The Shaping of Forms

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Acknowledgment

To my wife and sons

for their patience and understanding
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Abstract:
Structures of perfect symmetry, order and beauty exist in both discoveries of science and objects found in nature. With careful observation and analysis, creative applications of these interesting forms can be and have been applied in many architectural structures with great success.

In this project, the utilization of these forms can not only bring out the purpose of this Museum of Nature and Science, but because these forms are derived from natural studies, they can also give viewers a sense of familiarity and peacefulness.
Analogous illustration is one of the methods which is used to summarize our viewpoint and communicate it to others. It is much more effective if we use something we have a clear understanding of to present our design. Things that exist in nature are familiar to most people; thus, it is reasonable for architects to create an environment by studying natural forms. The term "natural forms" I mention here, means "forms found in natural creatures or forms constructed by natural creatures other than human". There are three architects whose works have inspired me in this project.

Antonio Gaudí (1852-1926, Spain): “Gaudi’s ideas were decisively influenced by this school of thought, which led him to a veneration of craftwork and the honesty of medieval art; to a mechanistic logic inspired by Viollet-le Duc’s conception of medieval architecture; and to nature as a source of inspiration, not only for decorative details but for structures as well…... he asserted that the straight line belonged to men, the curved one to God. He invented a system of well-nigh universal application, based on hyperboloids and paraboloids, though his designs were never purely geometrical... They always preserved a close tie with familiar living shapes: bones, muscles, wings, and petals, and at other times with caves and even stars and clouds” (1)

Gaudi created forms using principles derived from natural objects, and he combined them with his structural knowledge in most projects. The Hotel Milà (1907, Barcelona) and Hotel Batlló (1907, Barcelona), two projects in which he used columns and beams as basic elements, were shaped by the inspiration drawn from sculpture and bones. In the Church of the Guell Colony (1914, Santa Coloma) project, he designed the portico of the crypt with parabolic-hyperbolic vaults and inclined pillars, and the interior with rustic inclined pillars. He not only applied structural knowledge in this design, but also successfully applied the materials to show his intention.

Hotel Batlló (Source: "Antonio Gaudí", By: Cesar Martínell, Universal Books 1990)

Giovanni Micheluzzi (1891-1960, Italy): "...when I look at a stone, a cypress tree, .......then I feel fulfilled, as if I were made of that material. And I found my feet again...... Now I have discovered nature. I used to think nature was something that enabled man to enjoy himself and to look at things. But one does not get to know nature in this way, one knows the shade of the tree or its branches, but this is not nature. Nature is what gets inside us and arouses such an evolution in us that we realize something has gone wrong ......." (2)

I think the nature Micheluzzi talked about is the "order" we learn from nature, which keeps us in balance mentally. In his Church of the Autostrada (Autostrada) project, he used his knowledge of structure in the design of the roof about which he said that he took the shape of a "tent", but nature did not play an important role in his design. The vertical elements in the walls surrounding the church do not match the structural theme of the curvy roof.

Church of the Guell Colony
(Source: "Antonio Gaudí", By: Cesar Martínell, Universal Books 1990)

Church of Autostrada
Hector Guimard (1867-1942, France): "...everything should aspire to the unity demonstrated by nature - for nature's logic is impeccable......, when I sculpt , I think about those universal laws demonstrated by nature........, so that the whole building becomes an exercise in the demonstration of the nature and structure of materials." (*)

He has the knowledge that enabled him to apply natural forms in his designs of facades of buildings, of the railing of The entrance to a Metropolitan Station (1901, Paris) and of furniture. But he seemed to accept the idea of contemporary architectural trend, and did not use natural inspiration in his design of structural forms. His application of natural forms in design was basically for decorative purposes.

— M. —

(*) Encyclopedia of Modern Architecture pp.122 by Alexandre Cirici-Pellicer
(2) Domus, Oct '90, pp.30 *Talking with Giovanni Michelucci * by Mario Lupano
(3) *Hector Guimard -Romantic Rationalist?* pp.12 by Gillian Naylor
Premise

We should always ask ourselves "How can we really know these objects well enough to employ their principles in our designs?".

We should forget the ways in which we used to think about designing architecture, e.g. "How much area do we need?" or "What kind of space is needed for this kind of activity?". Such a way of thinking should be abandoned. Because the notions of area and space would lead us to think about wall and partition. Plan is the tool we would use to place the walls and partitions. Then section and elevation would follow. So, unless we start from ground zero and direct our way of thinking in an all new direction, we will find out later that we have ended up with the traditional kind of design, resembling what most people are designing. I believe that if we start work on our designs with section, accompanied by 3-D sketches, rather than with plan, our ways of design will be forced towards the involvement of more knowledge about various orders we encounter in our surroundings. We will find out that knowledge of science can help us to understand orders which exist in nature, e.g. knowledge about atom helps me "see" the "form" which exists in the revolution of electrons around orbits of protons in three dimensions. Despite the difference in scale, I can see the link between architectural form and that of the atom model. Perceiving this link helped me tremendously in solving the problem I had with making connection between column and roof.

