A Multi-Level Fusion of Evolutionary Design Processes

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Evolutionary design methodologies generally aim to present new form-finding processes, where nature-based approaches are used, such as self-organization, genetic algorithms etc. This paper aims to present a new architectural design approach that focuses on integrating these different evolutionary methods in an emergent process. The main goal is to achieve a high-level of integration where lacking qualities of each evolutionary method are completed by the other one in a synergic and especially emergent behavior.

Keywords: Evolutionary design; morphogenetic; self-organization; emergence.

Nowadays, there are so important and fundamental questions about reasons for evolving architectural designs asked by many people. In fact, the problem concerns not only the design solution but also the design process which several paradoxical but generative axioms happen in. As perceived, there is one unique design solution diagram in common design approaches which generally emerges. Indeed, architectural design is a multi-level algorithmic process where sometimes opposite but epistatic phenomena fight to form a complex, in contrary organized formation as well. My research briefly aims to establish a new design system, based on a dynamic fusion of different architectural design processes which focus on taking the design matter in hand within a natural bottom-top approach, in order to eliminate the general architectural disadvantage of approaching to a design problem with specific pattern designs.

Architecture has frequently drawn inspiration from nature - from its forms and structures, and most recently, from the inner logic of its morphological processes. Therefore, it is necessary to be explicit as to where architecture is literally taken as part of nature and there are analogies or metaphors, also absolutely where nature is a source of inspiration. For Rosenman (1997), the evolutionary approach is basically a generate and test approach which corresponds well to the processes of design synthesis and evaluation. He continues with the 2 main advantages of this design approach: first, a more diverse area of the design space can be traversed than with other methods and second, a probabilistic selection method directs the random generative process towards meaningful and satisfactory solutions. These are the direct results of the bottom-top design property of an evolutionary system. In a bottom-top system, all the components (wherever they are located as level) are hierarchically stimulated to generate a perfect order at a higher level, as perfectly happening in nature. The sensitive control of the hierarchically positioned components is the work area of self-organized
complex systems. Self-organization is a spontaneous action happening in different areas of multi-level structures to achieve a perpetual epistasis in the whole system. Heylighen (1989) states that there is not just one system and its environment, that there is a multitude of systems evolving simultaneously, partially autonomously, partially in interaction. He adds that this “network” structure of evolutionary processes entails that no absolute distinction can be made between internal and external, i.e. between system and environment. The conclusion is enough clear: what is “system” for one process is “environment” for another one. Self-organization design process stays indeed in the lowest level of the system hierarchy, to obtain an order within the chaos of the small input. The — self — concept maintains the natural and the perfect aspect of the whole organization. An unbreakable equilibrium between the small genes is established at the end of the simultaneous reactions during this phase. On the other hand, general behavior causing such a differentiation of level between these genes is the variety from simple rules attributed to them. Genetic Algorithms (GAs) in design methodologies, especially focuses on establishing heterogenic gene pools firstly, to obtain matures with variant quality and quantity; secondly, to support the information flow between distinct location of the system. In such a high degree of complexity; both in quantity (self-organization), both in quality (GAs) may sometimes unavoidably trigger reactions small in appearance, but highly big in content. These unpredictable emergences fabulously distinguish the design process. For Wiscombe (2005), emergence refers in fact to a very particular scientific phenomenon: the indivisibility and irreversibility of wholes-be they structures, organizations, behaviors, or properties. In particular, emergence refers to the universal way in which small parts of systems, driven by very simple behaviors, will tend toward coherent organizations with their own distinctly different behaviors.

After having briefly explained the main conceptual components of the system, we have now to highlight the general interactions between these different design processes to understand the synergy desired to emerge within this multi-level fusion and to focus on the physical applications of such a fusion within the example I propose for suggestion.

As I have already underlined, architectural design must be taken as a meeting point of different dynamic approaches where the sequence of production becomes an endless process which large cumulative interactions happen in. This point of view in design area can be helpful to open new possibilities to bridge the gap between several traditions of design. This idea is more realistic in the evolutionary design area because of its process oriented attribute. The most simple and quick way to conclude this multi-component equation is to pit the fighters against each other. I hope many obscure points will come into focus with this empirical synthesis.

