BRIDGES
Mathematical Connections
in Art, Music, and Science

Geometries of Curvature and their Aesthetics

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Abstract

This paper discusses my sculptures in relation to their two most basic geometric classes and the distinctly contrasting aesthetics of each. Viewers have sometimes remarked on these aesthetic contrasts, which stem entirely from differing three-dimensional geometries, and my assumption is that they will always to some degree be felt, if not necessarily in an immediately articulate sense.

1. Introduction

All my sculptures can be viewed geometrically as either surfaces or objects with volume. On the other hand they all have in common a signature of continuously varying curvatures which are always in integral relation to a holistic design logic. This decision to create sculpture distilled to organic essentials seems to have always been less conscious than natural, and in any event is now lost in time. Its fundamental nature is clear. It gave me a vision and a perseverance immune to distractions. It no doubt ultimately influenced the development of my neuroanatamy, dictating where dense networks of specialized synaptic connections would grow.

2. Surfaces and Volumetric Sculptures

It should be noted that the works I've referred to as surfaces, since actual sculptures rather than theoretic conceptions of zero thickness, obviously must have some volume to physically exist, but their aesthetics primarily relate to their coherence as surfaces. At first I didn't understand the nature of this coherence. In time, however, I became aware that I was intuitively approximating how a soap film would minimize the area between their edge constraints. More particularly these sculptural surfaces have the opposing upward and downward curves such a chemical film forms when bounded by an undulating wire ring. These surfaces are in consequence locally minimal in the degree to which their opposing curves cancel to yield zero mean curvature (Figures 1 and 2; [1, 2, 3, and 4]).

Despite their convolutions the volumetric sculptures I've recently made have a modular simplicity in using a constructive geometry of columnar tori with circular cross sections. Such tori graduate toward zero mean curvature on their inner face, and have positive curvature on their outer face radiating all their curves in the same direction from any of its apices. My recent volumetric sculptures all have this duality of curvatures (Figures 3, 4a, 4b, 5a, and 5b; [4, 5]).

3. Contrasting Aesthetics

Needless to say sculptures conceived so differently will also differ in their aesthetic resonance. Hyperbolically curving surfaces with zero mean curvature have an irreducibly spare elegance in which three dimensional form has the least surface area it can, relative to its edge constraints, and still exist theoretically with zero thickness or physically as molecular film or sculpture. They suggest a visible revelation of the microscopically hidden scaffolding of nature in processes such as cellular metabolism. They can also be seen as a visual analogue to sanity at the limits of moral possibility where it is taut like a chemical film which can contract no further. However, the most fundamental aesthetic significance these surfaces inherently possess lies in their visual evocation of nature's economy. No sophisticated mathematical understanding is necessary for this fraught significance to be felt in the mind of the viewer as aesthetic experience.

