BRIDGES
Mathematical Connections
in Art, Music, and Science

Spatial Constructs

William C. Bodenhamer
Visual Inquirer
P.O.B. 1028
Isleton California, 95641-1028

ABSTRACT

A spatial assimilation of visual relationships via an artistic systematic process.

" *In the behavior of rigid bodies and light rays, nature has presented us with a type of manifold which approximates Euclidean laws so closely that the visualization of Euclidean space was exclusively cultivated...There can be no serious doubt that we are here concerned with the developmental adaptation of a psychological capacity to the environment, and that a corresponding development would have led to Non-Euclidean visualization, had the human race been transplanted into a non-Euclidean environment*" [1]. (THE PHILOSOPHY OF SPACE AND TIME, Hans Reichenbach).

Utilizing abstract "constructs" (i.e. mathematics, visual conceptualizations), analogues are derived which correlate to spatial environments from which new forms and ways of seeing are developed. Acknowledging Reichenbach's statement as to our being influenced physically and psychologically within Euclidean space, when it comes to developing a spatial construct the influence of our surrounding space seems to be more of a challenging hurtle than an unwavering impositional obstruction.

The so-called Euclidean space from which our experience of reality emerges becomes the "defining point" in which a series of spatial constructs are developed. The spatial construct is a visual inquiry that involves an artistic versus a mathematical approach. Schooled in "Constructive art" (i.e. form is function, function is form) [2], a systematic process is used to create drawings, paintings, and relief constructions. The context of such work refrains from subjective over indulgence, but favors a more objective means in deriving final forms and resolutions.

To elaborate on an interpretation of the "defining point", I turn to Sigfried Gideons' statement written in 1941, "*The essence of space as it is conceived today is its many sidedness, the infinite potentiality for relations within it. Exhaustive description of an area from one point of reference is, accordingly, impossible. It's character changes with the point from which it is viewed. In order to grasp the true nature of space the observer must project himself through it...Recognition of the New Space Sense...*" [3].

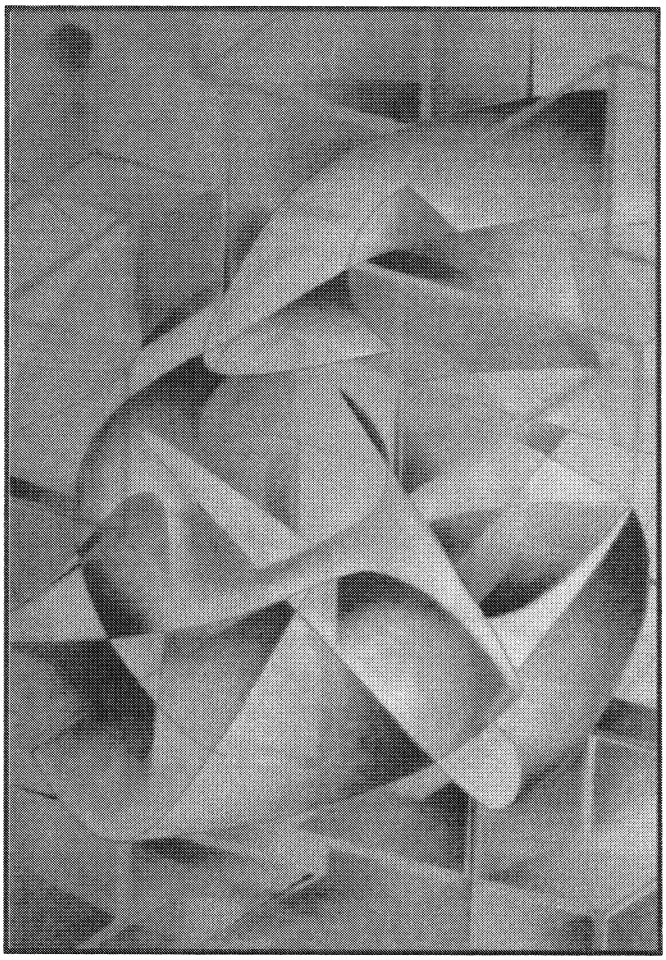

FIGURE 1: A study involving Figure/Ground relationships with emphasis on the figural form.
note: The figure is derived from the underlying defined structural space (ground element). Painting, acrylic on canvas 2'X3'.

To aid in the recognition of the "New Space Sense", a process of assimilation occurs. This assimilation is rooted in a Cartesian coordinate system that defines an underlying structure (ground element). This in itself is a physical factor which allows the construct to be realized.

Numerous drawings are made using a computer and CAD software. These drawings allow the viewing of constructs during various developmental stages complimented by the ease in which the computer processor/software allows for the comparison of one study with another.

