re-discussing some rigid principles related to what amounts as forms of intelligence belonging to other living beings.

One widespread notion in the fields of contemporary design and architecture is that the natural world can suggest solutions to human problems – for instance, in the research on new construction materials. Before addressing this topic, however, it is worth making a step back, and looking at the start of the debate on the dualism between natural and artificial.

**Natural and artificial – looking for a definition**

In the *Metaphysics*, Aristotle drew a fundamental distinction: some things exist by nature, others due to art-technique. However, such definition, which apparently conjures two forces that are opposite and irreconcilable, is immediately problematic. There are countless examples of things that are difficult to classify as natural or artificial. Dog breeds, plant cultivars, spider webs, paths traced by humans and animals by simply walking the same route over and over again… All of these things are both natural and artificial. This deals closely with the role of design. A table, for example, as Aristotle discussed, is artificial as it is built by humans, but it is natural due to its material (wood).

Advancing the same debate in the twentieth century was the Nobel Prize-winning economist Herbert Simon. His book *The Sciences of the Artificial* (1969) aims to establish a theoretical foundation for the study of empirical phenomena that are “artificial” rather than “natural”, and it is considered of particular interest for the sake of this essay.

According to Simon, certain things are artificial because “… they are as they are only because of a system’s being molded, by goals or purposes, to the environment in which it lives.” (Simon, 1969, p. xi) This is what characterizes the contingent artifacts of many human endeavors – from engineering to medicine, business, architecture, and city making. Simon put forward design as a key factor for investigating the artificial.

Today, Simon’s call for a design-driven rethinking of the relationship between the natural and artificial realms – indirectly pushing for an unprecedented harmony between them – is as crucial as ever. In fact, the urgency of this task has skyrocketed in the twenty-first century, in parallel with both the increasing penetration of digital technologies into the physical and biological world, and a growing concern over the pace of climate change. In particular, the vision of the Anthropocene (Falcon-Lang, 2011) – a concept emerged in the last two decades that posits that the main changes to the conditions of the Earth derive from human activity – is now compelling designers to discard a previous conceptualization of nature as an entity essentially detached from humankind.

The Anthropocene reinforces both Aristotle and Simon’s insights, that the biological world is not always natural. Simon presents the example of a plowed field to illustrate how the biological world can be and is often rendered artificial – that is, molded to a goal or purpose through a design process (Simon, 1969). In a similar fashion, but following an opposite trajectory, can the artificial world – the world of cities and buildings – become more natural? How can digital technologies facilitate this new harmony, taking the form of a double convergence, and what will happen if the natural and artificial fusion becomes widespread?

With the design practice CRA-Carlo Ratti Associati, we have had the privilege to explore this challenge in multiple concrete projects, many of them developed alongside Italian architect Italo Rota. Here we will explore such convergence from two points of view: from the natural to the artificial and, conversely, from the artificial to the natural.

**From natural to artificial: the birth of the cyborg**

Historically, the most explored side of the natural-artificial relationship has been the movement from the natural to the artificial. At the human scale, this is epitomized by the birth of the cyborg. In the 1980s, this nascent “cyborg theory” posited the cyborg condition as a new paradigm of human social-biological-technological existence. Donna Haraway articulated a social dimension of cyborg theory, connecting the concept to emerging discourses around womanhood and propelling the idea into broader public debate. Cyborgs, she wrote, are “… post-Second World War hybrid entities made of, first, ourselves and other organic creatures in our unchosen ‘high-technological’ guise as information systems, texts, and ergonomically controlled laboring, desiring, and reproducing systems. The second essential ingredient in cyborgs is machines in their guise.” (Haraway, 1991, p. 1) In the case of the modern cyborg, the artificial component has become a ‘dynamic’ extension of our bodies and minds. Digital technologies demand a constant and two-way cybernetic exchange in a way that our traditional (one-way) extensions, such as clothing or axes, have never done. In all these cases, we see the human body increasingly hybridized from technology, becoming less natural and more artificial.

**From artificial to natural: cybernetic visions**

The trajectories along which the artificial can be made natural have been less explored. Primarily, they can be framed as part of a series of experimental applications, in theory and practice, at the intersection of design and computer science. Norbert Wiener (1965), an American mathematician who published the book *Cybernetics – Or Control and Communication in the Animal and the Machine*, argued that most systems, both alive and nonliving, proceed through a series of “feedback loops”, incorporating sensors and actuators to regulate and modify their conditions in response to external stimuli. In the following decades, Wiener’s vision inspired countless experiments in both architecture and management – all ambitious, even if almost always doomed for failure or downsizing.

