Blog: Jenni Partanen

Self-organization of the organic city

We are living in the era of global urbanization. Depending on how we define urban areas, the majority of the world's population now resides in some form of urban settlement, and this proportion is expected to increase further.

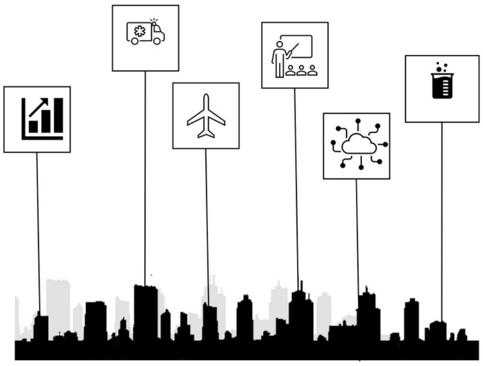
As cities expand, they bring forth numerous challenges, including pollution, overcrowding, and crime. However, the integration of digital technology with urban life holds the promise of solutions. Indeed, 'smart' or digital systems can help us manage and monitor traffic, regulate heating systems, optimize waste collection, save energy, reduce emissions, and even develop robotic transportation options while promoting a circular economy. It would be reasonable to say that such digital technologies would provide the most cutting-edge innovations that have the potential to save the world.

Empty promises of the smartness

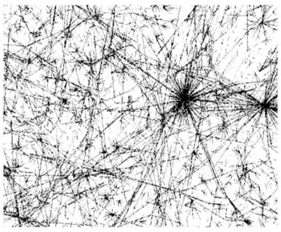
While preparing a presentation for the WNICS seminar series on this topic, I optimistically went online to search materials related to cutting-edge digital solutions in architecture, urban design, and planning. I indeed came across some promising language suggesting that architects should gain a better understanding of how "city will flow"; that "spaces are complex living data-driven organisms communicating with themselves"; and that "smart city forces architects to rethink their traditional models".

However, as I delved deeper into the content, I couldn't help but notice a disappointing trend. Beneath the surface, the ideas seemed to reflect a conservative, conventional, and modernistic vision of urban development. It appeared that we were attempting to address current issues using growth- and optimization-oriented solutions that had, in the past, contributed to the very problems we were trying to solve. This brought to my mind Albert Einstein's famous quote, suggesting that we cannot solve a problem with the same mind-set that created it.

In these modes, digitalizing cities seem to be neatly in order and control, often represented like this:



Whereas, in reality, the tangled and incrementally built digital systems of systems inseparable from the cities appear more like this:



Instead of delivering the groundbreaking holistic approach often promised, the 'smart city' concept reveals itself to be a traditional, linear, rational, and control-oriented urban model—reminiscent of the visions advocated by modernist designers a century ago. In this regard, Le Corbusier was - ironically - ahead of his time: the collective image of the future “radiant city” indeed appears as a living machine with all its bits and pieces in the right, optimal place, infinitely and increasingly griding out wellness and prosperity for us all once it has reached equilibrium.

However, the language employed does not capture this tediousness, but rather paints a more captivating vision of the future. The discrepancy between the rhetoric and actual practices suggests that we currently find ourselves in a state of transition, hovering somewhere between an emerging, embryonic comprehension of the core nature of city systems marked by their surprising and unpredictable urban dynamics and flows, sudden ruptures and transformations, autonomous characteristics, and bottom-up organization - and the (faltering) control-oriented linearity that has become familiar over the past century.

Yet I find myself pondering this indecisive attitude: it only needs a quick look around that reveals a barrage of wars, pandemics, and other global catastrophes. These events reflect the inherent uncertainty and uncontrollability of the complex systems in which we live. Societies and cities aren't isolated enclaves in the universe; in fact, they bear a strong resemblance to natural ecosystems.

Both are composed of nested systems of systems, featuring numerous lower-level interconnections that lead to unexpected dynamics at higher levels as they coevolve. These systems are rarely linear or easy to control; they are never static, and they do not aim for a specific equilibrium. Often, when they reach a permanent and perfect end state, they are dead.

In reality, life is messy and interconnected, consisting of networks (of networks) of complex adaptive systems. It resembles an impenetrable rainforest more than the neatly organized tree-fields we typically see resulting from optimizing (sic!) and monetary-profit-maximizing forest industry.

However, in this seeming chaos, certain mechanisms come into play, generating a sufficient degree of order to maintain systems on the *edge of chaos* and not tipping over. That mechanism is called self-organization.