The first stage begins with the defining of space by utilizing a linearly defined geometrical structure (In this instance the cube has been selected because of its ease of use). This skeletal structure becomes the basis from which the "ground element" acquires further dimension. A matrix, space frame/lattice, static or gradient takes form dependent upon set parameters (FIG 2).

In parallel and in correlation (inherent aesthetic) with the development of the ground element, the figural element derives its form. The figure is first defined using a set of points that are plotted in direct relationship to the cubic structure. A closed curve is then generated and "spun" creating a planar form. For the studies developed in figures 1 and 6, the planar form experiences a gradient in axis as it systematically rotates throughout the defined ground element (matrix) which in this case happens to be static. Except for the figures' changing position within the ground matrix, it too remains static in terms of its initial size and shape.

Reference has been made to ground and figural elements which are "static" versus "dynamic", an example of ground and figural elements other than static, but dynamic, are illustrated with the incorporation of the central projection of a rotating hypercube (FIG 5). Being utilized as the ground element, the rotating hypercube defines a changing/dynamic space [4].
A parameter is set, the figural element will be confined to the boundaries of the beginning inner cube, figural attributes are then made up of three intersecting planes oriented on the central x, y, and z axis. As the space of the hypercube rotates, the figural element undergoes a relational change as well. This example of dynamic ground and figural elements is embryonic and requires study to further develop spatial constructs utilizing this set of "dynamic" parameters.

Any number of combinational relationships can be introduced to generate ground and figural elements, one need only to define the attributes (i.e. area, size, direction, etc.) and parameters from which studies are developed.

Being initially drawn in wire diagram and having the three views that the CAD software allows for (top,side and angled view), the ability to recognize Gideons' "New Space Sense" is enhanced as a multi-perspective view of the construct occurs simultaneously.

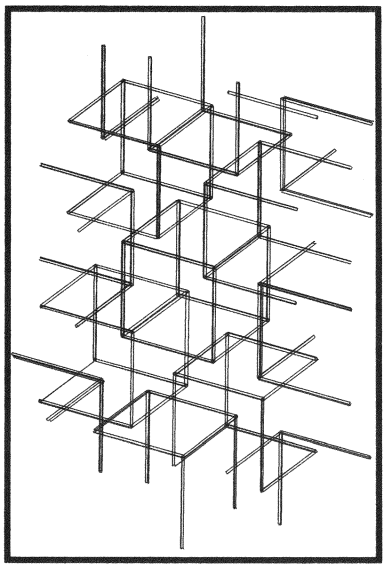

FIGURE 2: Space is defined using a static structural arrangement of cubic elements.

Once studies have been completed, compositions of the final construct can proceed with emphasis placed on a visual realization of relationships. (the aesthetics of color, composition and form).

It is interesting to note comparisons between completed 2-D spatial construct studies with that of early cubist paintings, specifically the one's completed during the analytic and synthetic phase of the cubist movement (during the 1910's). This is not surprising in that the cubists (Picasso and Braque) were interested in defining the outer 3-dimensional aspects of subject matter on the 2-dimensional surface of the artists' canvas. Painting multi-dimensional views of their subject matter, recognizable forms were broken apart by an overlay of multi-facets and planes, each plane and facet depicting a different viewpoint of the subject [5]. In this regard, the studies of figures in space can be compared, but from there, differences emerge. In the "spatial construct", not only is the outer characteristics of the figural element depicted, but the inner as well. The facets and planes that are seen in the spatial construct are not utilized as an overlay from which to define 3-dimensional aspects of a figure (as in the cubist works), but are features derived from a defined space from which the figural element is drawn.

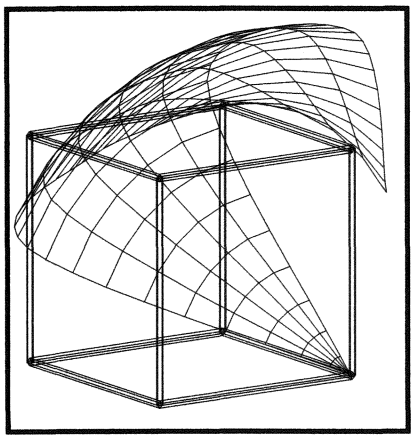

FIGURE 3: Within the cubically defined space, points are plotted to generate and "spin" a linear element with the result being the development of a curved planar form (i.e. figure form created).

