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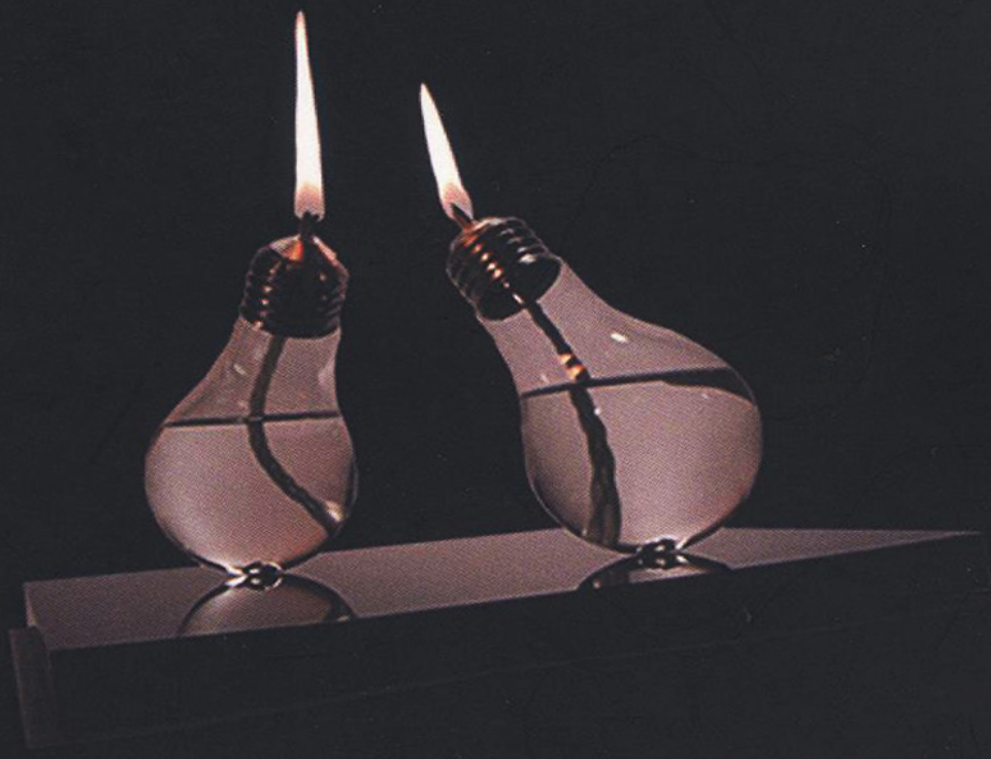

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FROM THE DEATH OF TYPOLOGIES TO THE RISE OF CELLULAR AUTOMATA: IN PRAISE OF TRANSDISCIPLINARITY

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"Cities [are] living organisms; [they] are born and … develop, disintegrate and die … In its academic and traditional sense, city planning has become obsolete. In its place must be substituted urban biology"
(Jose Luis Sert, Congrés Internationaux d'Architecture Moderne. (CIAM), 1942, quoted in Time Magazine, November 30, 1942).

Abstract

The title of this article to a certain degree could sound polemic and to some extent even iconoclastic. However, as a premise, it is important to underline that it is not meant to compare notions, tools or methods, but it is rather an attempt to present a shift of perspective in the way we look at architecture, cities and territory, an urge to change the paradigm of urban structures and town planning in the light of evolutionary sciences.
The research for a new alliance between humans and nature proposed by Prigogine and Stengers calls for a new view of human systems and of the relations they establish with the environment (Pulselli and Tiezzi, 2009) with sustainability as an aim as well as defending the opportunities for a new hermeneutic of the city which will bring along a new language and aesthetic.
The key to such a challenge resides within the concept of *transdiciplinarity,* a synthesis between disciplines that destroys academic barriers and creates new disciplines in which everything is more than the sum of the parts and which has something to do with the complexity theory. Its essence lies in combining pre-existing elements to create new synapses.
We will look at how the evolutionary theory, the complexity theory, systemic thinking and the contemporary debate on sustainability and ecology have radically changed the approach to the design of city and territory and, in particular, to the historic dichotomy between Top Down versus Bottom Up model and the emergence of *the self-organized city* as possible morphogenetic process for sustainable city design.
In general terms we could argue that the point is a matter of *order versus chaos* whereby chaos we mean 'not a cult topic but a dynamic state, its potential

revealed by science, that can indicate the way to a more subtle and flexible order than simplification and repetition.' (Portoghesi, 2009)