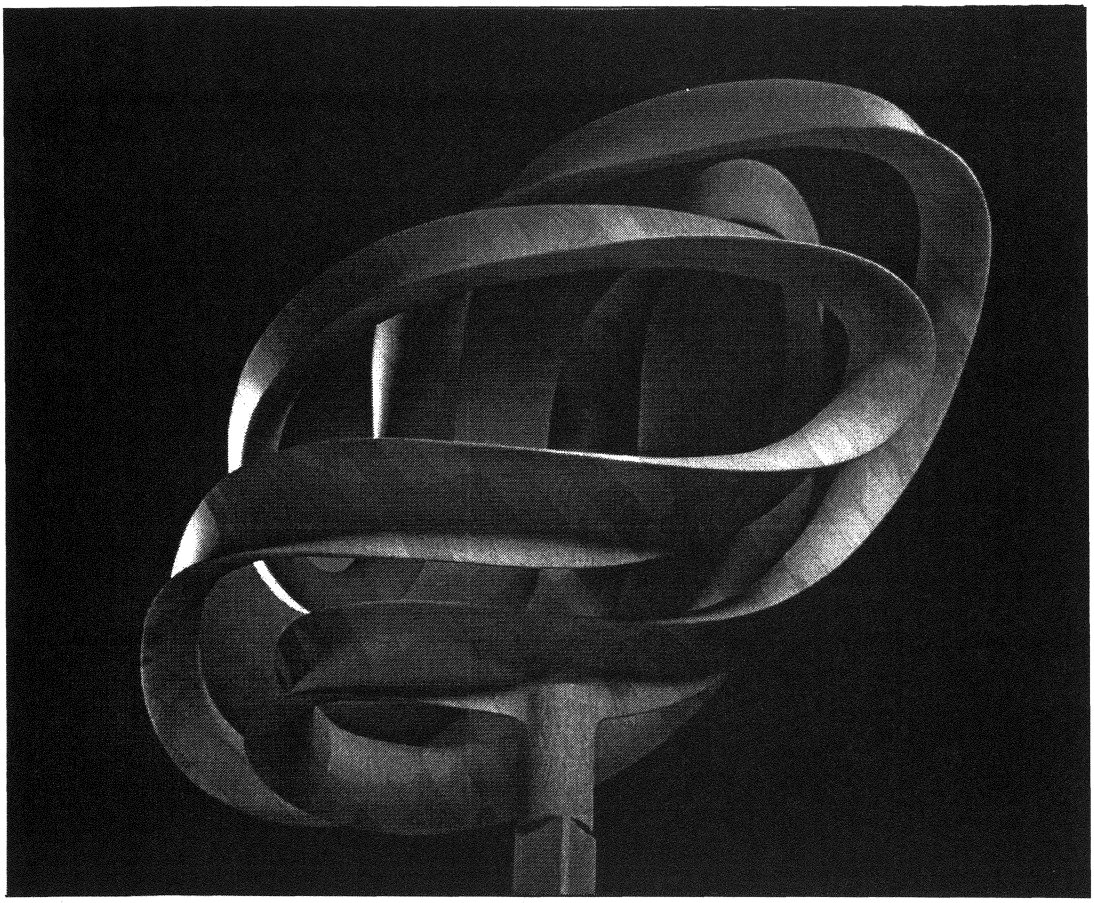

Figure 1: *This ribbon surface would more closely approximate zero mean curvature were it not for an aesthetic decision to deepen its outward facing concavity. It is configured as a double helix conforming to the surface of egg. I first laminated a hollow wooden egg, and then subtracted everything save the ribbon. Photo: Phillip Geller.*

My recent volumetric sculptures are analogous to the surfaces in also having an aesthetic dimension of economy. In them it relates to the degree of clarified economy with which their curvatures enclose volume. Resolving sculptural form to an economy of continuous cross-sectional circularity is always an inexact approximation. It entails a constant struggle to visualize and finely coordinate hand movements

guided by both vision and kinesthesia. Particularly when the form is actually part of a larger, complexly integrated layering of geometries. In my most recent sculpture any form circular in cross-section would, for instance, be part of either one of the two tori which intersect each other forming a cleft around which they also spiral while simultaneously following a periodically curving path over the surface of four spheres overlapping in a deployment reflecting the logic of the sculpture's global geometry (Figures 5a and 5b). Here I should note that sculpture whose geometric complexity can seem rather absurd when described in words, may nonetheless have immediate perceptual eloquence for the eye. Complex music can have similarly immediate eloquence for aural perception. The given in each instance being the incredible sophistication of our sensory processing in its original adaptation to the natural world. Being able to perceive the world in patterns of aesthetic congruence is an incentive to live no doubt given to us over the course of our evolution because it does have survival value. It is why artists work, suffering through the migrainous complexities of their work for the serene transparency to be found on the other side.

