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ON SIMILARITIES BETWEEN THE CONVENTIONS OF COMPUTER MODELLING AND THE CREATION OF ARCHITECTURAL FORM

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Abstract

The following remarks relate to the creation of a geometric representation, which determines the future form of a building. I also discuss the relation between the three main conventions of computer modelling: Constructive Solid Geometry, Boundary Representation, Metagraphics and the currently design methods. For the sake of comparison, I selected three contemporary architects, Zaha Hadid, Arata Isozaki and Rob Krier, who each represent a specific approach to contemporary architectural form. While Zaha Hadid and Rob Krier represent mutually opposed, and also strongly ideological currents in today's architecture, Arata Isozaki occupies the middle ground.

- Looking at any of the buildings composing the housing estate designed by Rob Krier for the IBA exhibition in West Berlin we notice that the form was created by compiling primitives. This convention is very close to the one used by modelers, called CSG.
- Vitra Fire Station in West German Weil am Rhein was the first realized design by the radical avangardist Zaha Hadid. We see an amazing play of surfaces, slashing at the space. Interestingly, each of these surfaces can be easily approximated by polygons, and especially by triangles, which makes the author very close to the second convention of representing space . Boundary Representation.

Take a look at the latest design by Arata Isozaki, the Center of Japanese Art and Technology in Cracow . The formally dominant element here is the softly multicurvical roofing. Using the methods described previously, an attempt to create this roofing would be either impossible or very laborious. Fortunately, the third of the methods we presented, metagraphics, comes to the rescue here. It seems that problems of representing space would be overcome if the three methods were somehow compiled.

A photorealistic computer presentation of a designed building is created nowadays in two basic phases: modelling (creation of a geometric convention) and rendering. The following remarks relate to the first phase, i.e. creation of a geometric representation, which determines the future form of a building. I also discuss the relation between the three main conventions of computer modelling and the currently used methods of representing space. Software used for 3D modelling are called modellers, and among the most popular of them is, for example, AutoCAD. The three conventions of representing space I mentioned are:

Constructive Solid Geometry (CSG)

Constructive Solid Geometry, used by CAD software, consists in isolating primitives, such as cylinders, prisms, globes, etc., and assuming spacial relations between them, based on algebraic functions, such as addition, subtraction and multiplication (copying).

Boundary Representation

Boundary Representation means that a solid is defined by determining all points lying on its surface. In practice, it is done by the use of triangles (polygons) or approximated by the use of analytical functions, such as Bezier's, Coons' or B-splines. The method produces good results with solids which can be described as a collection of triangles or polygons, but cannot be directly used to define curved solids, such as a globe.

Distribution Functions (metagraphics)

Metagraphics is a method using the so-called Distribution Functions and gives particularly good results for modelling curved solids. Where in the former method several thousand polygons would be necessary, here only a few dozen metaellipsoids are needed. That also means less data to be stored in the computer memory. Unfortunately, metagraphics is almost helpless in describing "cubistic" elements.

For the sake of comparison, I selected three contemporary architects, Zaha Hadid, Arata Isozaki and Rob Krier, who each represent a specific approach to contemporary architectural form. While Zaha Hadid and Rob Krier represent mutually opposed, and also strongly ideological currents in today's architecture (extreme traditionalism of Krier vs. extreme avanguardism of Zaha Hadid), Arata Isozaki occupies the middle ground. Let us now analyse the formal aspect of three designs.

Looking at any of the buildings composing the housing estate designed by Rob Krier for the IBA exhibition in West Berlin (Fig. 1), we notice that the form was created by compiling primitives. The author started from a regular rectangular prism and then subtracted a number of cuboids and added several cylindrical parts.