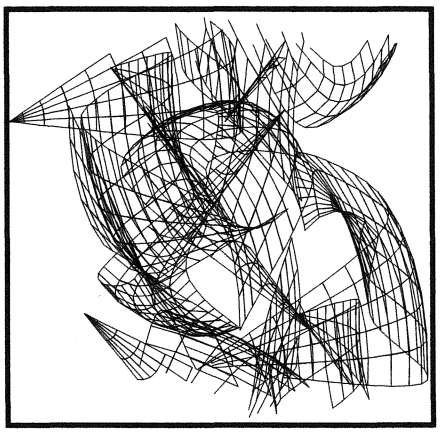

FIGURE 4: The figure is repeated via differing perspective in correlation to its position within the defined cubic spatial elements.

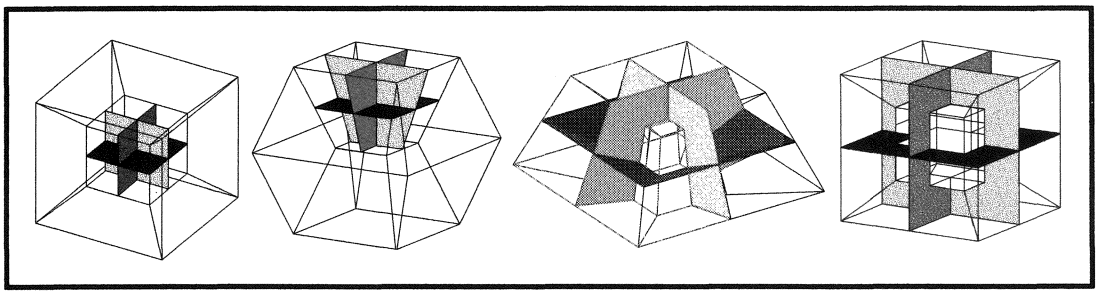

FIGURE 5: An example of "dynamic" figural and ground relationships incorporating the changing space of the projected hypercube.

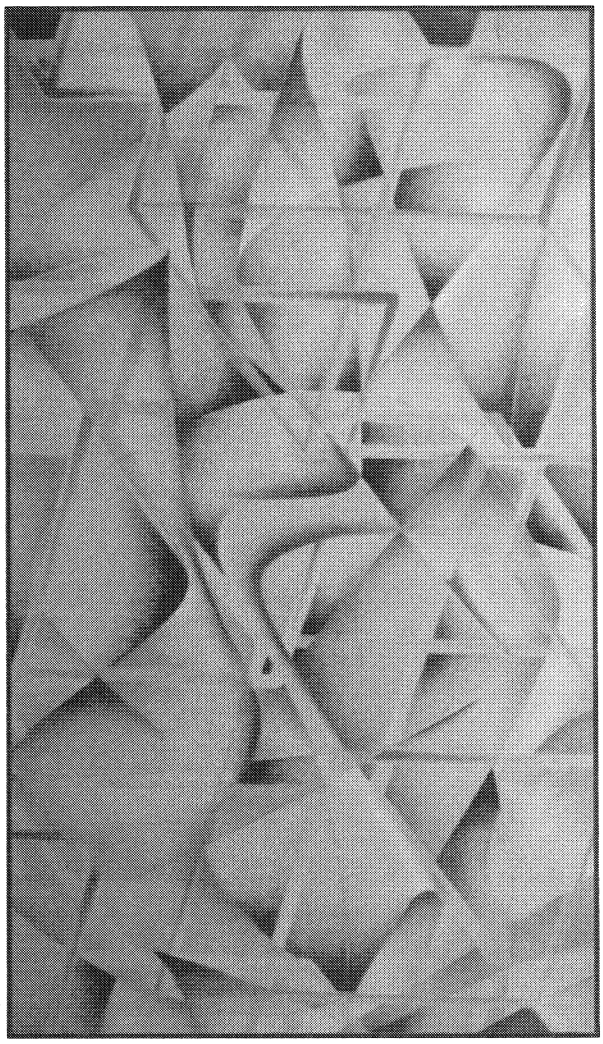

FIGURE 6: Spatial study with equal emphasis (visual) on both the figure and ground elements. Acrylic 30"x60".

This basic systematic process results in the creation of a construct that is more or less independent of the artist's subjective input. The construct, once realized will have it's own spatial magnitude and extension. The apex of assimilation is reached when the viewer is affected knowingly or unknowingly through the sensations that transpire upon interaction with the construct / independent object.

The process of assimilation asserts itself through the independent object or "phenomenon" as Imanuel Kant would perhaps call it, *"The form of the phenomenon brings order into the amorphous manifold of our sensations."* [6]. Once perceived / assimilated the construct is given some form of meaning, filtered through the conscious / subconscious inputs of the viewing participant.