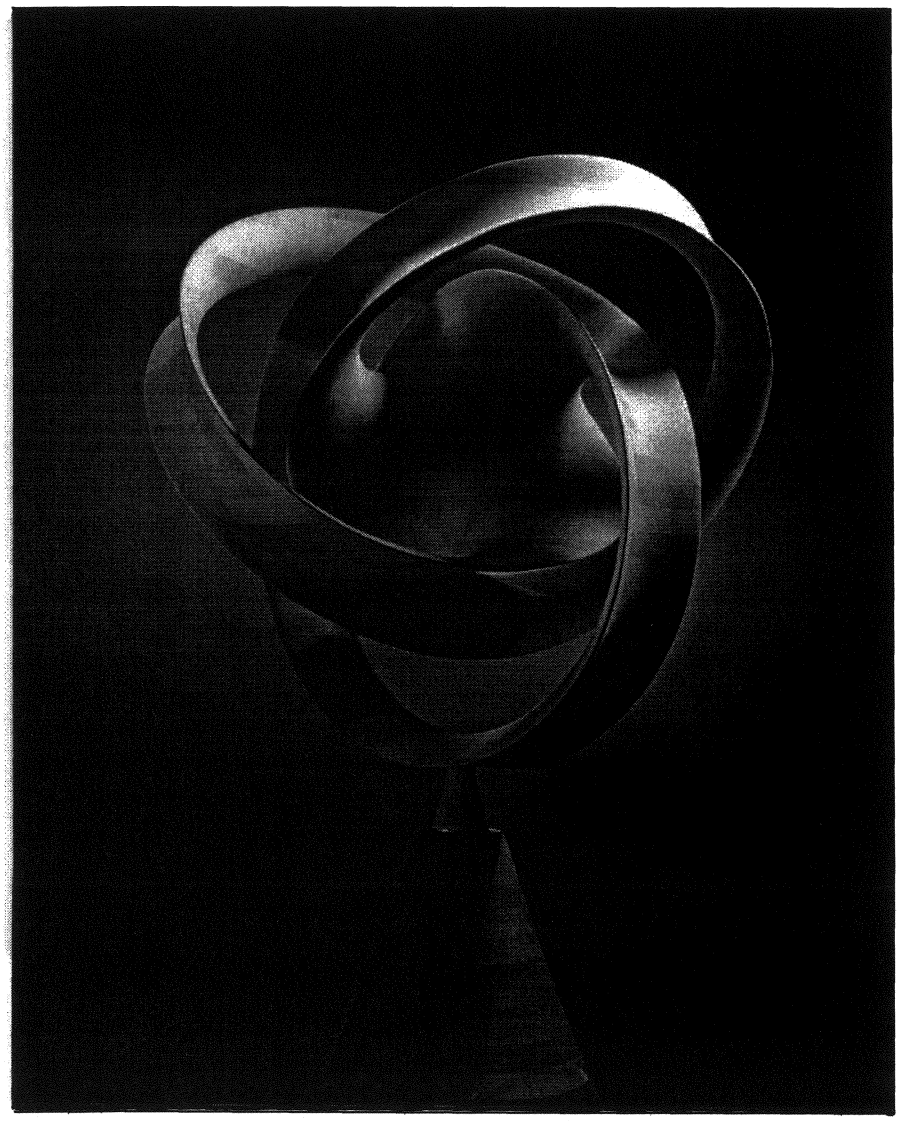

Figure 2: *This approximate locally minimized surface is a metaphor for the atom. Arching ribbons represent electrons, while the hyperbolic curvatures ensconced within form its nucleus. Photo: Phillip Geller.*