Instead of studying man-made objects, we should set our minds on examining things which were created without human involvement, e.g. plants, insects, etc. Using freehand sketches we can study sections and different 3-D views of the objects as we are sketching. The effects of such studies may not be evident in our designs right away; rather, our ways of thinking can gradually change as a result of our intimate knowledge of nature.

I experimented with two different types of sources. First I studied man-made objects, such as an automobile engine. Although, I have found some application for the studied form, e.g. in the design of a column (see pp. iii), the design of an engine employs only limited number of orders that can be applied in architectural designs. I believe that the reason for this limitation is the fact that the engine has been designed to be enclosed and to serve a specific purpose, whereas the purpose of architectural forms is broader and involves their artistic function. It seems that if we try to derive artistic inspiration from man-made objects, the best we can hope for is designing something on the level represented by the designer we learn from. So, there is little chance we can develop better designs out of ideas found in man-made objects. When I studied the structures of natural beings, e.g. of insects, I found it more fruitful and resourceful to look for design inspiration in natural objects. Sketches (e.g. 3-D and sections) can be very useful in helping us draw the inspiration from the object we are studying.
Photograph of a sea scallop shell (top left); the early stage roof plan (top right)
Sketch of roof plan (above left); the museum final roof structure plan (above right)
Study of architectural form translated from natural form

Museum roof plan at early stage
Studies of natural form in plan design

Plan of part of museum’s roof structure (top); photograph of part of spider web (above left); 3-D roof structure by computer (above right)
Axonometric of museum showing exposed roof structure
Studies of insect structures and transformation of roof structure system

Sketches of insect structures (top left); sketch of roof element (top right)
physical model (above left); roof element and column model (above right)
Physical model of roof element and columns
Studies of column design and human leg muscle

3-D sketches of column (top left); column elevation and cross sections (top right) anatomy of human muscles (above left); cross sections of human leg (above right)
Studies of column design and human leg muscle
Column models generated by computer
Studies of roof structure and human backbone structure

sketches of connecting roof structure elements (top left); human backbone & bone segments (top right)
elevation of columns and connecting structure (above right); 3-D sketch of roof structure element (above right)
Studies of connection between two roof elements
Study of connection between two roof elements
Study of connection between roof elements
Transformation of tower structure

sketch of tower plan (top left); drawing of tower plan (top right)
sketch of inspiration of tower section (above left); drawing of tower section (above right)
Transformation of tower models

3-D view of wire model (top left); elevation of wire model (top right)
3-D view of paper model (above left); elevation of paper model (above right)
Geometry of tower structure

section of upper tower structure (top left); transformation of inner supporting structures (top right)
cross section of upper tower structure (second from top left); section of upper tower structure (third from top left)
cross section of upper tower structure (above left); section of tower with elevation of lower tower structure (above right)
Geometry of tower structure
Geometry of tower structure
Studies of tower roof plan and natural form

tower roof plan by computer (top left); 3-D tower by computer (top right)  
spider web (above left); tower spatial model (above right)

Print source: "The Architecture Society Book of Ideas."
by Lea Line, Editor of Aedilion Magazine, and Lucie and Margery Milne
Tower model generated by computer
Tower model generated by computer
Tower model generated by computer
shaded tower model
Computer generated tower model

shaded tower model
shaded tower model
The intentions of an architect can be translated into architecture through different means. In working on this project, I did not find any architect who would design a museum using inspirations similar to those I used, and thus I was uncertain about the final result of my endeavor. I experimented with several possibilities and tried to keep the records of my results, both successful and unsuccessful ones.

In attempting to use an engine as an inspiration, I succeeded in learning that the engine has qualities of precise timing and accurate movement, but the problem is the difficulty in translating an engine's scale and proportion into architectural forms. The use of natural objects was more successful, because I could apply the inspiration found in the objects which are going to form a part of the exhibition in this museum.

In designing the columns which were to support the roof, I used the ideas suggested by the study of an engine and some ideas derived from the structure of the atom. Later, combining the ideas derived from studying insects with the original inspirations drawn from studying the engine and the atom model enabled me to transform the clumsy system of columns into a much lighter and structurally more economical one. Other natural inspirations used in this project include the overall plan of the museum, suggested by the structure of a sea scallop; the structural plan of the roof, inspired by a spider web; the shapes of columns, based on studies of leg muscles; and the elements of the roof structure shaped like a human backbone.
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