Kazimierz Butelski | *The Architecture of Curved Shapes*

In the 20th century, architecture remains the part of art where formal principles are very important for creators and spectators. Because form in architecture is so important, two questions arise: How can architects nowadays create forms? How can forms be described and classified? When we work only with formal analysis, we can point to an important criterion of innovation, that is, that certain forms have never before been seen in the history of architecture. In the present day, CAD/CAM technology permits us to realize any form our imaginations can create.

Introduction

We can analyse the architecture of a building in many different ways. Let us name three main categories:

- formal analysis
- functional analysis
- structural analysis.

In my opinion, formal analysis is the most important because it can show us a thin line that divides architecture from construction (or, the construction industry), and it can also show us architecture as an art.

In the 20th century, architecture remains the part of art where formal principles are very important for creators and spectators. Architectural critics are still around and have something to say because formal aspects of architecture can be criticised.

Because form in architecture is so important, two questions arise. How can architects nowadays create forms? How can forms be described and classified? When we work only with formal analysis, we can point to an important criterion of innovation, that is, certain forms have never before been seen in the history of architecture. I.M. Pei's Pyramids at the Louvre don't belong to this category, because he used very well known forms; only their locations within the urban structure and the use of materials is quite new. But I find the latest works of Frank Gehry and Peter Eisenman very close to my idea of new forms in architecture at the end of the century. The Guggenheim Museum in Bilbao (Figure 1) and the Disney Centre Hall (Figure 2), both designed by Gehry, display new ways of creating architecture very similar to those described as curved-line architecture by Chwistek in his theoretical works in the early years of the 20th century.²

Figure 1.
Guggenheim Museum, Bilbao, Spain, by Frank Gehry. Drawing by the author.

Figure. 2.
Disney Centre Hall, by Frank Gehry. Drawing by the author.

Is it a coincidence that forms of this kind emerged at the end of millennium, at a time when information technology has such a strong influence on our lives? For me, this is a rhetorical question. It is absolutely clear that the imagination of architects has never been constrained by classical geometry, but the fact is that at the end of the 20th century, perhaps for the first time, we can see material signs of this thinking in constructed buildings.

I would like to make two important points about the relation between the conventions of computer modelling and the creation of architectural forms³ and the influences of CAD/CAM

(CAD, Computer Aided Design; CAM, Computer Aided Manufacturing) technology, which I call practical geometry, in construction of a curved shapes building. CAD programs today use three main conventions of representing space:

- Constructive Solid Geometry (CSG)
- Boundary Representation
- Distribution Functions (Methagraphics)

Constructive Solid Geometry

When we have seen Roman Temples, we can easily describe their geometry by algebraic functions such as addition, subtraction and multiplication of primitives (in this case, primitives are cylinders, cubes, globes, etc). It is in this same way that CAD programs work in CSG mode (convention). Modern architecture, on the one hand, and traditional architecture, on the other, give us very good formal examples of such kind of space description. Buildings designed by Frank Lloyd Wright and Richard Meier (Figure 3) are typical example of this convention.

Boundary Representation

When we see the amazing play of surfaces slashing at space, very characteristic of the de-constructivist movement in architecture, we can clearly see what boundary representation means in CAD space description. In this method a solid is defined by determining all points lying on its surfaces. In practice this is done by the use of triangles, or analytical functions

Figure 3.
Richard Meier. Drawing by the author.

such as Beziers. We can say that very similar forms for this type of CAD space description are those designed by Zaha Hadid (with the exception of her latest design for the Museum of Contemporary Art in Rome, Figure 4) and the architecture group called Coop Himmelblau (Figure 5).

Distribution Functions

Distribution Functions is the last method of space description used in CAD programs, and is especially suitable for creating architecture of curved shapes. Where in the former method several thousand polygons would be necessary, here only a few dozen matalipsoides are needed. Some projects of Frank Gehry (Figure 2), Peter Eisemann and the latest design of Zaha Hadid (Figure 4) are good formal examples of such kind of space description used in CAD programs.

Methagraphics is especially interesting for us in the case of the creation of curved architecture. Methagraphics will describe such a form such as Gehry's design of Disney Centre Hall, but more importantly, here was the possibility of using CAD/CAM technology in the construction of a curved stone curtain wall. In this case, they used Catia software, well known in the space shuttle construction.

Conclusion

Finally, at the end of the 20th century, we can be proud to have the ability to create new forms in architecture, both in our minds and in reality, made possible by computers and geometry.

First published in the NNJ online January 2000

Figure 4.
Design for the Museum of Contemporary Art,
Rome, by Zaha Hadid. Drawing by the author.

Figure 5.
Coop Himmelblau.
Drawing by the author.

Notes

1. Leon Chwistek, Polish mathematician and painter, 1884-1944, first defined the term "Architecture of curved shapes" in his theoretical design based on the Krywań mountain in the Tatras.
2. See Kazimierz Pasenkiewicz, *Selected works of Leon Chwistek*, vol.1 (Warsaw, 1961), vol.2 (Warsaw, 1963).
3. K. Butelski, "On Similarities Between The Conventions of Computer Modelling and The Creation of Architectural Form", *Proceedings of ECAADE* (Education in Computer Aided Architectural Design Europe) XIII International Conference, "Multimedia and Architectural Disciplines", Dipartimento di Progetto e Construzione Edilizia, Università di Palermo, 16-18 November 1995, pp. 71-74.

The Author

Architect Kazimierz Butelski was born in Kraców, Poland. He studied architecture at Kraców University of Technology from 1983 to 1989. He studied in the US in 1987, and was science assistant to Prof. Wojciech Bulski at Kraców University of Technology Faculty of Architectural Design in 1989. He studied in France in 1991, and in Russia (Moscow, Petersburg) in 1992. He is currently working on his doctorate on the principles of planning and design methodology in the context of CAD. He has worked with architect Romuald Loegler of Loegler & Partnership (1988-1989), Prof. Arch. Zbigniew Kupiec (1989-1991), PUA Ltd (1992-present), and has cooperated with architect Janusz Purski BP Project Ltd on projects, theoretical works, awards and competitions. In 1994 he received the Kraców Scholarship in Architecture for Young Artist. He lives and works in Kraców.