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Study on Geometrical Emergence in the Architectural Design of Le Corbusier

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Emergence Creativity Architectural Design Le Corbusier
Design Process

1. Introduction

The interest in understanding how human designers design and generate creativity was increasing since the middle of the 20th century. Part of this interest comes from a need to develop appropriate computational support tools and to to provide a basis for models of designing. Generally, exploring architectural creativity was covered according to four approaches: Object-oriented approaches, process-oriented approaches (Suwa & Tversky 1997, Gero & Tang 2000), subject-oriented approaches (Mackinnon 1962, Hudson 1966) and context-oriented approaches (Kuhn 1962, MacAllister 1999). Because of research feasibility (time limits and means availability), this study was an object-oriented approach focused on the architectural works of le Corbusier as a great architect of the last century.

2. Conceptual framework

Architectural design is a complex, contextual and situated cognitive process of coherent manipulation of information and models in order to generate a response to a situation or a problem. A creative Architectural design means the introduction of new variables that change a common design model or structure through the emergence of unexpected design structures. Architectural Creativity is then a multidimensional process of reorganizing information and models (building blocks), following some specific geometric and logic rules of construction, in order to built solutions to a situation or a problem.

In his book: “Emergence, from chaos to order”, John H. Holland suggested that in creativity, the process of selection in our mind could be similar to the ones that take place in evolutionary biology, but in much faster scale. Concepts from chaos theory may contribute to clarify some of its aspects. Literature examination has revealed that the theory of complex adaptive systems

CAS is among the models that well reflect the interaction mechanisms within a chaotic system. CAS based models introduce an analogy between diversity in biological world and diversity in design by following some principles behind diversity in the biological world, like : emergence. Emergence is a process of making properties explicit, which were previously only implicit in a representation. It is related to a conscious or subconscious process of merging, combining and modifying forms or pictures in our mind that leads to discoveries in Design (Gestalt & cognitive psychology).

In this study, authors sketched a simplified mathematical model based on chaos theory, in order to explore Le Corbusier’s intrinsic geometrical logic that allowed the generation of his Architectural works. 02 hypotheses have been formulated:

1. The process of development and creative selection may be similar to the one that takes place in biology but in a much faster time scale.
2. The concept of Emergence might structure the background of Le Corbusier’s creative process.

3. Mathematical model

According to Stanislaus Von Moos, the work of Le Corbusier should be studied through forms rather than themes. Creativity can be considered as the search for the model that allows us to generate forms that obey to the proportional and topologic norms of harmony. Exploring Architectural Creativity through the design products requires the elaboration of a mathematical model that cover all their aspects and attributes: Shape, volume, texture, materials, etc.. This study is based upon the exploration of Le Corbusier’s Creativity at a 1st approximation. The concept of approximation means that the design is considered as a coherent set of volumetric components considered as cubic components (fig.1,2 &3).

According to Gero et al. (1994), design variation is not limited to binary string, but also to transformation grammars. Based upon chaotic algorithms concept (Lansdown, 1995), authors elaborated a simplified model that takes into account the geometric attributes of the design components (fig.4).

Fig.1 Villa Savoye

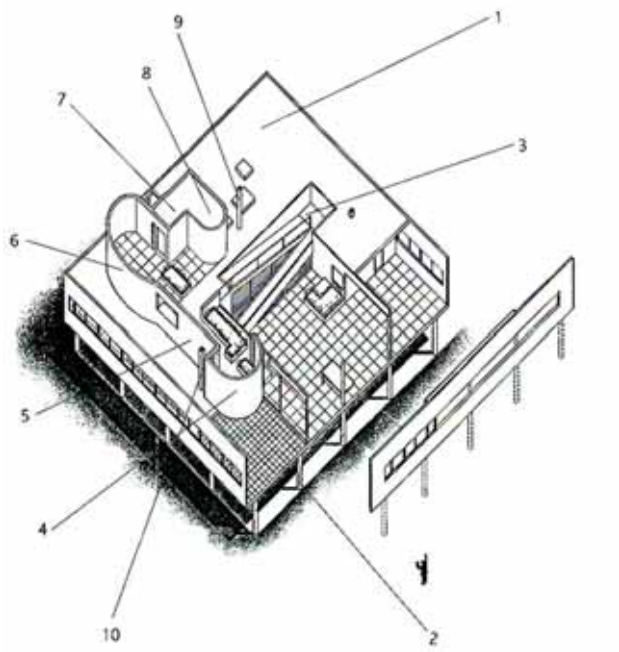

Fig.2 Design Components

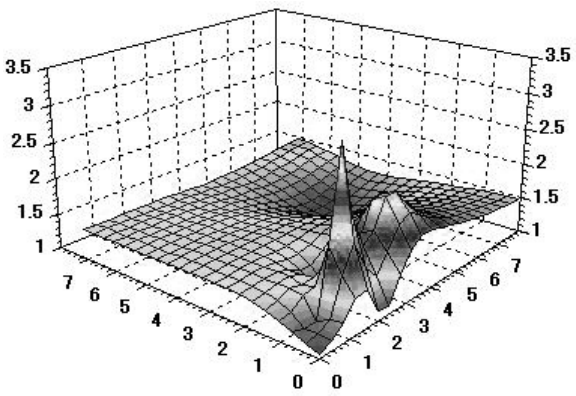

Fig.3 Pathway graph

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$$O_i = L^{path} \times O_{(i-1)}$$

O_i : Design component "i", the size attributes of which are represented by a matrix: (x_i, y_i, z_i).
L^{path}: Design pathway (logical matrix), represented by a square matrix composed by the size attributes proportions of the biggest design component and the smallest one (extreme components).
O(i-1) : Previous design component "i-1", the size attributes of which are represented by a matrix:

4. Results and discussion

The analysis of the results showed that Le Corbusier's creative process seems to obey to the complex adaptive systems operative rules. Emergence, Analogy and mutation represent concepts that may structure Le Corbusier's creative way of designing. Le Corbusier's design process seems to submit to the decrease scheme. Le Corbusier's purism allowed him to begin with a principal form (design component: often a cube or a parallelepiped), and then tries to generate a series of smallest forms.