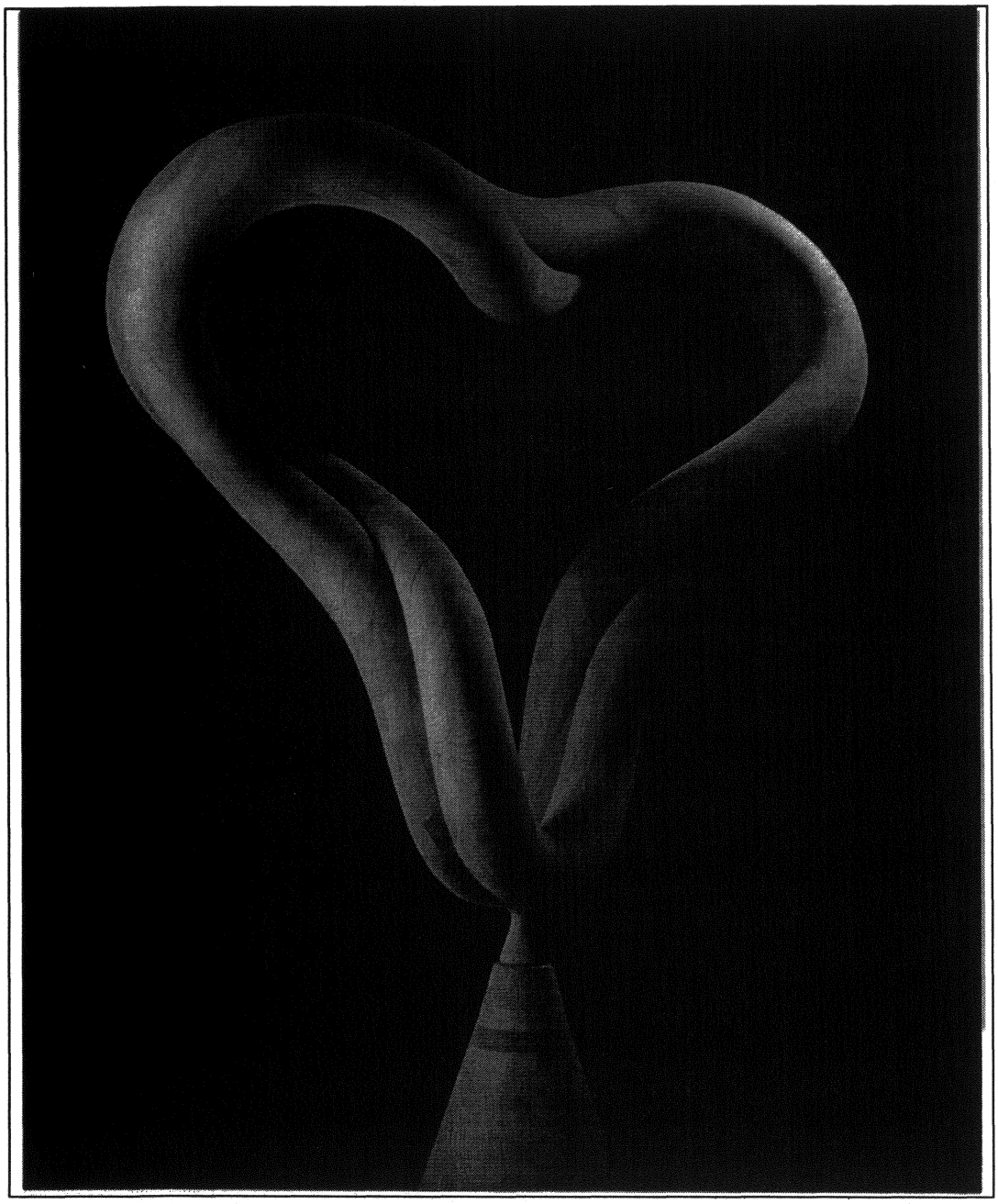

Figure 3: *This doubled, self-intersecting torus is a variation of a triply twisted Möbius band. It also has a trefoil's triplet of over-under crossings. While by virtue of its self-intersection, it becomes moreover topologically equivalent to a figure-8 Klein bottle. Photo: Phillip Geller.*

I have been interested in my recent volumetric sculptures not only from the perspective of my aspiration to beautifully clarify them, but also in terms of their biomorphic resonance, particularly in suggesting muscular tissue. When their toroidal columns intersect forming clefts around which they twist, a convincing sense of muscles in play is conveyed. Rather than the elegant spareness of zero mean curvature in the hyperbolic form of a soap film, these sculptures have the sensuous fullness of fruit and

the body's season of youthful maturity. As purely geometric conceptions these sculptures perhaps only have that much more potency as evocations of the significance muscularity has for our survival and the aesthetic frisson the selective pressure of evolution has genetically invested in human sexuality. In them the non-specific muscularity of both genders is distilled to pure form, which segues into an appreciation of our athleticism as well as our sense of the strength and grace of kindred mammal species. Though without implied differentiation into male or female, these sculptures are nonetheless visually resonant with contours which potentially connote sexuality. In the end, however, these sculptures must ultimately be aesthetically successful as formal compositions without reference to their biomorphic resonance. In work whose inspiration is a belief in the modest possibility of formal beauty nothing less is sufficient.

