MODULATION OF SPACE: A STRUCTURAL ESTHETIC

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INTRODUCTION

My present work is essentially an investigation of the two and three dimensional formations which can be constructed out of the combinations of the basic polygons. To facilitate this study I have designed and fabricated a system by which mass-produced polygons can be snapped together and assembled into modular structures.

Although my interest is more in the actual assembly of the polygonal modules than in their production, I have expended much time in the design and manufacture phases of the work. Had I had the financial resources, I would have hired professionals to do most of these tasks. Lacking such resources, I executed much of the technical work myself. This involved my obtaining considerable consultation and advice from various technicians and engineers. This perhaps is an unusual aspect of my work, that it has entailed collaboration between myself and those in other fields.

Also unusual, and of importance to me, is the fact that the direction of my work is limited and largely guided by the structural possibilities of a geometrical system. In this sense there has been a degree of interaction between the artistic approach and the mathematical approach. (Mathematicians have been traditionally the ones to study such geometries.)

My primary concerns are with the structuring and definition

of space, and with the process by which this is achieved. I feel the forms I construct, at their best, exist mathematically before my bringing them into physical being. I seek the processes that bring them into being with the minimum expenditure of energy.

My interest in structures evolved out of an interest in the tension between two and three dimensional space, and out of the process by which I had been attempting to organize simultaneously both types of space in painting.

During my first two years as a graduate student at the University of Colorado, I tended to regard the canvas as a window, through which a world could be perceived. As a window the painting involved two types of space, two dimensional space, defined by the surface of the window and it's borders (the limits of the canvas), and the illusionistic three dimensional space, the expanse behind the surface. I felt that both spaces should be considered, that both should be ordered.

I began to divide the surface of the canvas into equal units commensurable with the dimensions of the canvas (a grid of squares, each with an "X" from corner to corner). The grid defined and ordered the two dimensional space of the "window" by a structuring process which conformed to the angles and dimensions inherent in the shape of the canvas. Then I tried to position objects within the illusionistic three dimensional space, behind the surface, by orienting their edges to vectors established by the surface grids.

There was a process which started with the construction of the canvas and continued up to the point of putting objects into the

three dimensional space (illusionistic) that seemed to maintain a structural continuity. But at that point there seemed to occur a breakdown in the putting together of a complete object. Arbitrary - intuitive processes had replaced the structuring process. It did not seem right. The three dimensional space (illusionistic) did not hold together.

I had begun to be more involved in the structuring of three dimensional space when I first became exposed to the ideas of Buckminster Fuller. He pointed out that Man has become so accustomed to thinking in terms of rectangular coordinates that he automatically uses them even when they are not appropriate. He also pointed out that the square has no structural integrity (strength), nor does any polygon except the triangle. (A triangular shaped canvas will not warp.) It occured to me that I as an artist had been blind to the possibility of painting on other shapes than the square. And that this was a shortcoming especially since I had regarded the shape of the canvas as an important formal element of the painting. I tried some other shapes as formats and tried to become completely conscious of their three dimensional space (illusionistic). Shortly after this and after leaving school, I started painting on circular formats and became increasingly involved with Fuller's structures from an architectural point of view (geodesic domes).

The idea of a structurally sound approach to building (through the triangulation of a spherical surface), led me

to the idea of structuring a two dimensional surface according to the principles of triangulation. For several years, before painting on any surface, I divided the entire format into a grid of equilateral triangles. Then I tried to find two or three dimensional (illusionistic) forms whose edges would lie along the grid lines, or whose shapes would be occupied by configurations of the triangular modules.

The idea of simply assembling structures from identical modules appealed to me and I started constructing three dimensional structures (actual) out of equilateral triangles. Then I incorporated other polygonal shapes having equal edge lengths. I came to the point where I wanted many more shapes than I was able to manufacture by hand. And an easy method of joining them seemed very desireable. It became apparent that large quantities of identical shapes should be mass-produced rather than hand fashioned. For this reason I looked into the possibility of mass-producing plastic "snap-together" polygons. The type of mass-producing I had in mind, injection molding, I found to be an expensive process, beyond my means.

Upon returning to the University of Colorado, I learned that the Engineering School had injection molding facilities. After receiving permission to use these facilities I proceeded to undertake the project. I decided to produce triangular, square, and hexagonal elements, all interchangeable. The triangle, square, and hexagon comprise the three regular polygons that will tile a plane. They will close-pack either with their own kind or in a variety

of combinations with each of the others to mosaic an infinite surface. They are of special interest to me because they provide a structural link between two and three dimensional space. With the same shapes one can construct either flat grid surfaces or their three dimensional counterparts, polyhedral clusters.

After deciding to mass-produce the polygons, I was faced with the problem of having to design modular elements which were capable of being fastened along their edges yet as inexpensive as possible to manufacture. Most inexpensive would be elements of one piece construction utilizing a mold incorporating no undercuts. I received advice from moldmakers and engineers and eliminated several design possibilities before finally deciding upon a design which incorporated a "built-in hinge" fastening device.

Having decided upon a module design, I tried to find a commercial moldmaker to design and machine the mold base. The lowest cost estimate was too expensive and I found I would have to design the mold myself (under the guidance of a moldmaker), and machine it myself (with the assistance of university machinists). I purchased a commercially produced standard mold blank which considerably reduced the amount of machining required. The machining was done in university machine shops. There are several that students have access to. I hired university machinists to do certain precision work which was beyond my capabilities.

Upon the completion of the machining of the mold base and after receiving instruction as to the operation of the injection molding facilities, I started production of the polygonal elements. After manufacturing sufficient quantities of the shapes to demonstrate some of their structural potential, I began to assemble various structures, but on a smaller scale than I had intended. I feel that I have barely "scratched the surface" of the possibilities of this structural system. I plan to make some improvements in the mold base before starting production again. After that, I want to build much larger structures,possibly on an enviornmental scale, that the observer can walk into rather than view from the outside.

I feel positively about the formal aspects of my work. Working within a structural system is for me a beautiful and gratifying experience. The idea of my bringing into being forms which already exist mathematically, I find to my liking.

But I have some doubts about certain aspects of the direction I have taken. These have to do with the purposeful employment of industrial-technological techniques, and whether it is justifyable knowing the effect they are having upon the eco-systems. A traditional concern of artists is permanence. It has been taught that an artist should use high quality materials and that he should strive to make his works last forever. But I am engaged in the mass-production of thousands of pieces of a plastic material of such durability and weatherability, that I wonder whether they will outlast their use, and thereby contribute to the mount-

ing waste disposal problems. Also I have not been able to completely overcome certain preconceptions I have held about "cheap plastic junk".

Nature uses decayable materials to acheive her structures. The permanence of mankind is not accomplished through the use of permanent materials but through the use of a genetic coding system. I want to devise a coding system by which I could accurately describe polyhedral structures. It would contain all the information necessary for one to reconstruct replicas of my works. These formulas could conceivably outlast any material available, especially since they could be readily copied. Then I could use materials which have an "expiration date". Such plastics have been developed; they deteriorate according to a time schedule chemically built into them.

I expect to be involved with the assembly of modular structures for at least several years. But my interest is in the structures, not the plastic pieces. I am fascinated by structural transformations which take place over a period of time. Stop-motion cinematography could accomplish the illusion of growth and transformation through the manipulation of my plastic modules. I will probably attempt this. Using the coding system described, as a basic programing element, three-dimensional computor generated movies would perhaps be closer to the type of thing I want to do. This is the direction that I envision myself taking.