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The Sundial, Beyond the Form and Time...

Andrzej Zarzycki
227 Brighton Street
Belmont, MA 02478
E-mail: zarzycki@alum.mit.edu

Abstract

Architecture (är"k¹-tµk" ch...r) *n.* **1.** The art and science of designing and erecting buildings.

Can a building inspire scientific thinking? Can an architectural structure reflect the complexity of the universe? Is there a relationship between the artistic and scientific? This paper discusses an approach to design, which uses an architectural structure as a research apparatus to pursue scientifically driven beauty.

Architecture could be defined as the man-made universe — the universe whose primary function was to shelter us from elements, animals and other people. Broadly speaking, to protect us from the "outer Universe". It is not surprising that the evolution of architecture follows the same trajectories as the evolution of our thinking and perception of the surrounding world. However, somewhere along the lines of history, architecture acquired another purpose and began to play a new role in our self-awareness.

In ancient, medieval and even modern times, we have viewed architecture as a medium to express, symbolize, and address the meaning of our existence. Ancient temples reveal an intimate knowledge of geometry and human perception by purposefully distorting their forms to balance visual illusions. Medieval cathedrals manifested greatness of God through art and structural achievements, while contemporary monuments address the social and philosophical aspirations of a present-day society.

As a result of this centuries long evolution; we now associate architecture with its less utilitarian and more symbolic values. Buildings embody our history, knowledge, values and culture, contributing to who we are and how we see our place in the world.

However, symbolic values of architecture are not abstracts to be superimposed over the physical structures, but are meant to be derived from this very structure or its setting.

It is a common and good architectural practice to locate a building to take an advantage of solar orientation, climate, views and topography. As a fulfillment of the sheltering aspect of architecture, this attempts to identify with the environment in a mutually beneficial way. In a house, for example, this approach results in placing sleeping quarters—bedrooms, facing east while living spaces facing west. Similarly, many of the early medieval churches, such as Cistercian monasteries, were positioned with an altar facing east, the main entrance towards west, and the cloister south of the church –so not to be overshadowed by it.

These devices are often applied to optimize the benefits of the site and provide natural light for the building. Buildings often reflect the surrounding environment and engage in an active dialog with the Universe they are protecting us from.

The intent of this paper is to study this dialogue between architectural structures and the Universe, focusing on how both universes, man-made and natural, inform each others existence.

The critical question should be, "What can we learn about the universe by studying how the buildings react to the elements?"

This is not a quest for one answer, but rather an exchange of ideas and observations that will stimulate additional discussion and result in more meaningful architecture. In this way, a building becomes a research apparatus that informs us of its facts and routines through its response to the environment. The hope is that by studying these responses that one could gain a greater understanding of the Universe.

Is the idea of a building as a research and cognition apparatus a reasonable one? Can an architectural form that is often self-centered and mostly self-referential reflect the greater design of the Universe?

My search originates from a, perhaps Platonic, premise that we most often observe facts and events by the impact they have on their surroundings. We also build things as tools to facilitate our search for knowledge. If this is so, why not a building?

The *Foucault Pendulum*, hanged from the dome of the *Les Invalides* in Paris, was an example of a similar apparatus. Although confined to a particular space and extremely self-referential, possibly perceived as a piece of art having more to do with psychoanalysis or hypnosis than science, the *Foucault Pendulum* can inform us about the world outside its enclosure.

Could the thoughtful eye connect its behavior to physics and rotation of the Earth? Is this possible? Evidently yes, although not to everyone.

Can, then, architecture be a similar apparatus to read and understand the Universe? Perhaps, it already is, we just have to learn to see it.

I gradually became aware of this concept while looking at the façade of a building across the street from my window. (Fig.1, 2) Although, it is not architecturally significant, it had something that intrigued me. Its geometry, repetitive bays laid out on a semicircle, interacts with the sunlight in a unique way — each bay casts a similar shadow but at a slightly different angle. With each consecutive bay the shadows change respectively in response to a different solar bearing (horizontal sun angle).
This, by itself, is not a significant observation since the semicircular plan of the façade would naturally result in not coplanar, but slightly rotated bays, which in return would produce shadow variations. The real revelation came when I have realized that we could reverse this simple reading of the curved form facilitated by sunlight and state that all these different bays are not different bays of the same building arranged in space seen at particular moment in time, but rather represent the same singular bay, as it would interact with light at different times of a day. In other words, the façade showed a variety of shadows cast by a singular bay over a period of time. In simplified mathematics, one of the spatial dimensions would be replaced with a time dimension. Being a gross approximation of a projection of the four-dimensional time space continuum at the three-dimensional space. It had struck me how architecture could reflect science and life concepts through its form.

