

# Commissioning a Bridge

Brent Collins<sup>1</sup>

## Abstract

Two new large-scale sculptures for a new science building have been commissioned by Missouri Western State University. The geometry of these two sculptures and the thoughts accompanying them are briefly described.

## 1. Introduction

The author, in collaboration with computer scientist Carlo Séquin, has been commissioned to design two large sculptures for Missouri Western State University (MWSU) in connection with the construction of an annex to their science building. One sculpture, *Music of the Spheres*, will be cast in bronze and sited near an entrance to the Remington Annex; the other one, *Evolving Trefoil*, will be a lightweight fabrication in translucent epoxy and will be suspended in the atrium of this building. Both sculptures will be installed in the summer of 2012.

The description of the two sculptures was originally written to serve as archival documentation of this artwork for the University. It describes the two objects geometrically and posits an optimal synergy between art and science emerging from their common ground of perceptual pattern recognition, whose pleasing experimental frisson was evolutionarily selected as an adaptive feature of the mind. Implicatively it views the archipelago of cultural fields as a unified continent within the evolutionary horizon of our brain's inventive plasticity.

## 2. Artists' Commentary and Credo

The perceptual intelligence of past hominids was honed by unrelenting selection pressure to recognize increasingly complex patterns in nature, inclusive obviously of those in the behavioral dynamics between members of their own societies, the essential aptitude our species has culturally systematized in the mathematical sciences. A corollary cultural phenomena of pattern recognition has arisen from its preadaptation potential for extension to the creation and appreciation of aesthetically conceived patterns in the arts. Moreover, in as much as art and science have both emerged from the evolutionary axis of adaptive pattern perception, it is not surprising that they can have a synergistic relation in the mind, each inspiring and nourishing the other. Perceiving meaningful patterns is simply a generic function of the mind rewarded by an experientially pleasing frisson "naturally selected" as one of its adaptive features.

As a team professor Séquin and I sought to create objects for the scientific and larger academic community of MWSU which have the potential to awaken this synergy. In view of the selected sites for these two sculptures at the Remington – Agenstein complex, we hope their formal grounding in procedurally generated geometry will have special resonance for mathematicians and scientists. While the germinal content of these geometric sculptures originated from artistic intuition, they would never have come to fruition at the scale of public art were it not for the innovative software developed by professor Séquin and the graduate students under his guidance. Our larger ambition is for all who view these sculptures to be engaged by the counterpoint between their self-evident coherency and the more analytically elusive nature of their underlying geometries, which organically unify the topology of trefoil knots with curved surfaces minimizing the area between given edge constraints – the latter conforming to an aesthetic of elegant economy. We will be most moved emotionally if these artworks excite an

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<sup>1</sup> 90 North Hwy 169, Gower, MO 64454, U.S.A.

enthusiastic response from children, whose swiftly developing sophistication of generic visual intelligence is a natural wonder of genomics – to invoke the sense of wonder. Further it is worth noting that the molecular encoding of genomic information, in common with all biological processes, entails the recruitment of chemical elements forged in the late cyclic stages of stellar physics.