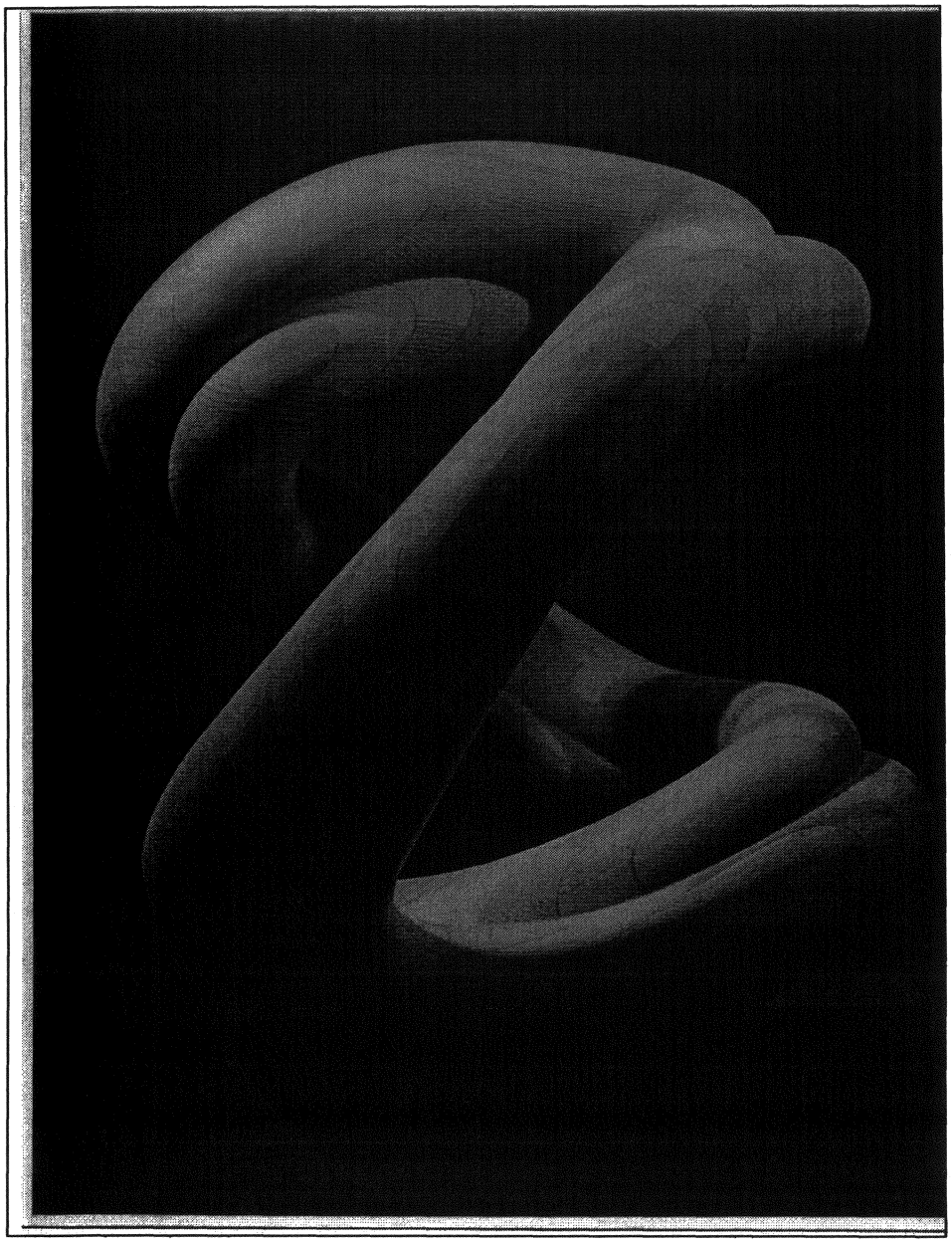

Figure 4a and 4b: *Though quite different in its global geometry, this sculpture is homeomorphic in all other respects to the object shown in Figure 3. Photo: Phillip Geller.*