My digital imagery (Fig.7, 8, 9) continues to study the dialogue between the man-made and natural Universe with a focus on the interplay of lights and shadows within an architectural space, as it is defined by the exterior shell of the structure as well as time. In order to achieve this objective I constructed a simple, virtual model (Fig.3 thru 6) and projected sunlight and shadow upon the structure and recorded the results.

The images of the interior of the structure reveal time through light in much the same manner as the sundial. As time passes, the light interacting with the structure changes. The result is the development of a

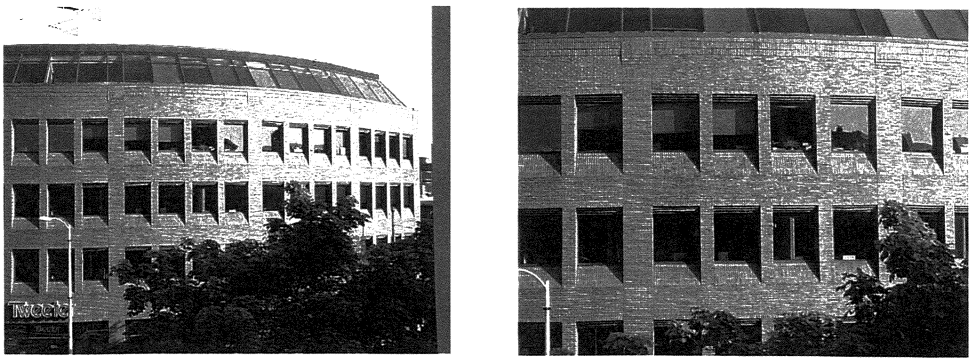

Figure 1, 2. *The façade of a building*

language of shapes, which inform the space and describe this passage of time.

In performing this study, I expected to see that the visual interplay of light and shadow would enhance the architectural character and meaning of the interior space. I understood that the light would mark the passage of time in the space. A surprising outcome of this study was the realization that even a small number of simple architectural gestures such as slot wall openings or sloped conical interior walls, could release such a broad array of complex and unexpected shapes. These shapes go far beyond the *banal* projections one might have expected and begin in earnest the process of informing the space. As a sundial, the structure not only relates the position of the sun to the shapes, but also creates a unique visual understanding of the inter-morphing of these shapes in a continuous way. It creates a shape continuum within time and space.

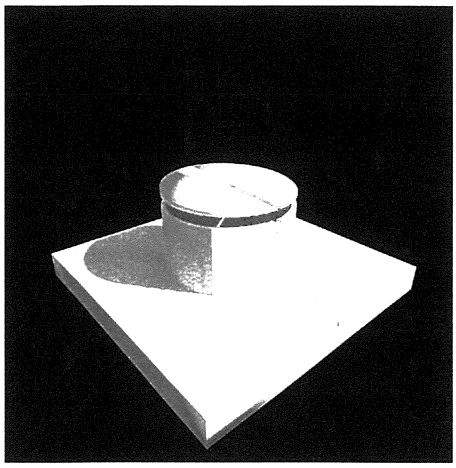

Figure 3: *Virtual model, exterior*

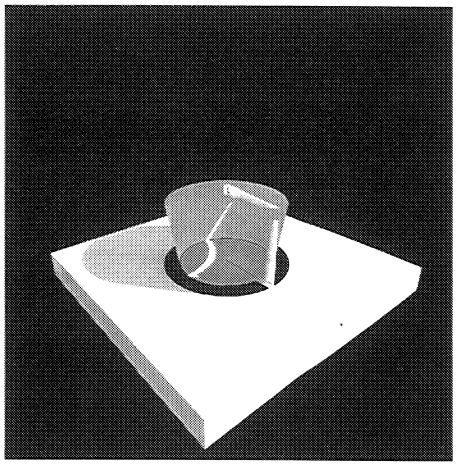

Figure 4: *Virtual model, interior*

Studying these projections we realize that the shape identity is not a permanent but rather a momentary characteristic. While the sun passes over the firmament shapes appear unexpectedly, they merge, follow a joint path only to later separate, and finally depart towards various destinies. They appear and fade into solid walls in an eternal play of lights and shapes.