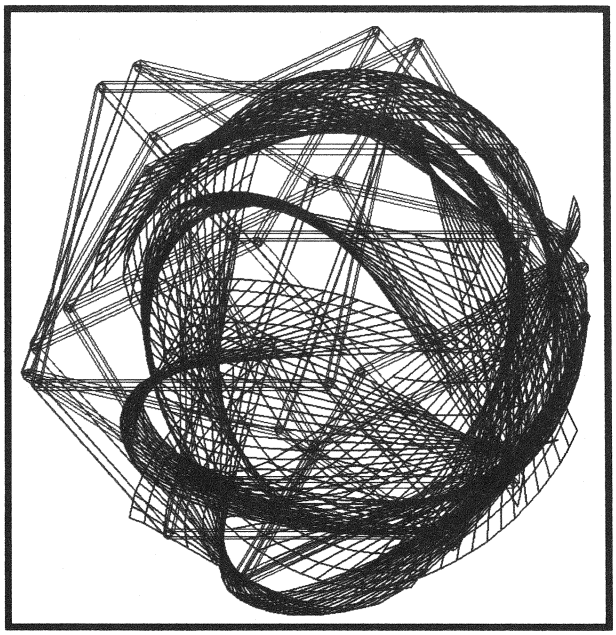

FIGURE 8: Ground and figural elements are static but experience rotational change. The figural element exhibits tentacle like arms, is it embracing or devouring the ground element?

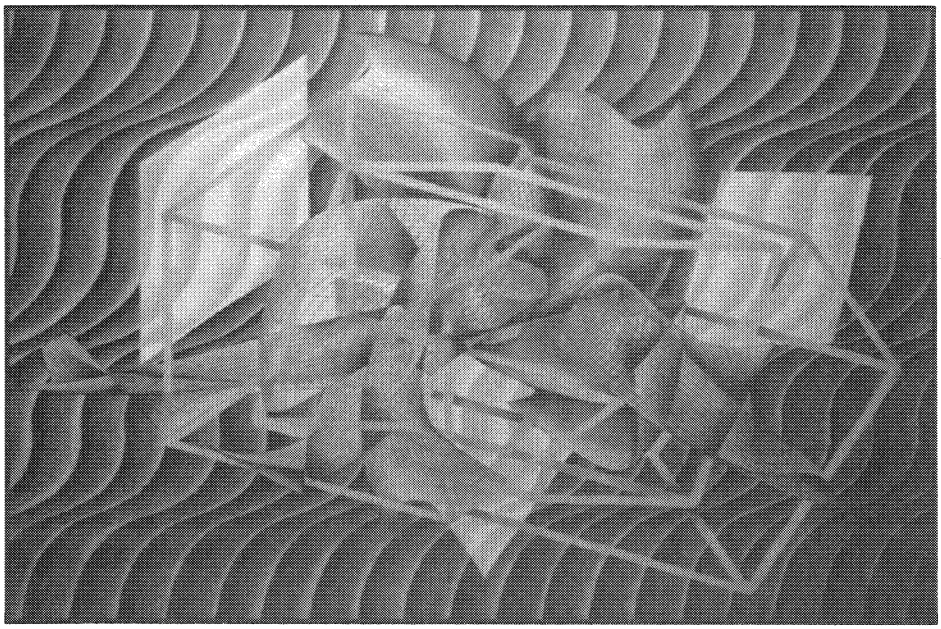

FIGURE 7: Gorgonzola cheese monster surfing the electromagnetic waves of the fourth dimension. Acrylic, 6'x5'.

REFERENCES

[1] Hans Reichenbach, *THE PHILOSOPHY OF SPACE AND TIME*, Dover Publications, pp. 82. 1957.

[2] Eli Bornstein, *DIFFERENCES BETWEEN EUROPEAN AND NORTH AMERICAN CONSTRUCTIVISM*, THE STRUCTURIST, No. 29/30, 1989-1990. [i]

[3] Sigfried Gideon, *SPACE, TIME AND ARCHITECTURE*, Cambridge Massachusetts, Harvard University Press, 4th edition, pp. 431,1963

[4] Thomas F. Banchoff, *BEYOND THE THIRD DIMENSION, Geometry, Computer Graphics, and Higher Dimensions.* Scientific American Library, pp. 120-122. 1990

[5] Horst de la Croix and Richard Tansey, *ART THROUGH THE AGES*, Harcourt, Brace & World, Inc. 5th Edition, 1970.

[6] Max Jammer, *CONCEPTS OF SPACE, THE HISTORY OF THEORIES OF SPACE IN PHYSICS*, Harvard university Press, Cambridge Massachusetts, pp. 136, 1969. [ii]

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[i] Refer to Bornstein's article for a more detailed description of Constructivism without having to resort to reading numerous books on the subject.

[ii] From Kant's *PROLEGOMENA & CRITIQUE OF PURE REASON,* Trancendental Aesthetic (Transcendental ideality of space).