

BRIDGES

**Mathematical Connections
in Art, Music, and Science**

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2002**

Reza Sarhangi, Editor

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Contents

Preface	ix
Sculptural Interpretation of a Mathematical Form <i>Robert J. Krawczyk</i>	1
Color Dependent Computational Aesthetics for Evolving Expressions <i>Gary R. Greenfield</i>	9
Set Operations in the Music of Nikolai Roslavets <i>Terry B. Ewell</i>	17
A Transformation Sketchbook <i>John Sharp</i>	25
3D Visualization Models of the Regular Polytopes in Four and Higher Dimensions <i>Carlo H. Séquin</i>	37
The Pi Symphony: Numeric Sequences in Music <i>Lars Erickson</i>	49
Computer Sculpture: A Journey through Mathematics <i>Javier Barrallo and Radmila Sazdanovic</i>	54
The Endless Wave <i>Bob Brill</i>	55
Geometric Patterns and the Interpretation of Meaning: Two Monuments in Iran <i>Carol Bier</i>	67
Two Poems <i>Gar Bethel</i>	79
Time-Space of Music <i>Marina Korsakova-Kreyn</i>	82
Exploring Fractal Geometry in Music <i>Brian Hansen and Cheri Shakiban</i>	83
Electrostatic Kaleidoscope <i>Haiduke Sarafian</i>	91

Layering Fractal Elements to Create Works of Art <i>Janet Parke</i>	99
Spatial Constructs <i>William C. Bodenhamer</i>	109
An Introduction to Polynomiography <i>Bahman Kalantari</i>	116
Gridfield Geometry <i>Douglas D. Peden</i>	117
Hearing With Our Eyes: The Geometry of Tonal Space <i>Julian L. Hook</i>	123
Art in Perspective: A Making Connections Cluster at Clarion University <i>Stephen I. Gendler and James R. Rose</i>	135
A Collaborative Parabolic Quilt <i>Mary C. Williams and John Sharp</i>	143
A Course: Mathematics and the Visual Arts <i>Ralph Czerwinski</i>	150
Vasarely Design and Other Non-Cubical Designs <i>Hana M. Bizek</i>	151
A Mathematical Analysis of African, Brazilian, and Cuban <i>Clave</i> Rhythms <i>Godfried Toussaint</i>	157
The Knight's Tour Problem as a Conceptual Tool for Interdisciplinary Studies <i>Ronald R. Brown</i>	169
Fractions in Art and Mathematics <i>Jane K. Bates</i>	181
Transforming Some Infinite Polyhedra <i>Paul Gailiunas</i>	189
Poseidon from Cape Artemision <i>Franz Gnaedinger</i>	196
168 Butterflies on a Polyhedron of Genus 3 <i>Douglas Dunham</i>	197
Preliminary Field Explorations in K-6 Math-Ed: The Giant Triangles as Classroom Manipulatives <i>Eva Knoll and Simon Morgan</i>	205

Exploring the Effect of Direction on Vector-Based Fractals <i>Magdy Ibrahim and Robert J. Krawczyk</i>	213
Choosing Diagrams for the Book of Beautiful Mathematical Diagrams <i>Samuel S. Kutler</i>	220
Anne Bulckens' Analysis of the Proportions of the Parthenon and its Meanings <i>Jay Kappraff</i>	221
A Musical Suite Based on the Platonic Solids <i>W. Douglas Maurer</i>	227
Exploring Algebra with Creative Designs <i>Iftikhar Husain</i>	234
The Rootsellers – Retelling the Galois Group of a Quartic Polynomial <i>Benjamin Wells</i>	235
Mathematics for Those Who Hate Mathematics <i>Julianne M. Labbiento</i>	247
Sentences on the Aesthetics of Mathematics and Art <i>Kaz Maslanka</i>	256
From a Subdivided Tetrahedron to the Dodecahedron: Exploring Regular Colorings <i>Eva Knoll</i>	257
Connecting Mathematics and the Arts in the Elementary Classroom through Movement <i>Virginia Usnick and Marilyn Sue Ford</i>	262
How a Math Class Can Be Two Places at Once: A Proposed Mathematical/Philosophical Collaboration <i>Eric S. Egge and Steven Gimbel</i>	263
A Museum Dedicated to the Concept of Harmony and the Golden Section <i>Alexey Stakhov and Anna Sluchenkova</i>	269
Techniques for Artistically Rendering Space-Filling Curves <i>L. Kerry Mitchell</i>	277
Pure-Tone Approximation to Equal-Temperament: How Close is Close? <i>Jack Douthett and Richard Krantz</i>	284
A Mathematical Look at the 7 Liberal Arts as Humanities <i>Stephen Eberhart</i>	285
Tonal Optimization in Music Playing <i>Jiashi Hou</i>	293
Beautiful Mind – Elegant Bridge <i>Daniel F. Daniel</i>	301

