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The virtual "Maquette" and the Synthesis of Images in the Architecture Project.

ASTRACT
Le projet d'architecture rapporte constamment le probleme de projet a son contexte.
Le changement continu d'echelle n'est donc pas un jeu de representation pure mais devient un changement de language qui s'efforce de rendre l'espace du projet visible et controlable.
Il est donc desirable de depasser les methodologies de CAD traditionnelles referables a' une casuistique parfaite dans un certain sens et independente du contexte de l'architecture et de son territoire.
Ce rapport explique les methodologies appliquees pour le controle du style de la representation et de la base de donnees dans la construction d'une maquette virtuelle qui devienne le miroir des intentions de projet.

The architecture project constantly refers to the question of projection in its own context.
The continous change in scale is not therefore a game of pure representation but becomes a change of language which attempts to make the project space visible and controllable.
It is therefore desirable to pass over those traditional CAD methodologies that refer to a casuistry which is, in a certain sense, perfect and independent from the context of the architecture and its sorrounding.
This report illustrates the methodologies used to control the style of the representation and the data base used in the construction of a virtual "maquette" which becomes the mirror of project intentions.

1. INTRODUCTION

The major part of the currently produced design systems, or CAD, have their origin in the field of mechanics or in that of schematics (for installations and for circuits).

Their extension to the architectonic planning sector has given very mediocre results: it is in fact not enough to produce images of objects extracted from a certain applicable field to demonstrate that the system is applicable.

On the contrary. It is not the subject or the theme of the image which defines the applicable sector but rather the context, the method of the model's construction, and the style of the representation.

In other words, the bases of knowledge and of information about specific problems are that which guarantee the applicability and utility of a system. The CAD and design systems currently on the market confront architectural and urbanistic problems essentially in configurations such as:

- systems for cataloging building components
- systems for thematic cartographics
- graphic layout systems

These approaches do not, in reality, intervene in the planning process, nor do they attempt to comprehend the real informative flux.

On the contrary, the requirements of research and of didactics in the architectonic-environmental planning sector translate themselves into a syncronic attitude with respect to the different scales in which the urbanistic-architectonic morphogenesis is expounded.

2. COMPUTER GRAPHICS IN THE ARCHITECTONIC PROJECT: MIMESIS OR RHETORIC ?"

The open problem of Computer Graphics, as in all innovations, is that of delimiting and defining the field beyond the demonstration of the efficiency of the computeral and photonics means.

To approach an explanation of Computer Graphics solely with the two concepts of "hardware" and "software" would inevitably lead us to a cataloging of algorithms, techniques and products already well-documented commercially.

On the other hand, the comparison between "eidos" and idea inherited from Platonic metaphysics is not sufficient to explain the complexity and relative autonomy of modern audiovisual communication.

The scope of Computer Graphics and of the methods which have been developed is not, in the strictest sense, scientific.

The enjoyment of the representation and of the ex-position

(Dar-Stellung) prevails over that of the explanation and of the project.

The use of technical apparati is incidental.

The matrix common to all the studies od Computer Graphics is the imitation of nature (not necessarily knowledge of it) and also the imitations of other imitations (televisual or pictorial, for example).

The question of mimesis and art in a modern and post-modern sense is therefore central to the method of producing the virtual "maquette" and using Computer Graphics in the architectural project.

The territory which separates art from reality is that of representation, while simulation and the construction of models form the science's metalanguage.

However, art, sceince and knowledge also form the terrain on which the techniques, old and new, which concern visual communication, encounter one another and collide.

Even if presented as pure information, the numerical digital mimesis is by consequence ambivilant: within it, as within every "simulation", representation and falsification coexist.

The heading "imitation" from Quatremere de Quincy's "Historical Dictionary of Architecture"is once again actual: "To imitate by means of art is to render to the senses the idea of a thing, with means different from those which form the same thing.

To imitate does not necessarily mean to create the image or to reproduce the resemblance of a thing... .of nature...

One therefore imitates nature doing as she does, that is, not duplicating the work as such but appropriating some principles which serve as guiderules to this work, that is, to its spirit, its intentions, its laws..." Here then are the two matrixes, the phantasmatic and the icono-demiurgic, which are at the basis of current computer-image production.

On the other hand it is also true that the architectural project cannot assume the artificial separation between modelling and visualization which is at the basis of the current systems. In architectonic composition, image and design are used as language.

The problem of controlling the style of the representation becomes, therefore, a central theme in the development of a visualization system for the project.

We can easily recognize three forms of rethoric in Computer Graphics:

- the special effect rhetoric, or virtuosity in the technical construction of the image, referable to the special machine.
- the rhetoric of computer-presence
- the rhetoric of graphic interface and of the continual flux of data.

