GAUDÍ, THE FORMS THAT EXPRESS GENIUS

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1 Introduction

As researchers dedicated to understand and explain physical phenomena, we frequently encounter geometric forms that are particularly appealing to our senses and intellects. Hydrodynamic instabilities, bucking of structures, pattern formation in many physical systems, two-phase flows with moving interfaces, waves, to name a few, produce interesting shapes for their aesthetic impression and for their physical properties. Looking at Spanish Catalan architect Antoni Gaudí i Cornet artistic creations we recognize, as in a déjà vu, some of the same geometric forms. Gaudí's works reflect an individualized and distinctive style. Under the influence of neo-Ghothic art and Oriental techniques, Gaudí became part of the Modernista movement which was reaching its peak in the late 19th and early 20th centuries. His work transcended mainstream Modernisme, culminating in an organic style inspired by natural forms. The forms created and employed by Gaudí in his architectural creations are inspired by an acute observation of the nature. "Everything comes from the Great Book of Nature" he had said.

The works of Gaudí materialize from geometric elements that have much in common with those found in the investigation of problems faced by researchers in applied science. Examples range from simple forms like the catenary curve and catenoid (arising by rotating a catenary curve about its directrix), to complex patterns and fractals common in dynamic systems. We know how similar differential equations seem to appear recurrently in problems very different from the physical perspective and very similar from the mathematical point of view, giving origin to patterns, shapes and behaviors, in space and time, that are conspicuous. Anthropomorphic, animal and vegetal shapes, as bones, shells, leaves, are derived from solutions of problems based in physical laws. These entities exist in the universe since its origin, following nature and human development, thus impregnating our collective unconscious and making part and dictating the behavior of our own physical stuff. It is not surprising that humans have an emotional response to natural elements. Examples of Gaudí thoughts and architectural creations, that illustrate his acute observation of nature, and the genial combination of a positive aesthetic and emotional response with very effective technical solutions in every detail, will be presented. In these examples we will point to some connections of the geometric forms with physical phenomena and their mathematical description.

2 Light

Architecture is the arrangement of light; sculpture is the play on light.

"Light achieves maximum harmony at an inclination of 45 degrees, since it resides on objects in a way that is neither horizontal nor vertical. This can be considered medium light, and it offers the most perfect vision of objects and their most exquisite nuances. It is the Mediterranean light. Paraboloids, hyperboloids and helicoids, constantly varying the incidence of the light, are rich in nuances themselves, which make ornamentation and even modeling unnecessary"

3 Waves, linear and non-linear, free-surfaces and interfaces, dynamic systems, patterns and fractals

"Form does not necessarily follow function."

"Nothing is invented, for it's written in nature first. Anything created by human beings is already in the great book of nature."

"Everything comes from the great book of nature."

"Originality implies a return to the origins, original is returning to the simplicity of the first solutions."

"The creation continues incessantly through the media of man. But man does not create... he discovers."

4 Conclusion

"Men may be divided into two types: men of words and men of action. The first speaks; the latter act. I am of the second group. I lack the means to express myself adequately. I would not be able to explain to anyone my artistic concepts. I have not yet concretized them. I never had time to reflect on them. My hours have been spent in my work."

Not all artists are so inspired by nature as Gaudí. We, as scientist, can draw inspiration in Gaudí's example.

Figure 1: Left and center: La Sagrada Familia. Shades of light and geometrical forms: The catenary, the catenoid, ruled surfaces and fractals. Right: Casa Batll. Helicoids and catenaries. Gaudí took care of every detail of all structural and ornamental elements, always making sure that his constructions had good lighting and ventilation. His study of nature translated into his use of ruled geometrical forms such as the hyperbolic paraboloid, the hyperboloid, the helicoid and the cone. Gaudí found abundant examples of ruled surfaces in nature, for instance in plants, shells and bones. These forms are at the same time functional and aesthetic, and Gaudí discovered how to adapt the language of nature to the structural forms of architecture.

Figure 2: Top: The roof of La Pedrera, showing wavy shapes, some typical of buckling. Left: Interior of Casa Batllo. showing surfaces found hydrodynamics, and employing adaptive tessellation of complex surfaces. Right: Roof of Casa Batlló: textures, that enhance the perception of forms, are found in many nonlinear dynamic systems, like in pattern formation and nonlinear surface waves.

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