Self-organization as a source of order

At some point, most of us have likely marveled at the magical forms found in nature—whether it's the cloud formations, dynamics of bird flocks, the intricate fractal patterns of old trees and other plants, or the orderly movements of ants. This 'magic' is, however, of natural kind, arising from countless particles, cells, or animals adapting to one another to establish a dynamic order that benefits the higher-level entity - the organ, tissue, organism or the community. It might lead to a fractal configuration of branches that minimizes material use while maximizing sunlight and hence efficient photosynthesis, or it can involve resisting local environmental conditions or distracting predators. What's crucial to understand is that these individuals don't receive global directives from an external source—there is no leading bird in a flock—and they lack perfect knowledge of the entire system. This phenomenon is common in all complex adaptive systems. Through self-organization, they are able to form resilient, organized structures that help them to survive and flourish.

It's intriguing to note that self-organization isn't confined solely to organic systems in nature; on the contrary, it manifests itself in societies, cities, and even within computing systems. An illustrative example of the latter can be found in the early 1970s when John Conway devised a simple, yet mesmerizing cellular automaton known as the 'Game of Life.' This elegant lattice of cells underwent state changes (on/off) based on the states of neighboring cells in each iteration, exhibiting self-organization. Unintuitively, this system generated highly intricate dynamics, and was capable to give rise to novel 'life forms' and even reproduction, a phenomenon previously attributed exclusively to living organisms.

In the 1980s, computer scientist Teuvo Kohonen introduced a groundbreaking concept known as self-organizing maps (SOM) within artificial neural networks. These maps mimic self-organizing processes akin to those emerging autonomously in the human brain, building the paradigm for unsupervised learning in computer science, and more recently, even influenced the development of self-organizing hardware structure.

The resemblances and biomimicry of self-organizing systems go even further: in human brain, also higher cognitive processes beyond the cellular level, such as memory, follow similar self-organization. According to the dynamic memory model, cognitive processes like understanding, learning, and memorization are intricately intertwined. Individual events give rise to self-organizing clusters known as 'remindings.' These remindings are later retrieved and adapted for problem-solving in new situations. This concept has provided inspiration for case-based computing systems, where previous solutions form a library that can be flexibly adjusted, combined, and adapted to tackle novel problems.

These examples of self-organizing principles in nature and technology can help bridge the gap between what we consider 'natural' and 'artificial,' opening up possibilities for more generalized system ontologies. All complex systems tend to adhere to somewhat similar principles of autonomous order formation. Self-organization emerges as a common, if not universal, underlying principle in how complex systems autonomously optimize themselves, seeking the most flexible, adaptive, and dynamically evolving solutions. Self-organization can be thought of as a form of pre-evolution of all matter, organisms, and communities: after experimenting with a variety of solutions, the fittest – those best adapted to the environment and benefiting the system – will prevail. This raises the question: what exactly is 'natural'?

In this thought experiment, my response to this question would be that perhaps there is nothing in the universe that isn't nature. All complex adaptive systems, including human artifacts, despite being the products of our conscious actions, adhere to more or less similar laws of nature. By adopting a profound (techno)ecological perspective instead of an anthropocentric one, one might conclude that everything is, in fact, a part of nature: there is nothing unnatural or supernatural in the world. We and all our creations – cities, technology, mines, and the agricultural industry – are integral parts of nature, not entities standing outside of it. Such understanding would be necessary, to have crucial implications in human behavior and over-utilization of resources, and consequently, to our attitude towards the ongoing climate change and reducing biodiversity.

EVOLVING, SELF-ORGANIZING CITIES

Urbanity is no exception from these self-organizing dynamics. Traditional cities built before the 1st industrial revolution and emergence of modernistic planning paradigm have emerged in evolutionary or computational manner. Each building was iteratively adapted to the existing ones and the environment, giving rise to gradually emerging local rules and codes that start to steer the system. The new buildings would follow these rules that might regard relation to adjacent buildings, routes, slopes, or views. Similar processes are currently prevalent in many informal settlements across the world. This urban evolution can be considered to be self-organizing process in many senses. For self-organizing systems, the relations and rules between entities become essential.

In evolutionary urbanity, there are two types of rules: emergent rules, and normative rules. They differ from each other in a similar manner than in linguistic. Emergent rules self-organize within the process of how language is spoken; in cities, these resemble the regularities and relationships that emerge during the becoming of cities. Grammatical rules limit and steer the 'legitimate' use of language. These are somewhat akin to urban plans that both reflect and guide reality. In self-organizing cities, emergent rules arise from human interaction, while normative rules aim to guide the process. However, they should reflect the preferred forms of self-organization.