The relative efficiency of the instrumentals has up to now

not compensated for the damages produced by the instrumental identification of information and knowledge, image and project.

3. DEVELOPMENT OF A SYSTEM FOR THE CONSTRUCTION OF THE VIRTUAL "MAQUETTE"

The principal objective of our research was that of identifying a structure of data and methods that permitted the effectuation of immediate manipulations of the image, and through the image, on the model, with the least possible recurrence to a "preliminary modelling".

In the traditional formulation, two frame_buffers are used to mantain color (c-buffer) and depth (z-buffer) data.

However, one quickly realizes that the usual 16 or 24 bit limitation of these buffers does not allow for the correct resolution of the field-of-vision depth and for the range of foci necessary for visualizing even very simple architectonic and urban landscape (such as a square, for example).

In such cases, one realizes that the in-depth resolution is more important than on the image plane.

Further, in this case, it is necessary to maintain other buffers for shadows (s-buffer), for normal ones and for shading (n-buffer) and for textures (t-buffer) in order to proceed to ulterior elaborations.

Now, even if the memory cost decreases, the dispersive and fragmentary character of this formulation is evident.

4. POINTER-BUFFER

In the system which we began to construct five years ago, the technique of a single buffer, called pointer-buffer (p-buffer) was adopted: in each pixel is registered not the single datum of color or other but the pointer or key of access to the data base which contains all the information regarding the object indicated.

In this way the modification of the image is identified with the modification of the model.

The results obtained even on small machines (PDP 11-23) and with 12 bits of p-buffer are surprising.

In particular, we believe to be of special interest the possibility of modifyng, in real time, the choice relative to materials, colors, and light sources.

This formulation is very similar to that developed by Martinez in France.

5. THE GENERATION OF SHADOWS

The system integrates different models of illumination and administers, in a similary simple manner, different algorithms for the generation of shadows, following a process logically divisible into six phases:

1. identification of the planes limiting the shadows' projection
2. identification of the light planes
3. identification of the planes or silhouettes which generate shadows.
4. extrusion of the silhouettes
5. resolution of the intersections in the p-buffer between shadow-volume and objects
6. generation of a model of coloration of the shadows themselves.

Only the fifth of these phases is developed in screen coordinates, while all the others are resolved in project coordinates.

6. THE SHADOW PLANES

The element of newness introduced is witout doubt the notion of a shadow plane independent from a light source.

The shadow plane acts not only as a clipping plane on the extrusion, tendentially infinite, of the solid shadow, but is the surface on which the shadows must necessarily appear.

Further, a polygon which lies on a shadow plane cannot generate shadows.

This concept leads to a notable simplification and to a factor-10 reduction in calculation times for detailed architectural scenes.

A first method of simplified visualization mai in fact consist of the simple projection of the invisible (or visible) faces from the light source onto the shadow planes.

For example, the cornices or reliefs of a facade will have, on the plane of the facade itself, the natural projection site of the shadows themselves.

This rule is valid in all the assemblages in which one object lies on anhoter.

The description of the shadows planes is therefore information which is determined at the act of composition ot modelling.

Naturally, every space can have one or more shadow planes.

If we consider a room, for example, it is logical to consider the walls, ceiling and floor as planes for the projection of shadows.

Having illustrated how to multiply the shadow planes, here are some rules by which to diminish the number of operations:

- 1. A shadow plane is not active if it is not visible from the light source
- 2. An object is active for the shadow processor only if at least one active shadow plane exist.

Another original aspect of the method is that of rendering visible the procedure of the construction of the shadows themselves and making possible, in real time, the modification od the shadow-coloration model and switching on and off the lights themselves.

For shadow-generation, in fact, a p-buffer is used for each light source, plus an auxilisry bit wich signals the processor to indicate if the state of the polygon's shadow is partial or definitive.

The pixels in which the shadow-stae is definitive will no longer be taken into consideration.

7. CONCLUSIONS

The mechanism for constructing shadows with the p-buffer has revealed itself extrememly efficient, and with a few variations has been adopted for the visualization of shafts of light.

Further, an extension of the method permits the administration of both the reflecting and the trasparent surfaces of the representation.

Naturally, it would be best to apply the method only to the surfaces that the architect has defined as mirrors or glass, and not casually on every pixel.

With the same method it has been possible to render and resolve, on the image plane, the problem of surface etching.

This does not yet correspond to Boolean algebra, but excellently resolves the problems of "bas-relief" and of the subtraction of material in the thickness of a volume.

The construction of a virtual "maquette" as a project operation requires a new methodology for the development of graphic systems for architecture in which the net separation between modelling and visualization is not assumed.

The experiments conducted and the method illustrated indicate a possible way of meeting model-construction problems on the image plane.

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