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# Learning Prototyping and Adapting

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**Edited by**  
Weixin Huang  
Mani Williams  
Dan Luo  
Yi-Sin Wu  
Yuming Lin

## LUIGI MORETTI, FROM HISTORY TO PARAMETRIC ARCHITECTURE

G. GALLO <sup>1</sup> AND G. PELLITTERI <sup>2</sup>

<sup>1,2</sup> *Università degli studi di Palermo, Palermo, Italy*

<sup>1</sup> *giuseppe.gallo03@unipa.it*, <sup>2</sup> *giuseppe.pellitteri@unipa.it*

**Abstract.** In this article we aim to give new light on the thinking of Luigi Moretti, first to have formulated the concept of parametric architecture, comparing it with those of some contemporary architectural theorists and designers. Latest researches on materials and form finding experiences have shown a new relationship between form and structure, Moretti understood it before the advent of internet. Moretti's parameter stems from the architectural tradition, as Carpo sees relations between parametric design and history. Moretti's Parametric architecture is interdisciplinary, open to science in ways that we are only now understanding. We therefore believe that recovering Moretti's methods of parametric architecture today, thanks to the power of artificial intelligence and the proliferation of big data, can open new opportunities for computational architecture, as well as Moretti's mistakes can be a precious teaching.

**Keywords.** Parametric architecture; computational design; data aided design; digital architecture; generative design.

### 1. Introduction

Looking at the architectures produced with computational methods by some of the major architectural firms in the world it is difficult to understand which are the connection with history of architecture, yet the very concept of parameter has demonstrated a relationship with tradition (Carpo, 2016). The names of Antoni Gaudí, Frei Otto, are, rightly, among the most cited as key figures, obviously they are not the only ones. John Frazer (2016) wrote an interesting article, also talking about the figure of Luigi Moretti, Italian Architect who appears to be the first to have formulated the concept of Parametric Architecture in 1940.

### 2. Moretti, man of Italian culture

Moretti is not a stranger for the architectural community, his works have been widely treated, especially in Italy (Bucci, Mulazzani, 2000; Reichlin,

Tedeschi, 2010), but it makes sense to review his thoughts, his experiences, his methods, his mistakes, after the evolution in the architectural field occurred during the last years (Carpo, 2017), to understand what is happening today, both from a technical and theoretical point of view.

Moretti's thought, his commitment to parametric architecture dissemination, make him comparable to Patrik Schumacher, architect and architecture theorist who launched Parametricism, promoting it as a new global style (Schumacher, 2009). We also see many differences between them, Moretti was born in Rome in 1906, Rome is where he lived most of his life and where he founded the Institute for Operations Research and Applied Mathematics in Urbanism (IRMOU), place of his first computational experiments.

The influence of Italian architecture is alive in his parametric architecture. We can therefore say that Moretti, born almost a century before the spread of the Internet, is a man of Italian, Western culture, not global.

His ideas, mainly spread by the Magazine Spazio which he founded in 1950, are born from the study of traditional architecture and art, developing into theoretical and therefore methodological analyses. On the other hand, Schumacher launches parametricism after the spread of Internet, promoting a broader, global theory, starting from the thought of the German philosopher Niklas Luhmann he also develops wide social considerations (Schumacher, 2011).

Quadrivio magazine publishes one of the first Moretti interviews (Diemoz, 1936), on that occasion Moretti announces the arrival of a new architecture, anticipating considerations on the relationship between form and structure deepen in the following years. Moretti announces the end of rationalism within ten years, defining it a movement born on paper, therefore primitive. History has refuted Moretti's prophecy, and even today rationalism has an influence on architecture, this according to Schumacher (2016), who sees in it a difficulty in accepting the need for a new architectural complexity.

### 3. From structure to form

Today, in a culture amplified by the web 2.0, thanks to form finding experiences and research on materials (Menges, 2016) we understood how a wider connection between form and structure is possible, according to the principle "Form follows Forces" (Bletzinger, Ramm, 2014).

The relationship between form and structure is a very important topic for Moretti, who declares a different relationship between plastic, constructive and functional values in architecture, stating that Vitruvius *Firmitas*, *Utilitas* and *Venustas* have been misrepresented in a education simplification by minor treatises since the 16th century (Moretti, Figus, 1951).

For Moretti Architecture is defined by a complex system of relationships, these can be read in the structural form, one of the  $n$  possible forms, in the functional form, answer to the functional needs of an architectural theme and in the expressive form, committed to Architect's will of representation.

To have an architecture it is thus necessary for these three forms to be identical, so that the relationships and rhythms of one of the "forms" are legible in the other two.

Moretti looks at the history of architecture, recognizing in succession of styles a continuous oscillation of the relationships between the three categories of forms, due to the two main generative directions of architecture: **Structure** → **Form** and **Form** → **Structure**.

Structure→Form direction is characteristic of Hadrian, Romanesque, Gothic architecture and Brunelleschi's buildings. On the contrary, during Renaissance, Baroque and the eight hundred, Form → Structure is the main path of the architectural design process.