Emergence appears in the earlier Le Corbusier's design works. No emergent forms have been found in the Unité d'habitation of Marseille (the 1st application of the MODULOR) and the couvent Ste Marie-de-la Tourètte. Emergent forms represent generally the pilotis (the smallest design components), (tab.1), (fig.5,6 & 7) .

References

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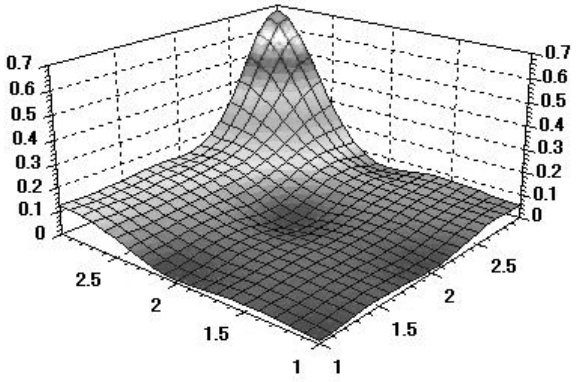

Fig.5 Pathway graph

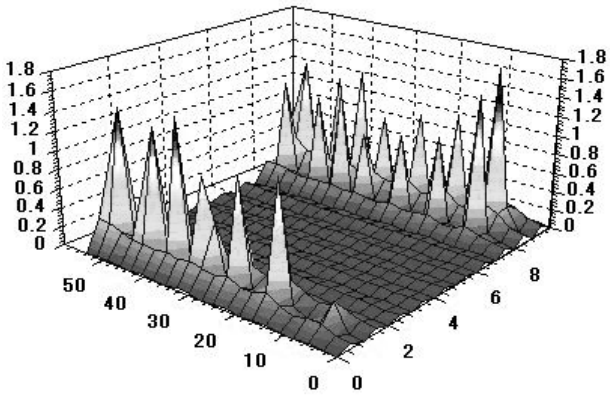

Fig.6 Graph of the geometrically emergent design components

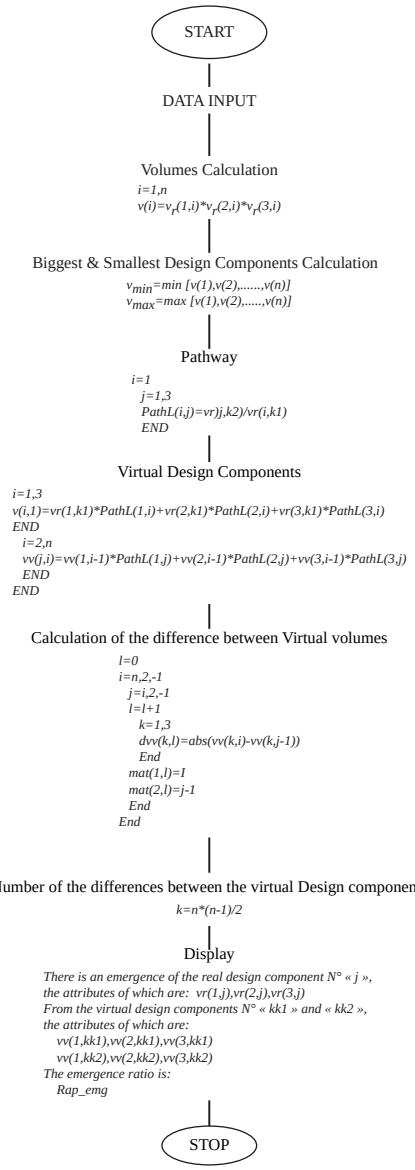

Fig.4 Algorithm

Tab.1 Geometrically emergent forms

Architectural work	Year	Forms generated by emergence
Dom-Ino	1914	Pilotis
Citrohan	1922	Pilotis
Ozenfant	1922	Triangular roof volumes
La Roche	1925	Pilotis
Savoye	1929	Pilotis, round shaft on roof terrace, roof terrace shaft
Marseille	1946-1952	
Ronchamp	1951-1955	Interior and exterior balconies
Tourètte	1957	

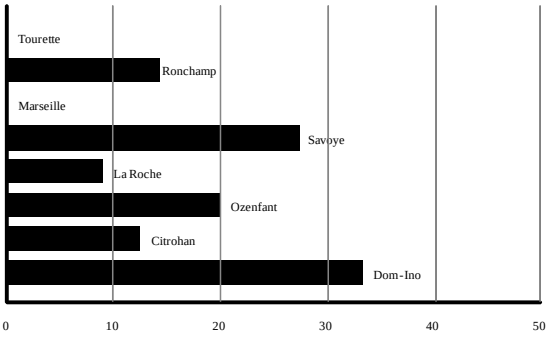

Fig.7 Pathway graph

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