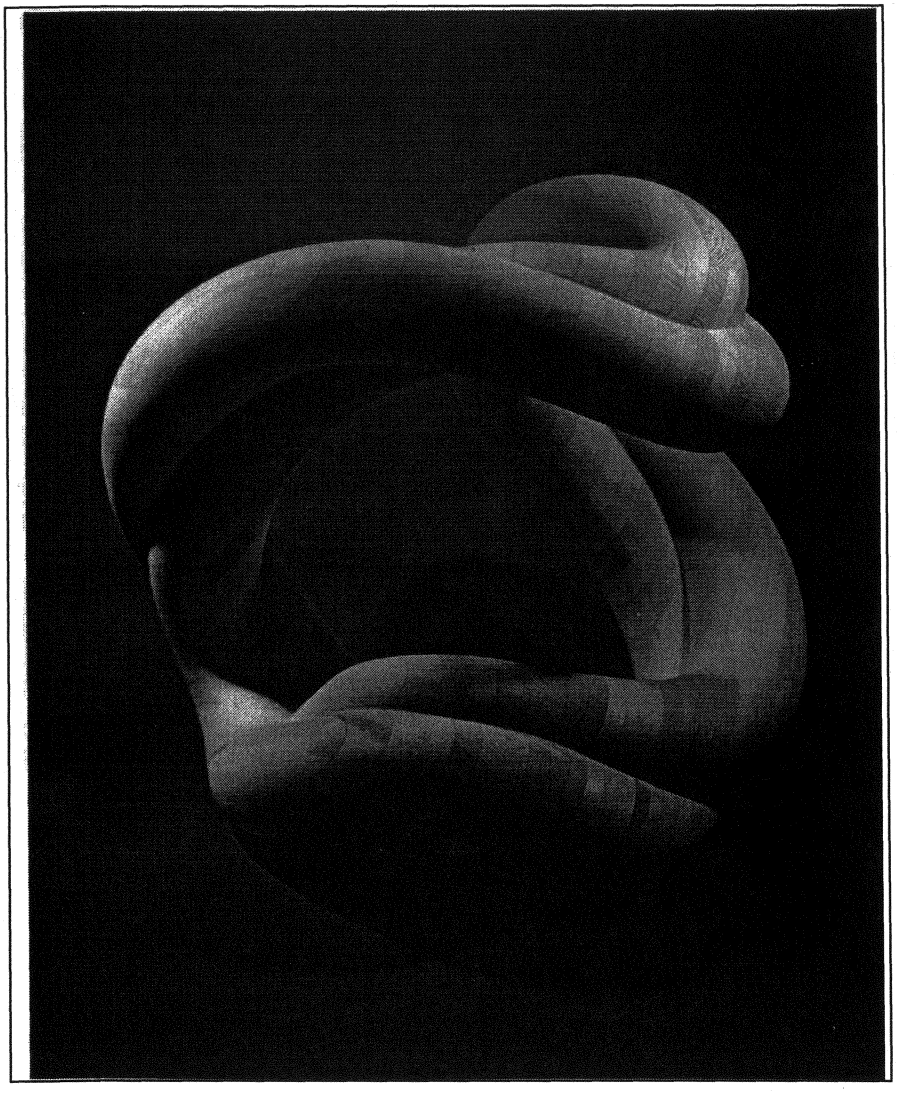

Figure 4b

Conclusion

My sculptures are constructed from their foundations as either surfaces or objects with volume. Subsequently an integrated layering of elementarily coherent geometries will form the distinct grammars of the works in particular motif cycles. The eventual organic complexity which emerges in them is managed initially by orchestrating it one step at a time. Essential to ultimate success, however, phase transitions must occur at certain points leading to a "peak" momentum of spontaneous creativity where everything feels right and thinking is unhesitatingly translated into knowing action. This state of conscious and neuromuscular grace has been variously characterized as "flow", the "effortlessness at the height of effort", the "zone" etc. It is another phylogenetically ancient potential evolution has given our species. Its rudiments are seen in all species which play, and in ours with the appearance of culture it has come to be sought in innumerable ways.