The virtual environment lets us manipulate these shapes along various space-time trajectories. Animating the sun at various times of a day, or different days at the same time, or even animating the location (latitude) results in series of images that form a space-time matrix. Through this matrix we can see how shapes transform in a continuous and metamorphic way into any of a myriad of possible shape-destinies. Their evolution is not determined but rather an open-ended process. Depending on its trajectory, the same starting shape can evolve into dissimilar 'offspring'.

These images had brought me the realization of how easily even a small combination of elements can create complex structures, and how these complexities evolve—the realization parallel to observations in other very different fields, such as genetics and microphysics.

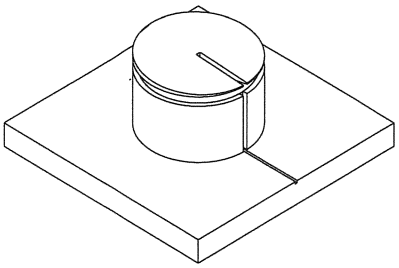

Figure 5: *Virtual model, exterior wireframe*

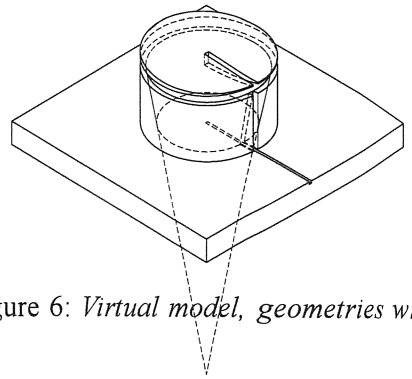

Figure 6: *Virtual model, geometries wireframe*

Arriving at the unexpected, I had realized in how many ways art and architecture could reflect the universe...

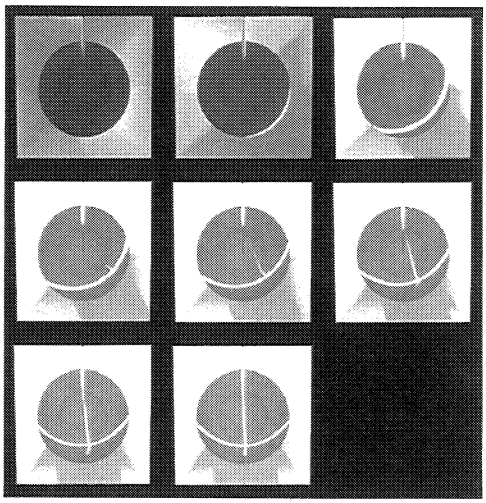

Figure 7: *Rendered plan views of the sundial for December 21st*

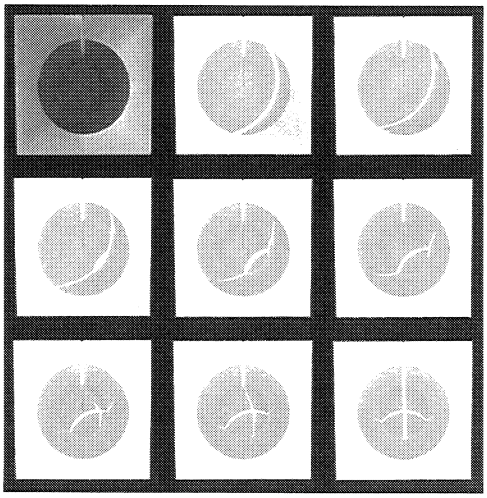

Figure 8: *Rendered plan views of the sundial for March 21st*

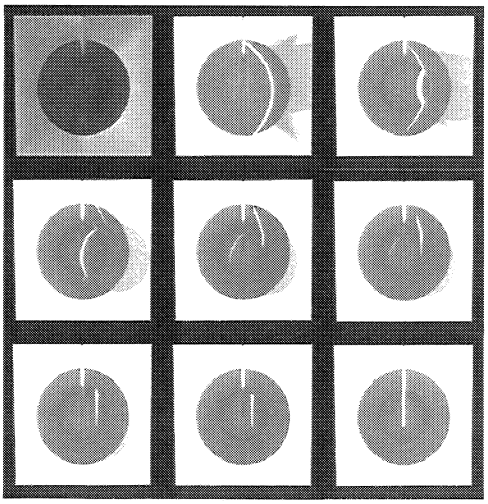

Figure 9: *Rendered plan views of the sundial for June 21st*