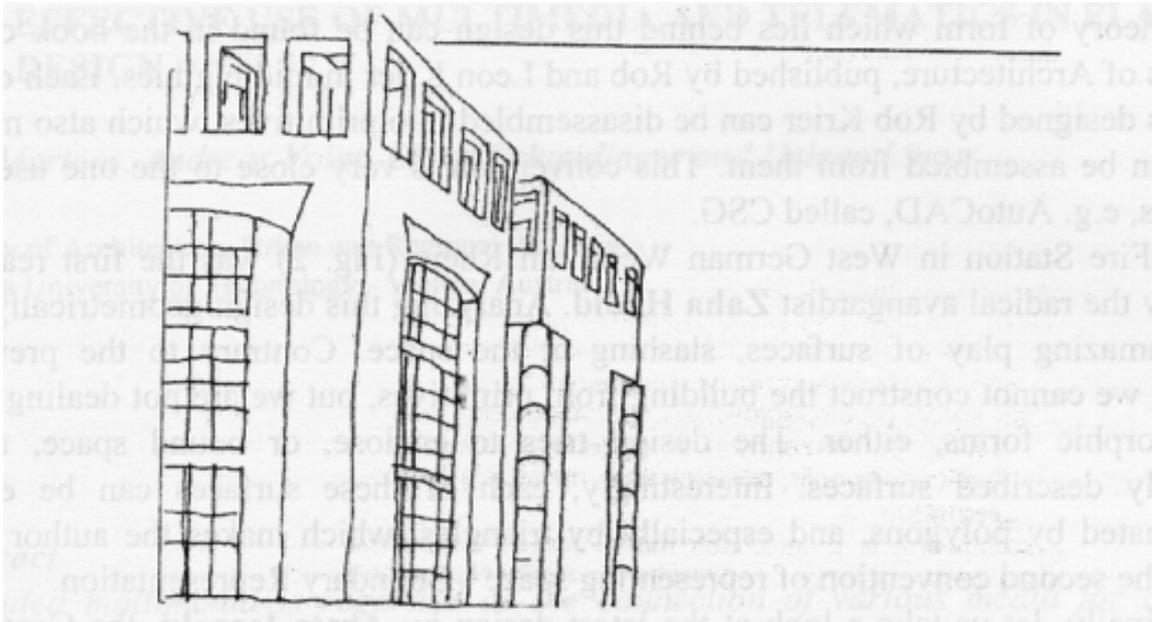


Fig. 1

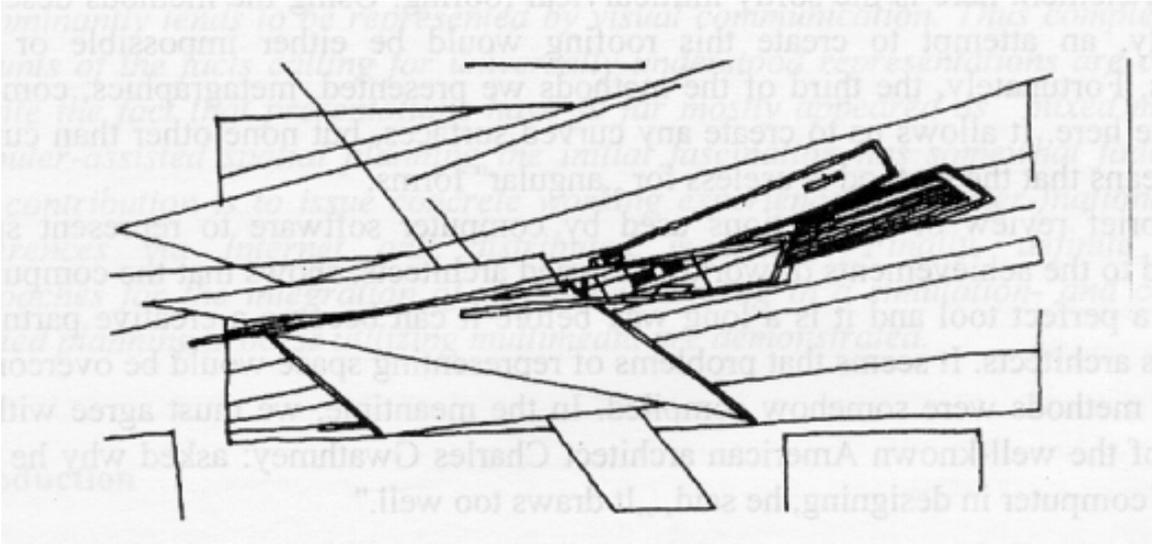


Fig. 2

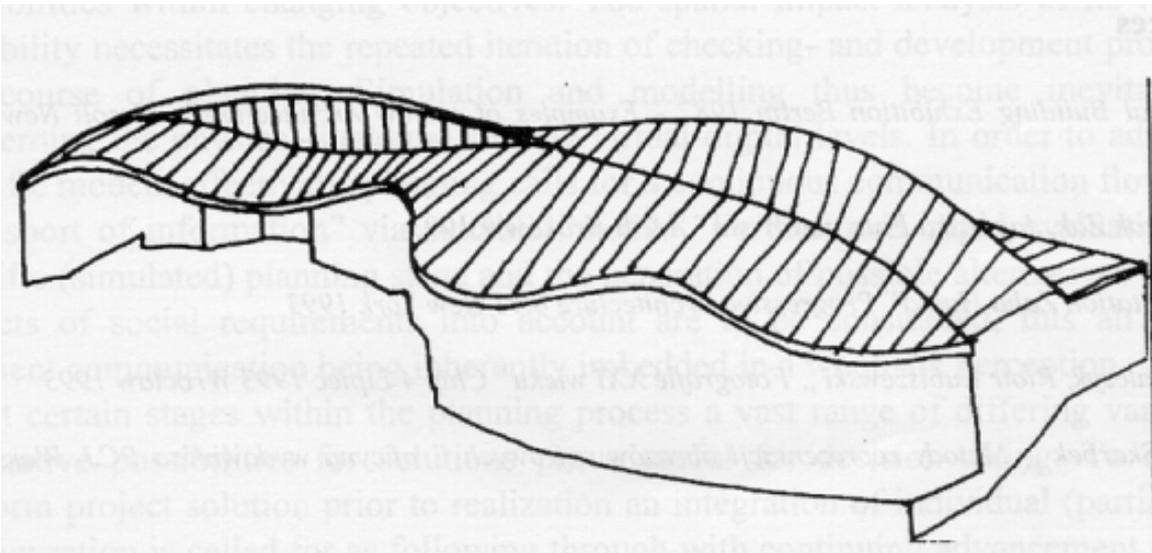


Fig.3

The theory of form which lies behind this design can be found in the book called *Elements of Architecture*, published by Rob and Leon Krier in mid-eighties. Each of the buildings designed by Rob Krier can be disassembled into primitives, which also means that it can be assembled from them. This convention is very close to the one used by modellers, e.g. AutoCAD, called CSG.

Vitra Fire Station in West German Weim am Rhein (Fig. 2) was the first realized design by the radical avangardist **Zaha Hadid**. Analyzing this design geometrically, we see an amazing play of surfaces, slashing at the space. Contrary to the previous example, we cannot construct the building from primitives, but we are not dealing with soft, amorphic forms, either. The design tries to enclose, or bound space, using adequately described surfaces. Interestingly, each of these surfaces can be easily approximated by polygons, and especially by triangles, which makes the author very close to the second convention of representing space - Boundary Representation.

And finally, let us take a look at the latest design by **Arata Isozaki**, the Centre of Japanese Art and Technology near the Wawel Castle in Cracow (Fig. 3). The formally dominant element here is the softly multicurval roofing. Using the methods described previously, an attempt to create this roofing would be either impossible or very