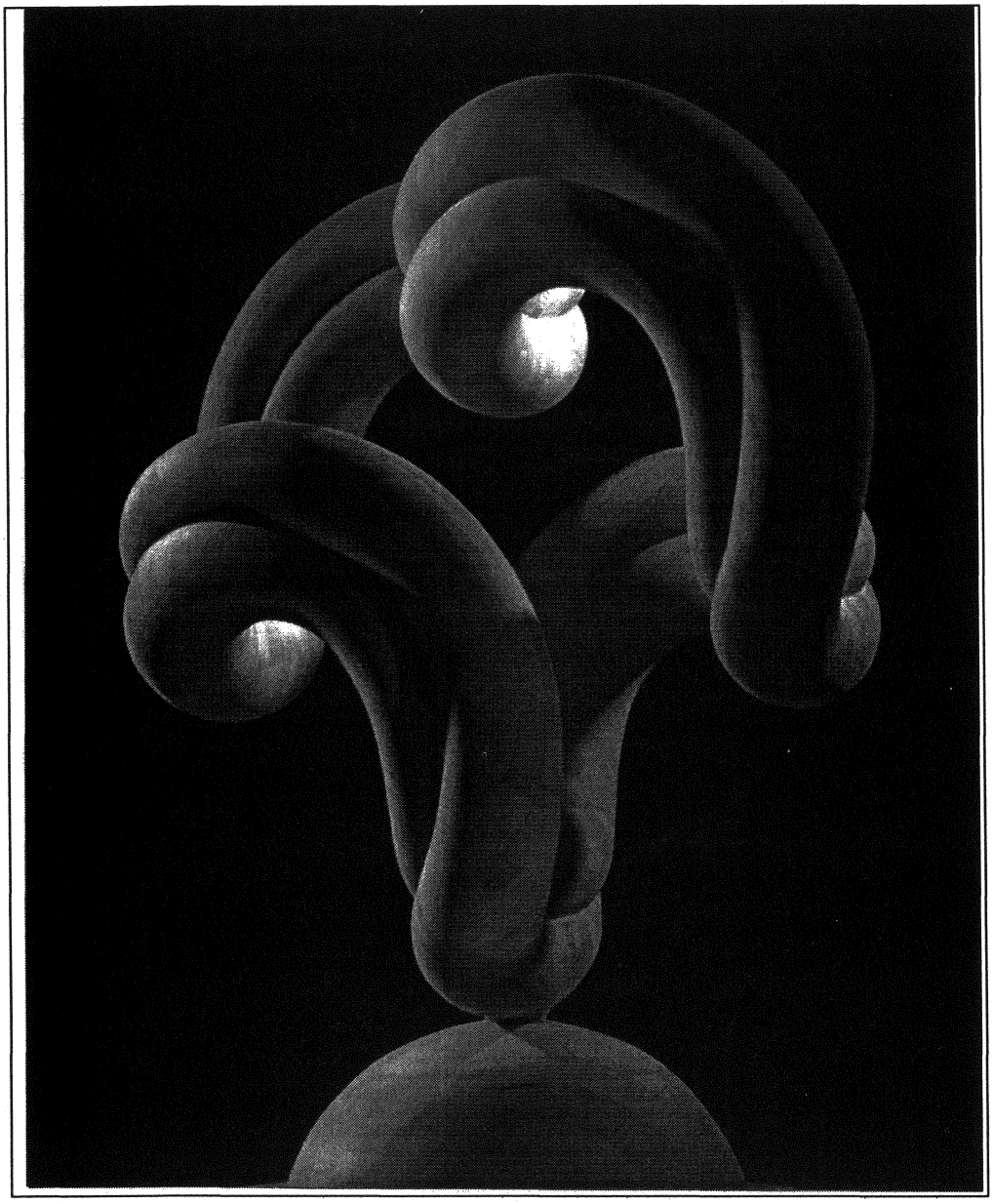

Figure 5a and 5b: *In this sculpture two tori intersect and traverse a complex pathway in space while twisting 360 degrees around the axis of their intersection. Photo: Phillip Geller.*

Parsing sculpture to its geometric grammar is somewhat analogous to viewing a living organism at the reductive level of biochemistry. While viewing sculpture aesthetically and in the light of the emotional associations it potentially evokes is correspondingly like appreciating the intelligence incarnate in a whole living organism. What underlies this is the enrichment of the world through the emergent dynamics of living nature's complexity. The creative expression of our neocortex and older substrates of emotion are part of this no less than the synchronized flashing of fireflies...we and they are immersed in life as separate species sharing helices of heredity with the same cheirality formed by the same four letter chemical alphabet.