The location of the project is the specific old villages in Istanbul. The most dramatic features of these villages are their preserved virginity against urban violent behavior and their spontaneous and nature-inspired formation next to the famous fluid in Istanbul: the Bosphorus. A natural formation as a rock cliff but an artificial island since a century, just in front of these villages sits on the waves of the Bosphorus: Kurucesme Island. Extreme attributes such as located on the water, bounded with historical virginity and urban violence at the same time make this land piece an excellent work area for this project carrying the similar chaotic behaviors.

The multi-level architectural design process begins with analysis of different qualities both natural and handmade, affecting the global character of the project site. The main problem is first to control the natural situation of the island against opposite environmental solutions and then to bring in a new morphological aspect supported from natural dynamics. In addition of these natural effects, the general architectural situation of the periphery habitations must also be taken as an important part of the analysis phase. There is indeed two potential source of information about the project site: first, concerning input about environmental habitations, so the static
one; second, concerning the natural inputs such as topography, water etc., so the dynamic one.

After having gathered data required, it is now time to organize them, better to say, let them organize themselves. Data collected is directly interpreted to small virtual genes in order to make the self-organization more successful within an analytic way. The static data here shows a homogeneous expansion of small and similar old habitations, but on the other hand a heterogeneous low presence of new design typologies. The projection of the static genes under self-organization concept aims to establish a resolute organization on the site with these two different approaches. A determined order in the network between the opposite existences of habitations in the manner of age, style, form and size will undoubtedly help to the next stage of the system. The images below describe the process of environment-space evolution (Figure 1).

When a continuous equilibrium is reached between the genes carrying data of different qualities, designer begins more to handle the situation with a genetic approach. The main aim of this sequence is to obtain varieties of genotypic constitutions without breaking the epistas established at the last organization stage. Data genes can now be included in a mutation pool where they will meet some cyclic actions such as evaluation, selection, reproduction, kill, move, crossover etc. The perfect offspring will probably derive at the very end of these mutations. This sequence indeed focuses on the determination, resistance and especially on the congruence of the data genes for the present project site and of course for the designers’ criteria. This period of the sequence concerns some subjectivity about the perfect time to stop the simulation happening in the gene pool but to choose the final phase of the cyclic before it repeats itself as a vicious circle seems the most logical behavior.

Until this period of the design study, data required for an efficient morphology has been collected, organized and then finally shaped with different interactions. During these interactions happening between processes, some unpredictable reactions happened in the system. Some were disqualified because of their dissonance and some were taken as catalyst for future stage. For example after a simple reproduction of a static volume gene with a dynamic water effect gene an extraordinary solution abruptly emerged: fluidity. Fluidity is an emergent idea, different from other solutions because of its physical impossibility for a realistic design project but extremely astonishing for a conceptual behavior before the metamorphose phase.

Figure 1
Evolution and self-organization of genes at a scheduled simulation.
It is finally time to handle all the projections we gathered from last processes and then interpret them to *morphogenesis*. The basic morphological element chosen is the fibres which extremely carry the opportunity to act under several stresses coming from data gathered. Local and global interactions happening between the fibres (curves) will positively affect the final surface of the design shell. Fibres behave here as a DNA spiral not only as carrying the genetic information belonging to the final design but also as shaping the whole structure (Figure 2-3).

Generating new form-finding methods in the light of traditional evolutionary design methodologies clarifies that architectural design has still a great dynamic to open new design spaces. Evolution here plays an important role to orient present plugged design methodologies with a different focus on processes instead of final results. This project aims to consider architectural design as a whole organized process where different conceptual design systems can (or must) behave together for the purpose of generating a synergic relational space; and most importantly, chooses not only to occupy with gathering the final matured fruits falling on the ground, but also to investigate the all design generation, maturation and demise phases, in order to acquire more fruitful, more natural and healthier harvests.

**References**