Keywords

Sustainability, urban planning, complexity theory, systemic thinking, multi agent systems

Typologies and Typological thinking

The notion of Typology in architecture implies indeed a desire for order, control, reason and syntax. It refers to what Caroline Bos and Ben van Berkel have named as 'a legacy of rationality' (2011, pp.68).
In times where, on opposite ends, both the economic recession in the West and the large scale opportunities in Asia and the Middle East are defining the conditions of city and territory, the aspiration for an ordering device as a sort of polar star to direct people seems to be tempting.
Typological design offers the advantage of a quick and standardized product with precedents, a clear taxonomy, strictly logic, extremely communicable, reassuringly predictable and the power of being both an instrument of analysis as well as an element of design.
Broadly speaking typological reasoning is a great model or principle for the legibility of socio-cultural and material products and its strength lies within its capacity to establish relationships: relationships between entities supposedly different , creating chains and resonances among object of different species, revealing the stratifications subjected to many experiences (Martì Arìs, 1993, pp.183-194); relationships between the collective memory and the city, informing the image of a city, what Aldo Rossi called the 'apparatus' for mediation between the individual object and the collective subject (Rossi, 1995); relationships between a design method, forms of knowledge and production processes, and, above all, between the architectural work and the broader set of 'conditions', the inherent forces and mechanisms of each production: '[…]a notion in common to designers, clients, contractors, users which allows the understanding and agreement of the social body in the setting-up of its built environment .It is the selective result of many further elaborations which enables capacity's collaboration in space and time and the improvement of the product, unattainable by a single talent.' (Benevolo, 2005)

Another important aspect of types and typology has been and still is the power to name, organize and speculate a particular knowledge, in the more specific sense of the disciplinary knowledge (Gregotti, 1985)
Types are meanings or *schema*, as Argan (1965, pp.75-81) would say, and they follow logics of significations, they have an incredible semantic and semiotic authority because they enable dialogue and discourses not only between the actors of the discipline but also and most importantly between architecture and the city. However, to do that, they need to synthesize and simplify the complexity of the urban in order to permit operability, both cognitive and productive, to reduce to a finite number of cases the possible infinite ones. This simplification of the complexity of the urban apparatus could be seen as well as an over-simplification and, in this perspective, as one of the disadvantages of Typological thinking.
In addition to the above, typologies suffer from another major weakness: quite inflexible and embedded with a structural and ontological need for control and repetition are unprepared and, paradoxically, disorganized to deal with self-organization, in specific with the so called 'informal' settlements which constitute the majority of urbanization processes (the so called *favela urbanism*), and with the relentless design output of large numbers (Salingaros et al., 2006). Their inadequacy to respond to such topics belongs in part also to their intrinsic condition of being a sort of syntax of the Top-Down approach to urban planning. They belong to what is also called the 'geometry of control' where control is exercised by not allowing individual variations, since '*complexity ad variation are perceived as losing overall control – not only of building typology, but also of the way decisions are made – and thus are avoided*.' (Salingaros et al., 2006)
Interestingly enough, precisely this tie together with their ordering agency has contributed to place them at the base of the birth of the sustainable agenda in city planning at the beginning of the XX century.
I believe however that this very birth was the beginning of their death.

The beginning of the fall

When in 1915 Patrick Geddes published '*Cities in Evolution'*, where he first introduced the concept of ecology and sustainability within city design and planning, he was trying to fight against the social and environmental chaos and evil of the spontaneous (read: Bottom–UP) sprawl of the city after the industrial revolution.