For instance, within the *typomorphological* school of design, the formation of traditional settlements was regarded as an evolutionary process where local rules emerged. These rules manifested in the local variations of basic building types and how they adapted to factors such as routes, neighboring buildings, topography, climate, and other environmental elements during what was referred to as *'spontaneous consciousness.'* This spontaneous consciousness implied a basic understanding of what typical building types, such as residential houses, schools, or libraries, should look like.

Now, if we return to the discourse of the 'smart city,' where physical and virtual urban aspects are intricately interwoven through AI, myriads of digital systems, data management platforms, and design tools, we may ask whether we are encountering a phase transition characteristic of complex systems, not entirely dissimilar to that of the 1st industrial revolution - where we perhaps require *'critical consciousness'*, rather than spontaneous consciousness, to innovate new building and urban types that have not yet been conceived.

Artists of the new era?

In other words, one might ask, is this a moment when we require the unique, artistic, creative capabilities of the human mind? Traditionally, this would imply significant design innovations akin to those of the master architects who attempted to curb what they perceived as a pathological growth of late 19th-century European metropolises. However, today, as designers, we find ourselves pondering the extent to which AI can assist in design – and I'm not referring to current programs that merely replicate and paste together Frankenstein-collages from the fragments of prior human work.

I've always believed that there's something profoundly unique within the human mind, and the art we create is something special and mysterious, beyond imitation. Yet, as I step back to contemplate the overarching theme of self-organization and the wonders of nature (in the conventional sense), which are artworks in themselves, I find myself less certain. Could it be that if we were to construct a digital neural network, even partially as complex as systems in the physical world, it might, in the future, be capable of generating something as intricate, surprising, and captivating as nature itself? Could it give rise to emergent rules or even innovations?

Even if it were capable of such feats, would we, as humans, be able to appreciate it? Art is also inherently cultural, as we've seen in the so-called 'dreams' generated by computers in recent years or the emergence of their own language during discussions between two unsupervised learning AIs. These examples have an uncanny quality; something about them feels out of place from a human perspective. Thus, I find myself wondering: should we willingly embrace this concept of transhumanism, extending our bodies and cities with technology and AI? And if so, under what conditions?

We are cyborgs!

Studies reveal that we touch our cellphones hundreds of times a day—more often than any living beings. We are continuously interconnected with numerous networks of humans, machines, and human-machines through computers, sensors, wearable technology, IoT, and more. By definition, we already are cyborgs—cybernetic organisms. When we delve into anthropology and the history of technology and society, this is not surprising. Throughout our existence, we have always co-evolved with technology as a species, and with cities that are more recently intricately entwined with technology. The rock or hammer in our hand has now been replaced by the smartphone. This fact compels us to reconsider our interconnected relationship with technology, machines, and cities, which can be coevolutionary on an entirely new level.

Blog: Jenni Partanen

Roads less travelled

Rather than continuing down the dead-end road of linearity, end-state optimization, and efficiency, we should seize the opportunity of a new crossroads that is emerging, and explore the uncharted path of self-organizing systems. One extreme example of these systems pushing the boundaries of our thinking is autonomous structures - robotic entities, potentially serving as basic building blocks like rooms or other spaces, that can move, climb, and cling to each other, giving rise to evolving urban configurations. These systems, exemplified by experimental practices like Minimaforms, led by Stephen and Theodore Spyropoulos, are not limited to adhering to static, simple, normative rules. Instead, they possess the capacity to create their own self-organizing emergent rules and realities, communicate with each other, and respond to their environment, a potential that I believe they will eventually achieve.

As experts of urbanity, us designers, builders, and visioners of the city, need to take a stand on such imaginary scenarios in a collaborative manner – we either actively participate in and steer such progress, or ignore it - and in the worst case, end up leaving the urban futures to the mercy of techno-optimistic propeller heads.

As experts in urban development, we - designers, builders, and visionaries of the city - need to consider these imaginative scenarios in collaboration with other experts. We can either actively engage in and guide such progress or choose to disregard it, leaving the future of urban development at the mercy of techno-optimistic enthusiasts of tomorrow.

Literature:

Corbusier, L. (1933). *La ville radieuse*. Éditions de l'architecture d'aujourd'hui.Minimaforms

Haraway, D. (1985). A manifesto for cyborgs. Soc. Rev. 80 (65-108).

Caniggia, G., & Maffei, G. L. (2001). *Interpreting basic building: Architectural composition and building typology*. Alinea.

Conway, J. (1970). The game of life. *Scientific American*, *223*(4), 4.