DISTORTED EYE

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Abstract

The paper is a brief analysis and presentation of computational visual effects as they may relate to our understanding of space and the depicted object. Euclidean and non- Euclidean projective geometries can be applied, altered, and visualized through computer systems.

Perspective systems are designed to construct pictures that, when viewed, produce in the trained viewer the experience of depicted objects that match perceivable objects. Space perception theorists have written about how our capacities to see are constrained by the perspective system that we use, that is, by our way of depicting what we see.

In the arts, the methods of depiction are of significant importance as they are the means of expression and description of imaginary worlds. Artists and designers engage in story telling and offer a glimpse into their fantasy worlds through unique, personal, private, and idiosyncratic visual methods.

Pictorial spaces are constructed through geometrical models. Each model is expressed as a geometrical transformation applied to Cartesian shapes of the physical environment. These transformations show how shapes are projected in pictorial space. For instance, the mapping of a cube residing in Cartesian space is projected to the surface of the viewing plane through straight lines representing light rays. (see figure 1)

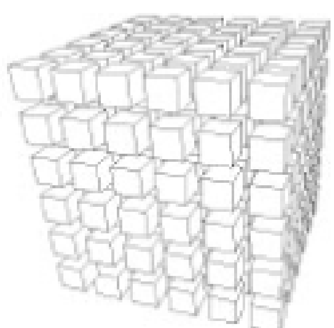

Fig 1 - Perspective projection

In architecture, the methods of projection serve also a subliminal purpose. While axonometric views are considered exact, precise, accurate, and measurable, perspective views are empirical, observable, factual, and expressive. Perspective projection is about the viewer's identity, existence, location, and orientation, while orthographic projection is about the depicted object's identity and characteristics. Isometric and oblique views are exaggerated and, often, extreme methods of orthographic projection, whose purpose is to express, focus, and attract attention to certain parts or angles of the depicted form. Another model of depiction is that of abstraction: black-and-white line drawings convey a clear, sharp, and sterile impression of the depicted form whereas blue prints are understood as working drawings.

In contrast, rendered drawings convey materiality, completeness, substance, and effect. The problem with rendered views is that form is not always conceived as made out of matter. In fact, form is rather an abstract entity that possesses certain geometric characteristics. For instance, dots on a piece of paper may imply a shape not because they are made out of ink but because of their geometric relationships.

The attachment of material qualities constrains the behavior of form and restricts the designer's imagination. In contrast, the lack of materiality liberates the form from its constraints and introduces behaviors closer to intuition rather than perception. Consistency is a phenomenon that ties together seemingly disparate entities. Traditionally, projection systems were constructed to simulate reality either subjective or objective using the principles of optics.

In that context, movement in a simulated three-dimensional space under the rules of perspective projection should be consistent to one's own experience of physical movement. Any distortion to the rules of optics should, in turn, distort the simulated environment. The distortion may not be recognized by reference to previous experience, but it is consistent within the new rules. More than ever now, through the use of applied physics and computation, design space can become a dynamic simulation environment for the exploration of visual behaviors far beyond experience or prediction. (see figures 2-3)

The work of Gauss, Riemann, von Helmholtz, and Clifford showed that geometries could be based on relationships other than Euclidean. This altered the notion of geometry by revealing its abstract postulational character and removed it from any connection with the structure of empirical intuition. Spaces can be constructed on the basis of non-Euclidean axioms revealing behaviors closer to our sensations rather than our perception.

For example, if we assume that visual space is hyperbolic and physical space is Cartesian, it is possible to derive a comparative model of mapping between the two spaces allowing a totally different conceptualization of space. Such a model is expressed as a hyperbolic transformation applied to Euclidean/Cartesian shapes of the physical environment.

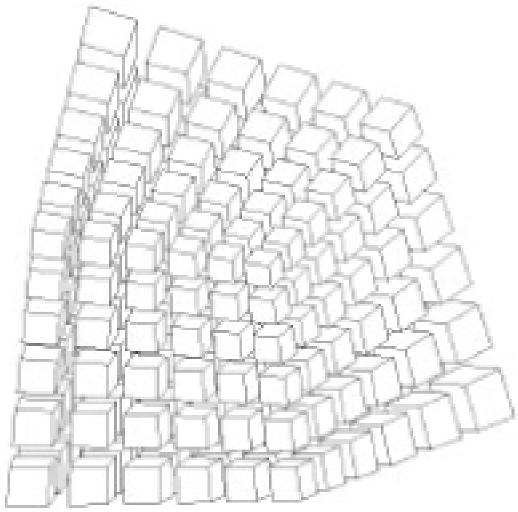

Fig 2 - Inverted perspective projection

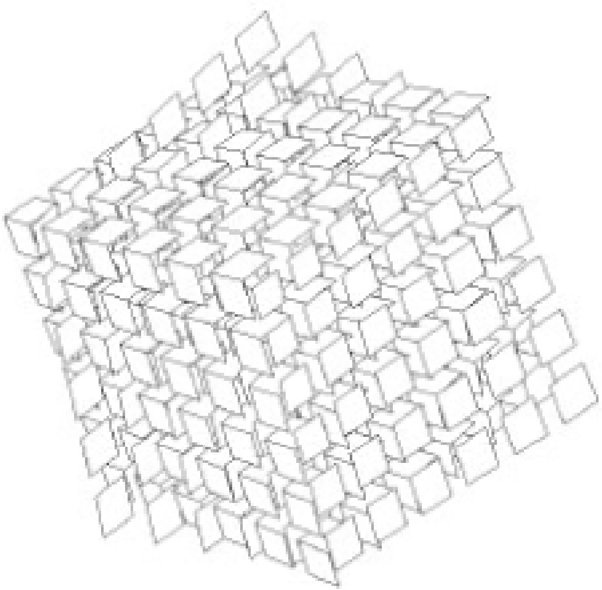

Fig 3 - Multi-viewer projection; each face of each object in the scene is projected along a different point of view. Specifically, different projection methods are used to depict every other face of each object along different values of the viewing distance d, that is, either d or -d. From the viewer's point of view, faces of objects seem to move in opposite directions at the same time as the scene is rotated.

$$face_{2n} \rightarrow view_{-d} \qquad face_{2n+1} \rightarrow view_{d}$$

The result is a hallucinating view of pictorial space where every form in the scene ***appears*** to be a caricature. Luneburg's idea of hyperbolic space was a first attempt to develop a theory of visual space in which geometrical structure is a metric space of constant, probably negative, Gaussian curvature.