He was the first one to consider the city as an environment which could influence, positively or negatively the organism it contained and in doing so, he was promoting a certain aesthetic quality of the city space and at the same time he was linking social progress to spatial design and quality of the environment through the use of different tools or devices, among which stood typologies. However, and here we tie back to the notion of *order vs chaos*, although his method can be clearly described as a TOP DOWN approach to planning in a very deterministic, organized and predictable way, his book was also the first publication to shift the accent from a developmental paradigm to an evolutionary one, following the neo-Darwinian framework where small changes can lead to big effects: from predictable to unpredictable, from form to function, from structure to process (Batty, 2010).

The Top Down approach promoted by Geddes, even though not initiated by him, was challenged again for the first time in the 60's by people like Jane Jacobs and Christopher Alexander, who both had rediscovered the potential of small incremental and spontaneous changes on a vast scale as per the evolutionary paradigm.

Jacobs in her '*Death and Life of Great American Cities'* in 1961 declared that 'the diversity of cities that marked their quality is the diversity that was formed from countless individual decisions, generated from the bottom up.'

A similar position was taken in 1964 by Alexander who in '*Notes on the synthesis of form'* argued pretty much the same: good architecture, he said, was well adapted to context, the product of many decisions about form which were tried and tested as those who lived and used buildings sought to adapt them to their purpose (Alexander, 1964) .

The trend towards the re-appropriation of the Bottom Up model had a final push in the '80s with the formulation of the Complexity Theory and the need to incorporate the 'uncertainty factor' about the result of the process of change: the essential principle for a complex system is a group of elements that perform independently of one another but nonetheless manage to act altogether, through constraints and limits to their actions and through competition and co-evolution. The physical map of complexity is the feature of self-organization. Such a passage becomes even more remarkable if seen in concomitance with the interest for clean and renewable energies which seems to flourish in about the same years.

If we look at history as a sequence of different human metabolic systems we see that the type of energy resource men used to draw on in the first two metabolic systems (hunter-gathers societies and agricultural societies) by acting

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on the biophysical matrix processes in their territory was always a cycle of production and consumption limited to the biosphere. With the access to mineral resources and therefore to the lithosphere, the sustainable cycle of production and consumption got broken because the biosphere was not able to metabolize the unwanted waste coming from consumption of the lithosphere materials (Rueda, 2008). Curiously enough the type of prevailing city models in the first two cases was a Bottom Up one, which was substituted by a Top Down one after the Industrial revolution.

The research towards new types of energies, shifted again in the biosphere realm, seems to have been accompanied by a renewed awareness of the potential of the Bottom up model of city planning, a more complex and emerging mode of action where the Bottom Up/Self Organized approach could be seen as a possible morphogenetic process for sustainable city design.

According to Peter Langley, Professor of Geographic Information Science at the Bartlett, University College London, 'self-organized cities are cities that seek to fill their space in the most efficient manner following rules of self-similarity that show how they arrange their parts to conserve and utilize the transport of their energy in the most efficient way'.

On the same line Michael Batty, Professor of Planning at the Bartlett, University College London and Director of the Centre for Advanced Spatial Analysis, argues: '[The self–organized cities are] models of cities simulating morphologies that are surprising in that their form cannot be anticipated from the assumptions and processes adopted in their representation.[…]It is a consequence of the complexity approach that appropriate models should provide 'information' rather than 'solutions', should 'inform' rather than 'solve'.'

The main differences between a 'Self Organized-Bottom Up' model and an 'Organized-Top Down' one could be summarized in eight couples of opposite modes: apart from the tautological Self organized Vs Organized, we could add Stochastic Vs Deterministic, Far from Equilibrium Vs In Equilibrium, Characterized by a Decentralized decision making Vs Characterized by a Centralized Decision making, Surprise and Novelty expressed in the language of transition Vs Predictability, Emergent Vs Founded, Topologic Vs Discreet, Heterogeneous Vs Homogeneous.