Graphical Fractals Based on Circles <i>Robert W. Fathauer</i>	305
Theory and Applications of Islamic Star Patterns <i>Craig S. Kaplan</i>	306
Art and Physics: Parallel Visions in Space, Time and Light <i>Leonard Shlain</i>	307
How to Make the Juno's Spinner <i>Junichi Yananose</i>	308
Towards a Geometrical Way of Thinking <i>Clifford Singer</i>	309
Heterarchy of Space <i>Lebbeus Woods</i>	311
Kindred Spirits: Hafez in His Poetry, Mathematicians in Their Theories <i>Saeed Ghahramani</i>	312
Theory of Design <i>Michael Leyton</i>	313
On the Shapes of Water Fountains and Times Tables <i>Stephen Eberhart</i>	314
Experimental Morphology: The Generative Dynamics of Form and Structure <i>Manuel A. Báez</i>	315
Real Kecak System <i>Akio Hizume</i>	319
About Enumeration of Isogonal Polyhedral Families <i>Vladimir Bulatov</i>	320

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.

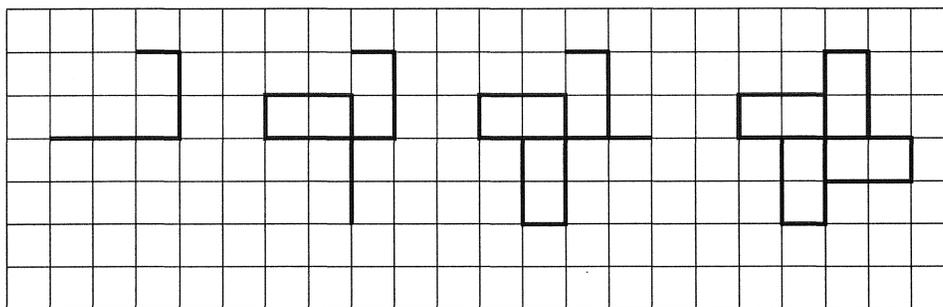


Figure 1: Generation of a 3_{90} spirolateral

A spiroilateral 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 spiroilateral, 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 spiroilateral unknown. Figure 1 displays the systematic generation of an order 3 spiroilateral; 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 spiroilateral 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.

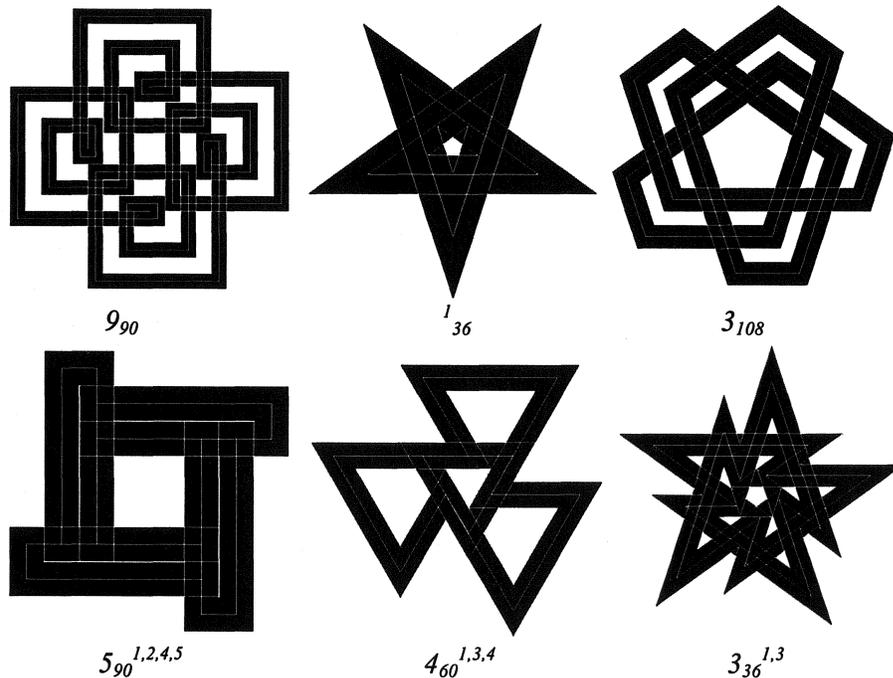


Figure 2: Closed spirolaterals including reversals

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