



## Use of Parametric Design techniques applied to Civil Engineering

**Annette BÖGLE**

Professor  
HafenCity University  
Hamburg, Germany  
[annette.boegle@hcu-hamburg.de](mailto:annette.boegle@hcu-hamburg.de)

**José M. ORTOLANO**

Civil Engineer  
HafenCity University  
Hamburg, Germany  
[jose.ortolano@hcu-hamburg.de](mailto:jose.ortolano@hcu-hamburg.de)

**José ROMO**

CEO  
Fhecor Ingenieros  
Consultores S.A.  
Madrid, Spain  
[jrm@fhecor.es](mailto:jrm@fhecor.es)

### Summary

Parametric Design has appeared recently for expressing a new paradigm in the field of design. This new methodology has been applied recently in the field of architecture. However, in the case of Civil Engineering, the number of examples that illustrate the use of parametrics is almost non-existent. This paper describes the main characteristics and the methodology of Parametric Design as a technique to solve the form-finding problem. A study of the main implications of these techniques for solving engineering problems is carried out. Finally, an implementation in a common engineering problem illustrates this new paradigm.

**Keywords:** parametric, design, generative, algorithmic, computational

### 1. Introduction

The term Parametric Design has appeared recently in the architectural field as a new conceptual paradigm of the design of structures. An increasingly number of works has been written, where some new concepts like generative models, associative modeling, algorithmic modeling and computational design are presented, without giving a clearly definition of the new implications for this new design methodology.

Parametric approaches are related closely to the widely spreading in the use of computers in Architecture and Civil Engineering. In this sense, the improvement of CAD software has produced a gradual transformation of architects and engineers from passive to active users. In this context, some authors make the distinction between computerized and computational design [1]. The proliferation of new programs with growing capabilities and the possibility of interacting through the implementation of additional plug-ins, codes, etc. have led to the recent appearance of new designs in the architectural field. These new forms, usually characterized by the freedom of geometry and the repetition of patterns, are included frequently in the concept of Parametric Design.

In the field of Civil Engineering, however, investigations in the area of parametrics are almost nonexistent. Only a few examples, most of them included in research projects, can be found in literature. This lack in the use of parameters for designing structures seems to be paradoxical, since the work with parameters in Engineering is far known. In addition, the immense contrast between the methodology used by architects and engineers can be crucial when facing a project together.

### 2. Main aspects of Parametric Design

In literature it is difficult to find a clear definition of the concept of Parametric Design. Among all these new terms and ideas – including works from architects, civil engineers and computer scientists – maybe the words of Wassim Jabi [2] summarize best the essence of the so-called parametric thinking: “parametric and algorithmic thinking is not about any one piece of computer software or any one particular syntax, but about logic, geometry, topology and interaction”.

One of the most important aspects in the aforementioned definition is the contemplation of Parametric Design as a technique or way of conceiving a design. But contrary to common thinking Parametric Design is not a new concept inherent to computers. In fact, there exist some good examples using parameters to search of a form before the generalized use of computers in Architecture and Civil Engineering. Among them, the work of Félix Candela and his designs based on the modification of geometrical parameters in order to design new structural typologies from the “elementary” hyperbolic paraboloid (*Fig. 1* [3]) results significantly representative.