The notion that cities are always 'out of equilibrium' and are constituted by a multitude of bottom up decisions which , though producing coordinated and ordered patterns, can behave in the most unpredictable ways, force us to take

on board the neo-Darwinian framework also when thinking about the effects of climate change, per se barely predictable.
Such point leads to the recognition of the need to offer solutions which would allow various elements of design to self-organize, guaranteeing a margin of improvisation, so that architecture, city and anthropic landscape could be understood and designed as 'amalgams of processes', spaces of vectorial flows which modify and adjust themselves according to some inputs: open languages of fluid and dynamic aesthetics based on the logic of biotopes, ecosystems and 'loop structures', typical of sustainability.

Order versus Chaos

Within this scientific framework of complex, emergent, bottom up logics a very confined and terminal place was left for typological thinking: as Deleuze and Guattari remind us, 'Darwinism's two fundamental contributions moved in the direction of a science of multiplicities: the substitution of population for types and the substitution of rates or differential relations for degrees.'(1999, pp.48-49)
It is this new ontological structure therefore that seems to have decreed in different disciplines the death of typologies and the rise of self-organizing/generating models such as the ones of multi-agents systems and cellular automata: algorithmic codes are being organized to digitally breed cities, dealing with the 'organization, quantification and systematization of quanta of data'(Parisi, 2013).
The use of Typological thinking and its related use of typologies as categories of thought is based indeed on a deterministic heuristic process, while cognitive processes are stochastic by nature since they combine choice and chance in the development of knowledge.
Such position has strong links to the origins of dynamical system thinking and in particular to the work of Joahn von Goethe, author of the 'Metamorphosis of plants'. Quoting Ernst Cassirer, 'Goethe effectuated the transition from generic thinking, from the habit of thinking about form within the fixed and decidedly typological lineal tables of genera and species, to the genetic habit of mind which sees form as an active process of generation, improvisation and expression'(Kwinter, 2011)
It is what Ernst Mayr, one of the fathers of evolutionary thinking, would later describe as 'Population thinking versus Typological thinking': '*For the Typologist, the type (eidos) is real and the variation an illusion, while for the*

Populationist the type (average) is an abstraction and only the variation is real.' (1976, pp.325)

Variations, differentiations, and *multiplicities* are categories of paramount importance within the evolutionary paradigm. They differ from the term *variants*, acceptation more proper to typological thinking, as they imply the replacement of visual sameness with similarity, in fact while variants represent modifications to an original artifact/project/model, variations do not imply the existence of a primitive, a matrix or an archetype, they rather indicate marking differences of one individual from another of the same species. Most importantly, shifting from biology back to architecture, they embody the passage from typicality to non standard seriality (Carpo, 2011).

It is the passage from the science of models characteristic of a series, where, by models, we mean rules, to the science of codes, where by codes, we mean rules; in other words, from types to variables.

Variables and multiplicities, interpreted through the Deleuzian lens, are yet again semantic entities of a rhizomatic way of thinking capable of self-organizing without internal hierarchies with neither entry nor exit points. This type of knowledge stands opposite the arborescent conception of knowledge - to which the concept of types and its 'relatives in law' such as archetypes, prototypes, etc… belongs - which is instead a type of research that proceeds with deterministic categories and binary choices.

Following the deleuzian form of thought once again, Manuel De Landa, examining evolutionary simulations as breeders of new forms replacing normative design methods, suggests that there are another couple of elements that distinguish standard from non standard approaches to design: Extensive vs Intensive properties and Euclidian geometry vs Topological geometry (De Landa, 2001).

The first couple of antagonists bring us straight back to the very beginning of the complexity theory as proposed by Ilya Prigogine through his study of thermodynamics and out of equilibrium systems: Intensive properties refer to quantities that cannot be subdivided as such like temperature, pressure, speed, conductivity, resistance, etc.. in opposition to extensive properties which instead refer to magnitudes such as length, area, volume etc…. Beyond the obvious lack of divisibility what really interested Deleuze about intensive quantities were those *degrees of intensity* which are productive since they 'drive processes in which the diversity of actual forms is produced' (De Landa, 2001) and in this matter he is still dealing with differentiations and variations.