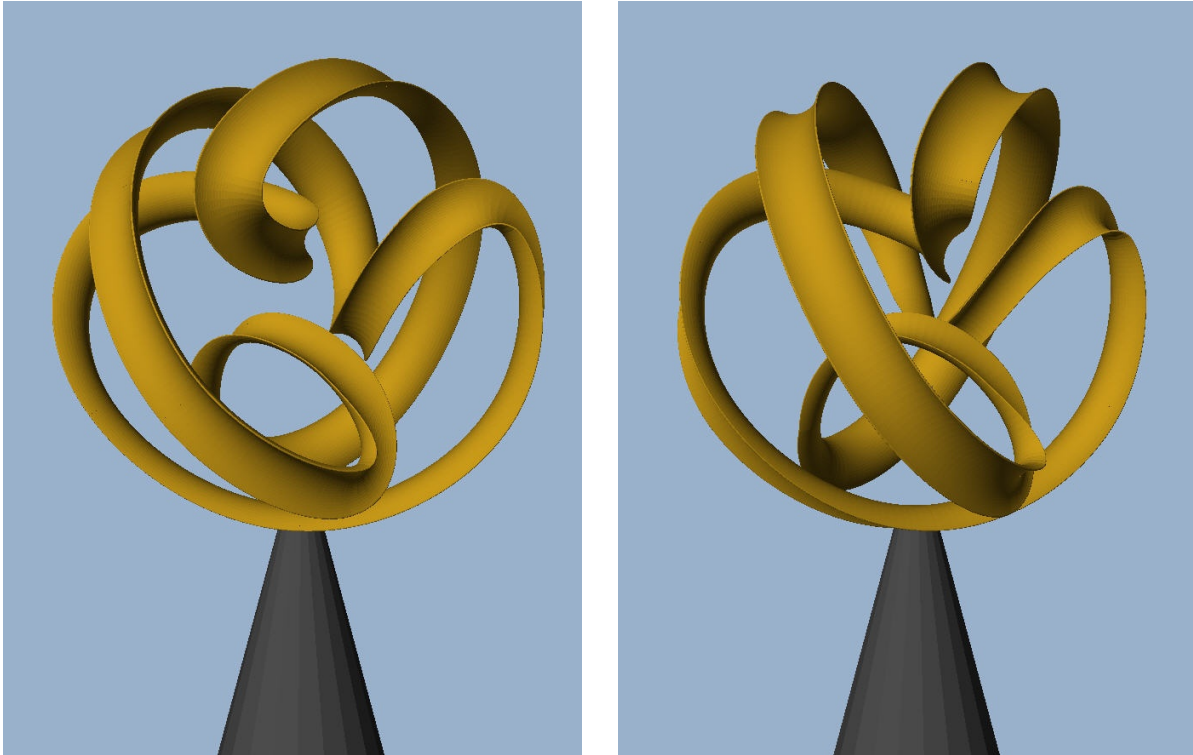
The sentience we have in common with other species along with our language and cultural paradigms of science and art all originate in the biochemical orchestration of tissue differentiated at its genetic inception for responsiveness to fields of energy. The evolutionarily ancient transmitter of this sensory information, the neuron, has been preserved for eons through myriad branches of speciation in a great continuum of generations. The life cycles of innumerable organisms have transpired in this protean planetary spectacle. Even the number of distinct species over time is incalculable. So much of undoubted significance has left no hint in the fossil record, so much has vanished in the silence of past time, so much is forever unimaginable. However this may be, from primitive beginnings in the simple motile sensitivity of early life forms to the flux of their environment, minds eventually with a theory of other minds would evolve, conferring reproductive advantage at every stage of their emergence. Such minds were preadaptively poised on the threshold of empathetically sensitive awareness as a moral compass. A critical catalyst for the beginning of an actual crossing was the appearance of “mirror” neurons in the evolution of primates. Suites of these neurons acted to elevate a formerly more instinctive nurture of family members to an acutely felt vicarious experience of their vulnerability to injury. Our empathic sensitivity is fraught with potential extension to others not merely outside our immediate families, but ethnically differentiated from us. More than that it is in fact the evolutionary foundation of our humane impulses to prevent cruelty at our own hands to other sentient species. Given that our minds did not evolve to comprehend their own dynamics, and that our evolutionary psychology is often problematic in our propensity to fear and aggression (in some measure our fear of the ethnically “other” may be an immunological defense mechanism), the preferential guide of a humanism informed by science is our potential for an inclusive empathy embracing our billions of conspecifics as well as sentient creatures from other species. If the present interconnectedness of our global population density is an equation of genetic inertia foreclosing significant future evolution for our species, we will still have – and only have – the moral dimension of our empathy as imperative animus for a scientific program of reorientation addressing the ominous trajectories of industrial civilization for the sake of our future children, other sentient species, and the sustaining ecology on which organic nature systemically rests. The looming risk is that our overreach in the planetary narrative will devolve into a chaos of obscurantist sound and fury signifying only shortsighted failure to take timely or sufficiently concerted action consistent with scientific consensus ... What lies ahead may be the painful discovery that we have become evolution’s greatest error as a cascading destabilization of advanced anthropogenic global warming approaches irreversibility.

### **3. *Music of the Spheres***

The crescent cross-section of this sculpture’s ribbon is oriented to curve in the opposite direction to the denouement of its curvature through space. Consequently, in gravitating towards zero mean curvature, the area of the surface that spans the ribbon’s edges always has an economy conforming closely to how a soap film, drawn taut by contractive molecular forces, would form a natural minimal surface between them. The sculpture can be viewed as preserving the aesthetic elegance of this transient physicochemical phenomena in a medium whose “energy content” is solidly frozen within the current range of temperatures on earth.