Furthermore, the projection of a four-dimensional space into a three-dimensional one, allows the depiction of objects that can only be understood through the behavior of the "shadowed" projection. (see figures 4 -5)

More than ever now through the use of computer tools and visualization techniques, art and architecture find themselves in a position to rediscover and challenge their traditional methods of depiction.

Designers are presented with tools that allow them to manipulate the overall order, organization, and representation of their forms, thus replacing a single design with a range of designs. The new soft and workable design space negates the singularity of the old rigid space and asserts the freedom of an open system where change is celebrated.

New emphasis is placed on curvature and proportion and therefore to organic and dynamic relations. The surprise of the unexpected result infuses new energy to the act of conceiving as well as experiencing form. (see figure 6)

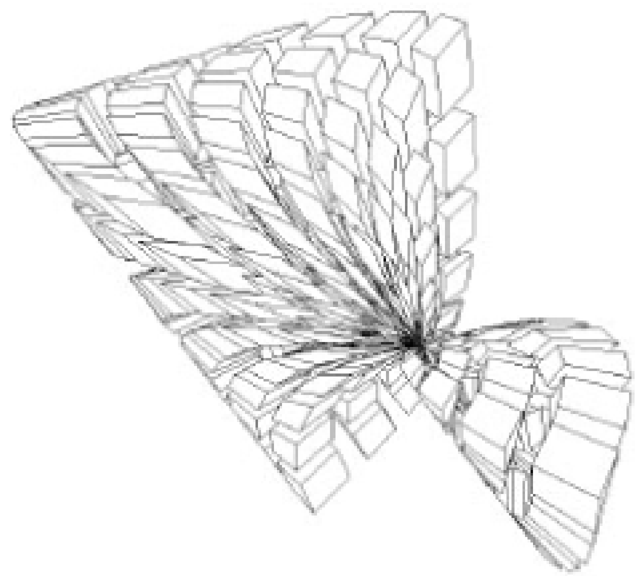

Fig 4 - Projection of a point (x,y,z) on a viewing plane does not have to occur along a straight line

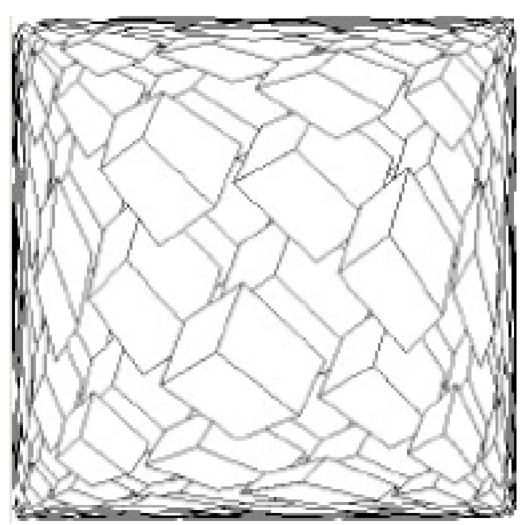

Fig 5 - Hyperbolic projection mapping

Fig 6 - An object showing the result of a non-euclidean projection bound to the Euclidean space

A challenging point is the fact that this new aesthetics is about the unknown, the unpredictable, and the unforeseeable. It requires the cooperation of two brains: that of the human and the computer, for without one another it is impossible to plan or execute imaginary design spaces. Most of all, they lead to the creation of computational schemes, which are available for experimentation, analysis or play across disciplines. Dynamic design space contributes to our understanding of aesthetics and creates a new dimension of how it may change our perception. It also brings up a social point: who is the creator? How will it change our perception if science and mathematics can mold into the creative process?

Endnotes

[1] Panofsky, E. «Perspektive als 'symbolische Form'.» In Saxl, (ed.), 1927, pp.258-330

[2] Clifford, W. K. "The Common Sense of Exact Sciences." New York: Knopf. 1946. First publ. in 1885.

[3] Heelan, P. offers an extensive survey on "Space-perception and the Philosophy of Science." (Berkeley: University of California Press, 1988). Also Lunenburg, R. in his paper "The metric of visual space." (J. Optic. Soc. Amer. 40: (1950), pp. 627-642) offers a description of hyperbolic space. A simulation of the mapping between physical and visual space has been implemented as a real-time computational application in Terzidis, K., "Experiments on Projection Systems", ACADIA Quarterly, vol. 16, no. 4, (1999), pp. 8-15.

[4] Lunenburg, R. "The metric of visual space." J. Optic. Soc. Amer. 40: (1950), pp. 627-642.

[5] One of the first theorists to identify and explore the idea of soft objects in architectural design was Marcos Novak. In his paper "computational compositions" (ACADIA 1988 Proceedings) Marcos identified the three important principles of digital architecture: a) the replacement of the finite object by the variable object, b) the idea of pluralism replacing singularity and c) the existence of equally accessible information. In his work, he explores the idea of architecture as process rather than output.