BRIDGES

Mathematical Connections in Art, Music, and Science

Conference Proceedings
2002

Reza Sarhangi, Editor

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Preface

The fifth gathering of *Bridges: Mathematical Connections in Art, Music, and Science* is being held this year at Towson University, in the metropolitan area of Baltimore, Maryland. The conference is far from its birthplace, the small, beautiful town of Winfield in Kansas. It appears that our child has grown rapidly and now is traveling around in search of even more friends, and newer horizons.

Among other artists, Baltimore claims Edgar Allan Poe as her own. Early on Poe wrote of himself as a child who lisped his earliest word. In *Preface* he writes,

> While in the wild wood I did lie
> A child--with a most knowing eye.

And in *Dreams*, he again offers the image of childhood and the movement to other realms.

> ". . .as dreams have been to me
> In my young boyhood--should it thus be given,
> 'Twere folly still to hope for higher Heaven.
> For I have reveled, when the sun was bright
> I' the summer sky, in dreams of living light
> And loveliness,--have left my very heart
> In climes of my imagining, apart
> From mine own home, with beings that have been
> Of mine own thought--what more could I have seen?"

The conference is surely filled with beings which are of "my own thought" and to gather even more of these beings is a major goal of a conference which is indeed leaving its childhood in the wild and pleasant plains of Kansas and entering its adolescence in the rough and tumble of the Baltimore-Washington, D.C. metroplex. Although not a Baltimore resident, Walt Whitman was a frequent visitor in the D.C. area during the Civil War. In *A Noiseless Patient Spider*, Whitman writes of our need for bridges:

> "And you, O my soul where you stand,
> Surrounded, detached, in measureless oceans of space,
> Ceaselessly musing, venturing, throwing, seeking the spheres to connect them,
> Till the bridge you will need be formed, till the ductile anchor hold,
> Till the gossamer thread you fling catch somewhere o my soul."

We too shall continue to seek the connecting spheres and form the bridges that will join us and, in that joining--anchor us.

The Bridges Conference and its proceedings have become symbols for our effort at Towson University to bridge several colleges: colleges of Science and Mathematics, Liberal Arts, and Fine Arts and Communication have supported the conference financially and spiritually. We are grateful to Dean Gerald Intemann, Interim Dean Beverly Leetch, and Dean Maravene Loeschke for their support and continuing encouragement.

The Conference has also received great support from faculty members of these colleges and also from other parts of Towson University. I cannot thank enough the Design and Graphics Chair, Tiziana Giorgi of the Mathematics Department, the Chair of Logistics and Space Management, Diane Luchese of the Music Department, and the Registration and Invitation Chair, Robert Smits of the Mathematics Department for their tireless efforts on behalf of the conference. I also would like to thank the Visual Art Exhibit Co-Curators, Christopher Bartlett and James Paulsen of the Art Department who are coordinators of the Bridges exhibition, and Peter Wray of the Theater Department and his crew who will perform for the Bridges participants. I am grateful to Vladimir Bulatov of the Department of Physics, Oregon State University, who is directing the first Bridges Poster Session, and Carol Bier, Research Associate of the Textile Museum, who is organizing the Bridges Tour. There are more hands involved, directly and indirectly, at Towson and elsewhere, in the preparation of the conference and its proceedings. Many colleagues, here and around the world, refereed papers and improved the quality of the proceedings extensively. Thanks to all of them.

The front cover, *Gazmogenesis*, 1997, by George W. Hart, copper, 12″ diameter is a construction of 30 identical pieces, each cut into the shape of an elongated ellipse and hand formed into a curve with 2-fold symmetry. The assemblage is soft soldered. George's intention was to create a simple form, both organic and geometric, reminiscent of a radiolarian with a spiked spherical body containing internal structure. Each copper ellipse spans one edge of a dodecahedron, along a detoured route which passes through the interior.

The back cover, *The Moirai*, by Janet Parke, is based on an advanced process of using fractal elements to create a composite work of art. The reader is invited to examine her paper on this subject titled *Layering Fractal Elements to Create Works of Art* in this collection.

This publication could not have been completed without the help of Shifra Elan at Towson University and the Office of Communications and Public Relations at Southwestern College in Kansas. Thanks also should go to Simon Luhur and Robert Craig for updating the Bridges website and compiling the Bridges index at this site.

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Sculptural Interpretation of a Mathematical Form

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Abstract

A number of sculptures have been created based on three-dimensional mathematical forms and surfaces. In most cases, the sculpture is an exact copy of the mathematics that it is based on. This paper explores another method to mathematically create sculptural forms by starting with a two-dimensional figure. The goal is to develop methods and insights on which elements in the original figure can be expressed in three-dimensions and still keep some of the mathematical properties found in the original figure. The creation of each sculptural variation is completed in custom software. The software becomes the modeling material and the sculpting tools.