Differential, variable, multiple and semiotic are also the features of the 'abstract diagram' or 'abstract machine' which develops out of Topological geometry in opposition to Euclidian geometry. The 'abstract machine' of Deleuze and Guattari 'consists of uninformed matters and nonformal functions.[…]it is not made up simply of formed substances (aluminum, plastic, electric wires, etc.) or organizing forms (programs , prototypes, etc.) but of a composite of unformed matters exhibiting only degrees of intensity…' (1999, pp.511)

In our attempt to describe the ordered, extensive, Euclidian *Typological thinking* compared to the chaotic, intensive, topological *Population thinking,* the distance between typologies and algorithmic codes brings to the surface another major issue of divergence in terms of approach: the notion of style and authorship.

The authorship question

As previously mentioned, one of the key strength in the concept and use of typologies in architecture has been its ability to re-engage the architect and his disciplinary knowledge, re-empowering him with the authority of reason and reinvention. (Lee and Jacoby, 2011)

On the other end, in a field like the one of algorithmic morphogenesis, self-organizing and emergent systems are playing a major role in challenging the 'modern notion of architect's full authorial control and intellectual ownership of the end product' (Carpo, 2011) and the contribution of the designer to the process could run the risk of being downgraded to a simple breeder (De Landa, 2001).

However, I believe that it would be worthwhile to dwell a bit more on a couple of points in order to better understand the implications that concepts like subjectivity and agency could have in morphing the discipline's future.

First, the same notion of complexity, as it has been developed not only in architecture and urbanism but also in other fields such as artificial intelligence, urban physics, climatology, economy, ecology, civil engineering, information and data study, software programming, etc. has been modeled and applied through the use of parametric algorithms (PA) or Interactive genetic algorithms (IGA) and they imply a sort of dialogue, a notational code, between man and machine. This dialogue would be better described as an interface and has a particular privileged role to play in the production and use of subjectivity as we

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find it in the definition of the aesthetic paradigm of Guattari's *Chaosmosis*. An idea of subjectivity strictly linked to the concept of ecology and virtuality. It recalls indeed the designation of *machines of virtuality, '*blocks of mutant percepts and affects, half-object half-subject. […]They are becomings – understood as nuclei of differentiation. […] Not a gestalt configuration, crystallizing the predominance of "good form". It's about something more dynamic, that I would prefer to situate in the register of […] the autopoietic machine to define living systems' (Guattari, 2006).

From a semiotic and ontological point of view the interface and its autopoietic, self-generating/organizing assemblages are 'incorporeal ecosystems'(Guattari, 2006), de facto resembling the notion of VIRTUAL ECOLOGY, or ecology of values, wished for by Guattari: 'a speech (of thought, sensation, consultation…) between men and machines that would mark the change from 'the contemporary world - tied up in its ecological, demographic and urban impasses incapable of absorbing, in a way that is compatible with the interests of humanity, the extraordinary techno-scientific mutations which shake it', to a world characterized by a 'generalized ecology – ecosophy - […]as a science of ecosystems, as a bid for political regeneration, and as an ethical, aesthetic and analytic engagement.' (2006, pp. 91-92)

The very notion of the interface, together with the one of bottom up systems, entails concepts like open-endedness, participation, interaction and mass collaboration and reconnects to the concept of Population thinking as the method of reasoning which remind us that the population, the group, the society is the medium for the production of forms, not the single person.

This position in the history of art is neither new nor revolutionary as even in the XVth century Leon Battista Alberti, 'master builder of the Italian Renaissance' (Grafton, 2000) committed to achieve personal recognition through the affirmation of 'his role above the others' in the construction of a building, believed that creativity was a social and not an individual process (Carpo, 2011).

Often criticized as the theory of 'out of control', definition that becomes even more pregnant in terms of critical agency, the complexity theory applied to the urban could instead, in my opinion, be the enabler of a new paradigm where the notion of single authorship with intellectual ownership and his aesthetic language is substituted by the concept of a collective and a new *aesthetics of choice* or 'aesthetics of decision'(Shaviro,2009), where aesthetics might recover, according to the evolutionary theory, their essence of an adaptive system (Orians, 1998?, Appelton, 1975, and Marchetti, 1998, pp.22-35) and an ecological category (Di Carlo,2012).