This sculpture is actually a trefoil knot, although this fact tends to be obscured by its ribbon’s complexly curving transit through space. In the canonical depiction of the trefoil knot, the linear curvature between its triplet of over-and-under crossings hovers near a minimum of direct connectivity. The ribbon of *Music of the Spheres* in contrast traverses a symmetrical constellation of invisibly projected volumes consisting of a larger sphere enclosing three smaller interpenetrating spheres. Through this spatial

maneuvering, the front-to-back symmetry of the canonical trefoil is lost, but its rotational symmetry is retained: A rotation of 120 degrees around the mid-points of the sculpture’s two different facial morphologies fits them back onto themselves. The “needless trouble” *Music of the Spheres* takes as a trefoil in following what topologically are entirely superfluous convolutions in space has no justification other than an aesthetic one, aiming to qualify the work as geometric art.



**Figure 1:** “*Music of the Spheres.*” Computer graphics rendering of the sculpture geometry, re-designed to be fabricated as a partly hollow ribbon, looping around three invisible spheres inside an outer sphere measuring six feet in diameter. The software developed by Carlo H. Séquin that generated this rendering [3] also outputs the files that control the milling machine that produces the master geometry patterns for the mold used in the casting of individual ribbon segments.

#### 4. *Evolving Trefoil*

In “Evolving Trefoil” a truncation of Scherk’s second minimal surface [1,2] is warped into the closure of a trefoil configuration, while simultaneously being helically twisted. This center portion of a “3-way” Scherk surface has a sextet of edges, and the sculpture’s helical twisting can be experienced through the visual gymnastic of tracking a sufficiently long segment of any one of these edges. An actual linear abstraction of any of them in its entirety would be a trefoil with a helical rotation of 360 degrees around its longitudinal axis. Bringing this abstraction into the foreground when simply viewing the sculpture, however, defies the scope of visual perception – not that viewers aren’t welcome to try.

The Scherk surfaces are all serial articulations of modules whose balanced opposition of curvatures yields the zero mean curvature of minimal surfaces. By retaining this morphology, *Evolving Trefoil* is a locally minimal surface in relation to its edge constraints. It also retains the canonical symmetries of the trefoil. Its identical faces have front-to-back symmetry, while in being a divisible-by-three truncation of 24 modules from Scherk’s surface with a uniformly phased helical twist of 360 degrees, it also retains perfect rotational symmetry: A rotation of 120 degrees around the axial mid-point of its identical faces will fit them back within themselves. We might through an exercise of imagination also view it as having

slide symmetry in which all of its serially articulated modules can flow fluidly into their contiguous neighbors on either side if we grant them the malleability needed to always conform with the constantly varying curvature of closure into a trefoil, as well as the 15 degrees of rotation per stage necessary to account for the helical twist of 360 degrees.



**Figure 2:** “Evolving Trefoil.” A 7-inch plastic maquette of the final sculpture design, created on a fused deposition modeling (FDM) machine. The geometry description for this model [3], produced by Carlo H. Séquin at U.C. Berkeley is also used in a numerically controlled milling machine to fabricate the master geometry module for making a mold to cast this 12-foot diameter sculpture from six identical pieces.

*Evolving Trefoil* can (and will) be assembled piecemeal from replicas of a modular  $1/6$  section, consisting of four modules from Scherk’s surface, which corresponds to one half of one of the three trefoil lobes. The symmetries of its design aesthetic are integral to resolving the sculpture into the modular simplification choreographed in the precise puzzle of fusing its sextet of identical sections into the complete sculpture. More details about the design and realization of these two sculptures are found in [3].

## References

- [1] B. Collins, *Evolving an Aesthetic of Surface Economy in Sculpture*, Leonardo, Vol. 30, No. 2, 1997, pp. 85-88.
- [2] C. H. Séquin, *Virtual Prototyping of Scherk-Collins Saddle Rings*, Leonardo, Vol. 30, No. 2, 1997, pp. 89-96.
- [3] B. Collins, D. Lynn, S. Reinmuth, and C. H. Séquin, *Realization of Two New Large-Scale Sculptures*. Proc. Shape Modeling, International Conf., FASE track, Texas A&M, May 25, 2012.