Mathematical vitamins for the development of architectural design

Amadeo Monreal Pujadas

UPC Polytechnic University of Catalonia
ETSAB Barcelona School of Architecture
Technology Department (Mathematics field)
Barcelona, Spain

e-mail: amadeo.monreal@upc.edu

ABSTRACT

Mathematics can contribute in many ways to ease and improve the set of tasks that concern Architecture. Among them, in this presentation we propose one to take advantage of (one might say recycle) concepts and tools related to Mathematics to model and generalize designs and procedures related to Architecture.

Usually, an architectural design is assumed for a specific range of application, possibly a single work, and its conception is developed within the intellectual universe inherent in this discipline. But Mathematics can reinterpret many of these designs in their own language, providing them with a model in terms of mathematical functions. Apart from the obvious utility in terms of easing the whole project and development process, this reinterpretation and this model not only enhances and gives greater prominence to the perception of the original design but also suggests many possible variations and generalizations that eventually widely overflow the scope of the original idea, in such a way that, although it constitutes a single functional typology as a mathematical model, it induces the conception, now from mathematics, of forms and objects that correspond to different architectural typologies. For this reason, it also opens an additional path of experimentation of forms and spaces that comes from outside Architecture.

As a pretext or particular theme to briefly illustrate this bridge between both disciplines, two generative laws invented by Antoni Gaudí have been chosen: the double twist, designed to generate the shafts of the columns of the Sagrada Família temple and what we can call the double helix, which governs the morphology of some chimneys of Palau Güell.

First, a brief explanation of these two design procedures is offered; then, the mathematical tools concerned to carry out the planned task are related and finally it is shown how these tools are settled to obtain a mathematical formulation of both Gaudinian procedures, as well as possible extensions to other plastic proposals and different typologies, far from the original objects, by means of specific examples.

Among the mathematical resources involved in this task, we can mention the use of the notion of loxodromic curve on a surface, quadratic surfaces, especially the hyperbolic paraboloid in its formulation as a Bézier surface, and families of operators used in fuzzy logic, such as the t-norms and the t-conorms.

References

[1] Alsina, Claudi; Frank, Maurice J. and Berthold Schweizer: "Associative Functions: Triangular Norms and Copulas." *World Scientific 2006.*

[2] Gómez, Josep; Coll, Jordi; Burry, Marc C. and Juan C. Melero "La Sagrada Familia. De Gaudí al CAD." *Eds. UPC. Barcelona 1996.*

[3] Monreal, Amadeo: "t-norms, t-conorms, aggregation operators and Gaudí's columns." (collective book) *Soft Computing in Humanities and Social Sciences (ed. por Rudolf Seising y Verónica Sanz). ISBN 978-3-642-24671-5 Ed. Springer-Verlag, Berlín 2012*.

[4] Monreal, Amadeo "A propósito del doble giro y otros mecanismos matemáticos para el diseño" *Proceedings of the VII International Mathematics & Design Conference, Tucumán (Argentina), 2013*

[5] Nocito, Gustavo J. "Los cuerpos geométricos en la arquitectura de Gaudí." (PHD Thesis) *U.P.C., Barcelona 1997. ISBN 9788469301357.*