Transdisciplinarity and new models

There is a need for a new hermeneutics which would bring along a new aesthetics as a property of matter in evolution according to the 'fundamental law about the creation of complexity: all the well-ordered systems that we know in the world, all those anyway that we view as highly successful, are generated structures, not fabricated structures. (Alexander, 2003)'

New models are required in order to breed cities in 'digital laboratory', models that can be borrowed by other disciplines like biology, genetics, economics, cybernetics, botanic, etc..

The key to such a challenge resides within the concept of *Transdisciplinarity,* a synthesis between disciplines that destroys academic barriers and creates new disciplines in which everything is more than the sum of the parts and which has something to do with the complexity theory. Its fundamental nature lies in combining pre-existing elements to create new synapses. Quoting Herman Daly, a founder of sustainable development, and Joshua Farley*: '*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.*'* (Daly and Farley, 2004)

In this mind framework the supremacy of typological reasoning to re-engage the architect and his 'disciplinary' knowledge might sound quite obsolete and reactionary. The discourse about the urban has already taken advantage of the migration of certain models from other disciplines.

A reference could be for example the loan from biology of *sugar-scape models*, agent based social simulation that make possible to explore the connection between the micro-level behavior of individuals and the macro-level patterns that emerge from the interaction of many individuals; or *allometric models*, studying the relationship of body size to shape, anatomy and finally behavior, can be used to link the size and shape of living objects to the networks they use to deliver resources to their parts; or again *stigmergic models*, mostly interesting within the framework of a sustainable agenda because they represent the social mechanism of coordination based on interaction through local modifications to a shared environment, where subsequent actions tend to reinforce and build on each other, leading to the spontaneous emergence of

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coherent, systematic activity. As form of self-organization they produce complex, intelligent structures, without need for any planning, control, or even direct communication between the agents.

This last model has been further enriched in terms of cognitive emergent behaviors when borrowed in turn by IT scientists who introduced the presence of *artifacts as environmental modifiers.* In the paper *Cognitive Stigmergy: a Framework based on Agents and Artifacts* published by a team of the IT department of DEIS at the University of Bologna, headed by Prof. Alessandro Ricci (Ricci et al., 2007) the research team, working on the concept of Stigmergy as a MASs (multi-agent systems) technique for realizing forms of emergent coordination in societies composed by simple, non rational agents, introduced the use of '*suitable engineered artifacts*' to explore, instead, the concept of Stigmergy in the context of societies composed by cognitive/rational agents, 'as means for supporting high-level, knowledge-based social activities.' The standing hypotheses at the base of the study were mainly two: *the environment as subject to open interpretation and perception,* therefore subject to an aesthetic conventional and collective system of signs and *the environment as mediator of behaviors,* articulated and composed of artifacts which, subjects to human cognitive activity, assemble the social workspace. Artifacts are therefore entities representing the environment that mediates agent interaction and enables emergent coordination but most of all, within the computational model; they promote awareness and represent the rationality/intentionality of agents' actions.

In this perspective the environment acquires a key role, acting not only as a container, a passive landscape against which all the interactions occur, but rather as a negotiator and a ruler of interactions promoting the emergence of local and global coordinated behaviors.

This specific research is of particular interest in the field of architecture and urban design because, as Patrick Schumacher rightly points out, since architecture and even more urban design are at the genesis of modes of abstract thinking, of ordering, of classifying where conceptual structures and schema can emerge, it follows that architecture sets up social order and in this line becomes explicit the importance of the role of artifacts because 'they are the factors upon which society is built up.' (Schumacher, 2011)

Transdisciplinarity is thus the new paradigm, in the Kuhnian sense of '*change in the visual gestalt […] capable of envisaging the elements of a problem in a new light, permitting to reach the solution for the first time*.' (Kuhn, 1969)

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