laborious. Fortunately, the third of the methods we presented, metagraphics, comes to the rescue here. It allows us to create any curved surfaces, but none other than curved, which means that the method is useless for "angular" forms.

This brief review of conventions used by computer software to represent space, compared to the achievements of world-renowned architects, shows that the computer is far from a perfect tool and it is a long way before it can become a creative partner of ambitious architects. It seems that problems of representing space would be overcome if the three methods were somehow compiled. In the meantime, we

must agree with the opinion of the well-known American architect Charles Gwathmey: asked why he does not use a computer in designing, he said, "It draws too well."

References

International Building Exhibition Berlin 1987 - Examples of a New Architecture", Rizzoli New York 1986.

Ewa Dworzak Zak, Japonska Fala nad Wisla" A&B Krakow 9.1993

Vitra Fire Station Zaha Hadid" *Progressive Architecture* 8.93 New York 1993

Jerzy Michalczyk, Piotr Kubiszewski "Fotografie XXI wieku" Chip 4 Lipiec 1993 Wroclaw 1993

Wladyslw Skarbek "Metody reprezentacji obrazow cyfrowych " oficyna wydawnicza PCJ. Warszawa 1993

Metagraphics" (the 22nd International Tornee of Animation) *Film Comment* Julay August 90

Teresa Pineda Davison "Computers CAD the Medium of Exchange " Progressive Architecture 1.93. New York

Kent Larson "Computer Modeling as a Design Tool" Progressive Architecture 10.91. New York.