1. Introduction

There already exists a rich history of using three-dimensional mathematically based forms to create sculpture, both in methods to develop them and actual works of art. Carlo Séquin [1,2] discusses a series of computer based approaches to develop three-dimensional forms that include modeling and procedural generation. Séquin also covers a series of computer assisted methods to actually construct such sculpture and to visualize it. As for actual sculpture, for example, the works of Helaman Ferguson, Charles O. Perry, Robert Longhurst, Brent Collins, Robert Rathburn, and John Robinson; are all described in detail by Ivars Peterson [3]. Most of these works are the result of advanced computer software tools and some by related automated manufacturing techniques. Most use a mathematical basis for generating the form in total, or at least some portion of it. In all cases some related three-dimensional mathematical form is used. In this exploration, a two-dimensional figure is the starting point for interpretation into three-dimensions. The overall concept is to investigate how a basic mathematical form can be expressed in a three-dimensional fashion still keeping many of its original mathematical properties. The two-dimensional figure used here will be a spirolateral.

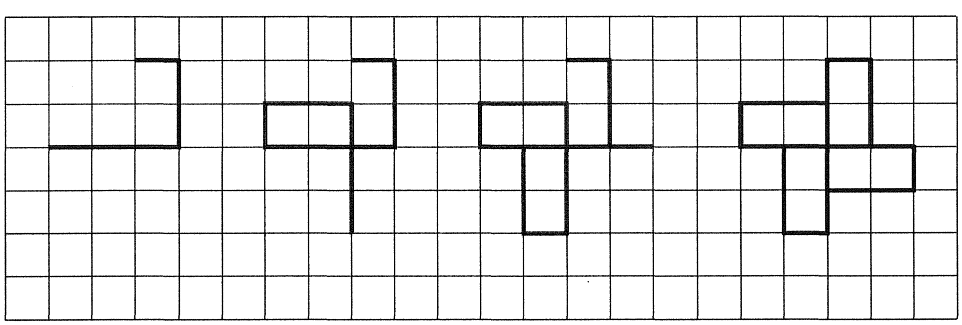

Figure 1: *Generation of a* 3_{90} *spirolateral*

A spirolateral is created by drawing a set of lines; the first at a unit length, then each additional line is increased by one unit length while turning a constant direction. To complete a closed spirolateral, it is necessary to only repeat this procedure until the starting point is reached. The first apparent reference to this geometric figure was by Odds [4]. Further information was found at Abelson [5] and Gardner [6]. In addition to the property of closure, spirolaterals need not always turn the same direction. The direction can be reversed at any turn, which makes the total number of possible spirolateral unknown. Figure 1 displays the systematic generation of an order 3 spirolateral; one that consists of 3 segments at turns of 90 degrees.

Previous research and development by Krawczyk [7,8,9] included identifying a large number of closed spirolaterals using a variety of turning angles, turns, and repeats, including turn reversal. The first set of these were represented by a simple line drawing. To further develop these mathematical figures in an artistic fashion, a line thickness was added and an optional overlay of center and edge lines. This representation was used to create over 300 spirolaterals in galleries found at www.netcom.com/~bitart. Figure 2 displays a few of these, including some with turn reversals. The line thickness gave each spirolateral an additional variety that did not appear in the simple line version. When the overlapping center and edge lines are included, in addition to segmenting the thick lines visually, they also develop their own unique pattern over the underlying image.

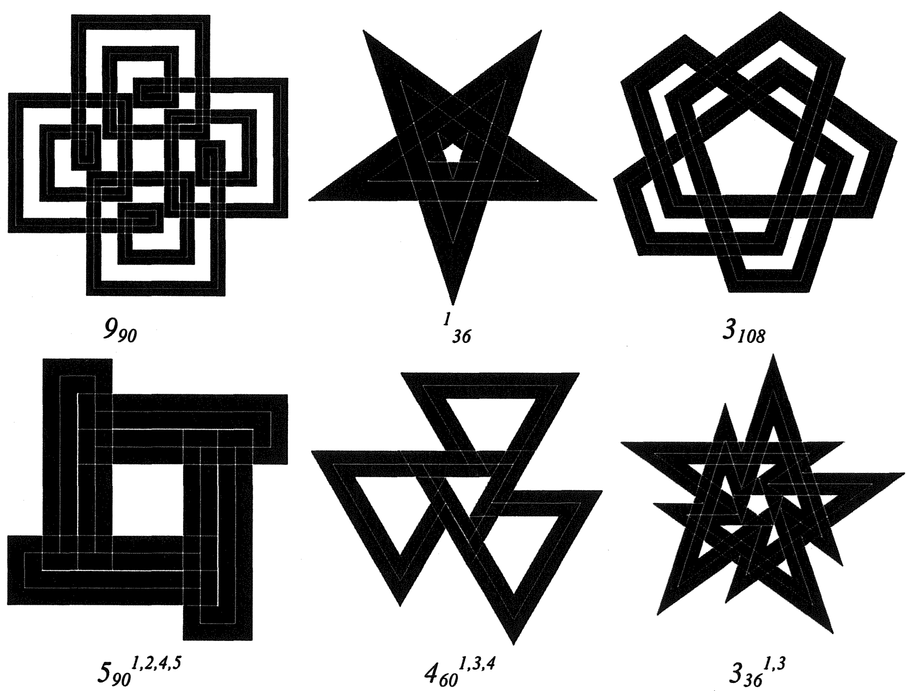

Figure 2: *Closed spirolaterals including reversals*

All the previous investigations have created spirolaterals in two-dimensions. For this particular series, three-dimensional constructions were investigated. Figure 3 displays the spirolateral that was selected for this series. Figure 3a. and 3b. are the original spirolateral, and 3c. is the variation selected. In this version the line thickness is decreased so to better articulate the turns as separate sculptural elements.