Moretti hopes in a return to the Structure →Form direction, in antithesis with the Form → Structure approach also adopted by Rationalism and Organicism masters. He also criticizes the effectiveness of **Function**→**Shape** direction in which, only theoretically, rationalist architecture and the Bauhaus industrial design agreed. This is because function is always describable as a series of parameters that determine spaces, their articulation and material qualities. The "functional" approach leads us to two possibilities: if parameters are limited in number, solution might be unique and technically determinable with scientific rigor, on the contrary, if Parameters are many, or some of them are not identifiable, as it happens in Architecture, we will obtain an approximate form, which only the definition of the structure can solve, in a design path that follows the direction **Structure** → **Shape**.

#### 4. A new meaning for the word Structure: form as structure

Perception of objects and space is a theme of great interest for parametricism (Schumacher, 2012), it is also starting for the formulation of Moretti's parametric architecture. Thus, within the article Form as Structure (Moretti, 1957), he speaks about the way in which forms are perceived by human, this happens through the **differences** (relationships) between forms. Each form can be defined by its differences, so our perception of reality can be assimilated to a system of ordered differences in a rhythm that constitutes the law of form.

To proceed with the reasoning Moretti makes a mathematical analogy recalling the Galois Theory (Viati Navone, 2010), defining the system of differences as a **group**.

The group is not a quality of form, but a set of instantaneous relationships, a greater number of differences present within a form, makes a more vivid perception of the form by humans. Thus, the human face, full of rapid and sudden differences (color series, quality of materials, Chiaroscuro relationships) is the most indicative and incisive element of the human figure.

Moretti then affirms that the group of differences that we can perceive simultaneously is limited and defines it as a **chain**. The perception of a complex and unitary form happens therefore through the flow of a series of chains, each chain is linked to the next ones by relationships that oblige order, so that the chain can be defined as an **isomorphism** in the group of differences. (Hofstadter, 1980).

The set of chains that define a non-elementary shape is therefore defined as **structure of form**. Moretti enumerates different types of structures in architecture: chiaroscuro structure, structure of static relationships, structure of spaces, structure of plastic relations, structure of surfaces, structures of light density, etc. All these families of relationships are interdependent (isomorphic) and a new approach is necessary to manage them all together: parametric architecture. In fact, with the aid of scientific disciplines and quantitative mathematical analysis, Parametric Architecture can strictly define all parameters that generate a form, also allowing absolute expressive freedom where the mathematical scientific method does not find numerical solutions.

### **5. Moretti's parametric architecture, relationships with art, science and tradition**

The concept of Parametric Architecture is extensively developed within an article published in Moebius, where Moretti (1971), two years before his death, renews the need for a new architecture, rigorous in the definition of form through the help of Mathematical logic, computer techniques, and methods of operational research (Viati Navone, 2010), necessary to overcome the empirical state of current architecture.

Moretti then enumerates 8 points that define his parametric architecture:

- 1 - Rejection of empirical decisions.
- 2 - Assessment of traditional phenomena as objective facts based on interdependence of expressive, social and technical values.
- 3 - Exact and complete definition of architectural themes.
- 4 - Objective observation of all the conditioning elements (parameters) related to the architectural theme and identification of their quantitative values.
- 5 - Definition of the relationships between the values of the parameters.

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- 6 - Indispensability of different skills and scientific methodologies according to the criteria of operational research to define conditioning elements and their quantities.
- 7 - Affirmation of the Architect's freedom in decision and expression, only if it does not affect the characteristics determined by the analytical investigations.
- 8 - Research of architectural forms towards a maximum, therefore definitive, exactness of relationships in their general "structure".

In these points we clearly see how Moretti, in his late years, is still calling for a method that guarantees the best solution to meet the needs of architecture, rejecting any empirical choice, choosing the scientific method for the functional solution of form and at the same time declaring the architect's freedom of expression, considering Architect as an artist able to manage the whole architectural process (Diemoz, 1936).

This marks one of the most important differences with Schumacher's theory of parametricism, which states the need for a differentiation between art and architecture, as well as between science and architecture (Schumacher, 2011 pp. 144).

Moretti's position regarding tradition is another fundamental characteristic of his thought, if traditional facts need to be analysed according to dictates of parametric architecture, the same concept of Parameter as we have seen arises from the observation and analysis of the examples of the great masters. For Moretti the parametric component of historical architecture is clear, as demonstrated by Mario Carpo, who recognizes a Classic and Medieval Parametricism (Carpo, 2016).

## 6. Conclusions

Comparing Moretti's thought with those of current architects and scholars, we realize how he managed to grasp a different relationship between form and structure, arriving to conclusions which the current architectural culture has come to formulate through experiments and computational methods. While today we can read a different relationship through parameter and tradition, Moretti roots parametric architecture in history, also declaring the need for a multidisciplinary Architecture, obtained through a pragmatic, rigorous and scientific approach.

His aversion to rationalism, which throughout his life, usurped the role of *Global Style* of parametric architecture, lead him to underestimate rationalism power, same error we risk to commit today.

Summarizing the whole theories of a great architect in a single article is impossible, here we see only some aspects of Moretti's parametric architecture and theory, many of his other writings deserve further study.

Others have discussed the reasons of Moretti's Parametric Architecture failure (Viati Navone, 2010), almost 50 years after his death, it is perhaps possible to recover his theories and researchs on parameters which could find new space in the field of big data architecture, thanks to Machine learning methods, artificial intelligence and robotics.

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