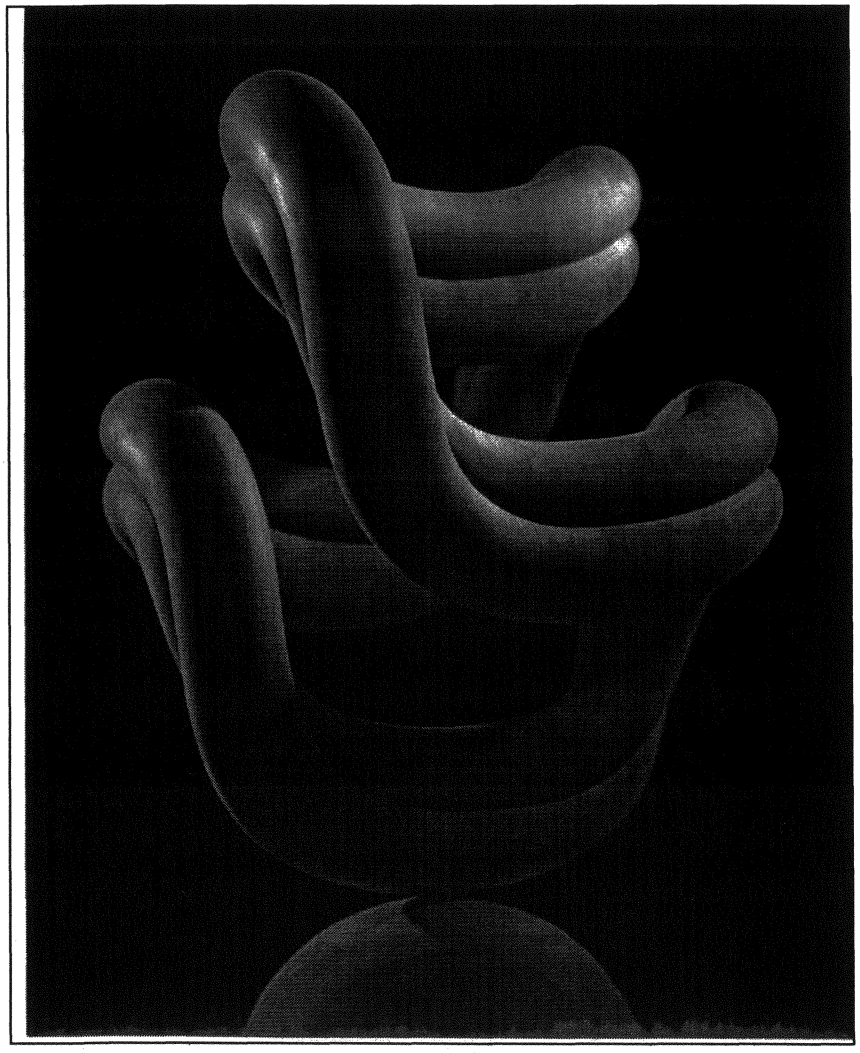

Figure 5b

My human faith as an artist draws strength from the accomplishments of those who have gone before, some known and many more unknown, but all exemplifying the native visual intelligence of our species so movingly apparent in the high naturalism and anonymity of early Paleolithic cave art. Just how is it that we in so many times and places have created artworks of wonderful mathematical subtlety, as well as pure mathematics, were we not preadapted to do so using our phylogenetically ancient capacity for logical perception coupled with a more recent one for symbolic representation which appeared with the evolution of language. Think of an early speechless hominid unable yet to call his or her tribe sapient. Think of this creature mentally mapping a landscape or picking up a stick. This primate would have possibly had an evolutionary destiny to dream creative solutions, concentrate meaning in poetry, and have compassion for all sentient beings.

References:

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