The pervasiveness of digital technologies that came to be since the beginning of the twenty-first century generated a whole new scenario. Mark Weiser, a computer scientist working at Xerox Parc in California, was already describing this phenomenon with the term “ubiquitous computing” in the mid-1990s. He hoped to find a non-intrusive technology, capable of receding into the background of people’s lives and ultimately infusing any kind of object with the ability to respond in real time to changes in external conditions (Weiser, 2002). This is exactly the promise of the digital revolution applied to the artificial world. The convergence of bits and atoms, sometimes labelled as Internet of Things, creates the possibility of “animating the artificial”. Sensors, actuators, and artificial intelligence are capable of infusing new life into the environment, strengthening the continuity between living and inanimate systems. In turn, this is likely to be the most radically disruptive change that has ever recast the design, construction, and operation of our built environment.

In our firsthand work with exhibitions and experiments in different countries, we have explored two possible ways to use the emerging digital tools to achieve the objective of animating the artificial – and thus bringing it closer to the natural world.

**Animating the artificial: the computational way**

The first way to make the artificial resemble the natural is animation through computation. At CRA, we have explored the possibility of a living architecture – one that can “sense and respond” – at many scales, from objects to pavilions to entire neighborhoods. One of the most substantial advantages of making the built environment responsive is the possibility to tailor it to the needs of its users. For instance, consider how we regulate temperature in buildings. We heat and cool our buildings in a standardized fashion, ignoring the presence and preferences of individuals, and wasting a staggering amount of energy on heating and illuminating empty or partially occupied buildings. Digital technologies can be used to make the built environment more responsive. We have been following heat since the Stone Age. What if we could make the heat follow us instead?

This was the idea behind Local Warming (Senseable City Lab, 2012), an experiment first prototyped outside of MIT’s main building in Cambridge, MA, in which motion-tracking sensors followed individuals’ movements and used beams of collimated radiations to generate a localized climate around each one. A few years later, when redesigning the Agnelli Foundation’s Headquarters in Turin, Italy, we implemented this design for sustained, real-world usage. The employees potentially enjoy what we might call a personal “thermal bubble” which follows them around the buildings, adjusting the temperature and light to their preferences through a smartphone app. This living system is not only comfortable; it could entail significant savings for energy consumption.

These examples tell us that, just as living beings become cyborgs when technological elements are embedded into their lives, buildings and streets undergo their own transformation when they are animated. We could say that they become robots, a unit that has some sensors, some intelligence, and some actuators. In other words, it can read the world, process that information, and then respond in a purposeful way. By animating the artificial “through computation”, architecture can cloak us in a third skin – an endlessly reconfigurable space able to adapt to human needs – rather than the other way around.

**Animating the artificial: the material way**

There is also a second way through which we can animate the artificial. We can find new ways to bridge the traditional urban-rural divide and affirm a novel concept of the built environment as a space where humanity can coexist with other forms of life. The outcome of such approach would be one that can contribute to satisfy humankind’s innate longing for nature – our “biophilia”, to borrow a term from Harvard biologist Edward O. Wilson (1984).

As the twentieth century came to an end and evidence of climate change became undeniable, environmentalism gained ground in many Western societies. Along with it, attempts to animate the artificial through nature multiplied in the design world. This, in turn, would be attained by two means: either through the literal incorporation of greeneries into architecture, or through experiments in which new organic materials served as construction elements. In the former, New York City’s High Line (Scherer, 2019), an aerial greenway built from a converted rail bed that opened in June 2009, was one of the first projects to capture this new ambition in urban planning.

Another way to embrace the living world is to invite it inside. CRA won the C40’s Reinventing Cities competition in 2019 with VITAE (CRA, 2019), a building in south Milan featuring a 200-meter-long urban vineyard, accessible to the public through a pedestrian path moving from a brand-new green piazza up to the roof. Sometimes, the presence of nature can be facilitated by new technology, as it is the case with urban agriculture, where advances in hydroponic and aeroponic farming techniques make it easier to grow vegetables in confined spaces.

**What future for architecture forms**

Whatever philosophical interpretation of the new ecology we adopt, it is clear that we can no longer afford a strict separation between the artificial and natural worlds. Designers have a critical role to play in deciding which future will come to pass: design responses that adequately balance the two realms can bring true harmony to the urban environment. On the contrary, ill-conceived attempts of integration could make them destroy each other.

In the list of disciplines that inspired his work *Sciences of the Artificial*, Simon included architecture and engineering along with painting. He wrote: “… Those things we call artifacts are not apart from nature. They have no dispensation to ignore or violate natural law. At the same time, they are adapted to human goals and purposes.” (Simon, 1969, p. 3) Could this be the starting point of our quest for a new, more harmonious architecture and urban design?