

Mathematics and Visualization

Series Editors

Gerald Farin

Hans-Christian Hege

David Hoffman

Christopher R. Johnson

Konrad Polthier

Claude P. Bruter

Editor

Mathematics and Art

Mathematical Visualization
in Art and Education

With 284 Figures, 127 in Color



Springer

Editor

Claude P. Bruter

Université Paris XII

Mathématiques

UER Sciences

61 Avenue du General de Gaulle

94010 Creteil Cedex

e-mail: bruter@univ-paris12.fr

Cataloging-in-Publication Data applied for

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

Mathematics and art : mathematical visualization in art and education / Claude P. Bruter ed.. -

(Mathematics and visualization)

The cover figure reproduces a classical Kleinian tessellation of the hyperbolic plane by triangles (Klein, 1878-1879). In the present case, the angles of each triangle are $(\pi/2, \pi/3, \pi/7)$. All the triangles have the same area, $\pi/42$: they are the smallest triangles with which the hyperbolic plane can be tiled.

Mathematics Subject Classification (2000): 97D20, 97C50, 97D30, 97U99, 00B10

ISBN 978-3-642-07782-1

ISBN 978-3-662-04909-9 (eBook)

DOI 10.1007/978-3-662-04909-9

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag Berlin Heidelberg GmbH.

Violations are liable for prosecution under the German Copyright Law.

<http://www.springer.de>

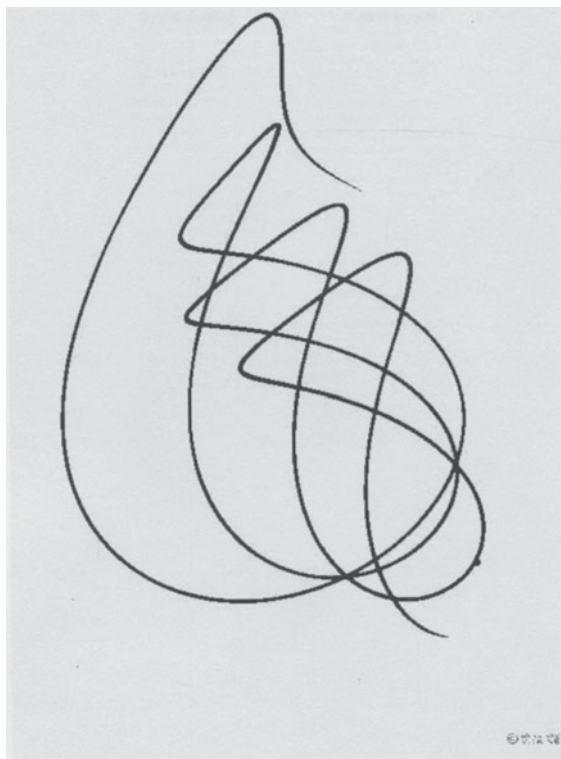
© Springer-Verlag Berlin Heidelberg 2002

Originally published by Springer-Verlag Berlin Heidelberg New York in 2002

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Cover design: *design & production* GmbH, Heidelberg

46/311LK - 5 4 3 2 - Printed on acid-free paper



Born in 1910, Alexandre VITKINE, vitkine@wanadoo.fr, became a photographer and a graphic artist after a career in the industry. He is now a sculptor.

His drawings, photos (obtained through electronic equipments made by himself), and his sculptures produced by computer-controlled machines (info-sculptures), are based on mathematical forms, mainly those of Lissajous curves.

The drawing above was chosen as the basis for the poster announcing the Colloquium.

Preface

*I am convinced that the work of the artists
is to create order from chaos*
Fred Uhlman¹

A Colloquium on *Mathematics and Art* was held in the French city of Maubeuge in September 2000. The scientific committee included Jacek Bochnak (Amsterdam), Ronald Brown (Bangor), Claude-Paul Bruter (Paris 12), Manuel Chaves (Porto), Michele Emmer (Roma), Tzee-Char Kuo (Sydney), Richard Palais (Brandeis) and Valentin Poenaru (Paris 11). We would like to warmly thank Francis Trincaretto and his team who arranged to have the meeting in such an agreeable venue: the “Théâtre du Manège”.

Placed at the transition of the second and the third millennium, this Colloquium presented original ideas related to the development of new forms of civilization based on the many recent and rapid technological advances in communication and computation. With the strong encouragement of the local organizer, Francis Trincaretto, the Colloquium was – unlike more formal mathematical conferences – videoed and could be attended on the web. The speakers were true artists and mathematicians of rather unusual standard: while the artists were partly inspired by advanced mathematics, or even were sometimes ahead of mathematics, the mathematicians intended to show the beauty of their work and to share their feeling with the greater part of the population. They used all the old and new means of static and dynamic visualizations. Their works may be understood as symbolic and iconic representations of our environment and as essential tools for the understanding of our world, and the development of mankind.

Indeed, this Colloquium can be related to a renewal in the ways of diffusion and of teaching of mathematics. While schools of plastic or musical art are beginning to ask for some mathematics, mathematicians are seriously thinking of setting forth the artistic qualities of their work to attract the mind, and to support and facilitate the learning of their discipline.

We hope that readers may find in these proceedings ideas, projects and realizations which can contribute towards the inspiration and promotion of new cultural developments in Society.

The order of the articles follows that of the talks. Pictures and images appear in grey in the articles. Images appear also in colour in the Appendix. Such an image is labelled [XY]k where XY are the main initials of the author, while k numbers the image.

¹ (1901–1985) German advocate, then British painter and writer: his booklet *Reunion* is a true masterpiece.

To conclude, we would like to thank Mike Field who accepted to help the translations into English of most French written texts, Bill Mac Callum who did that work for the second part of my first contribution, and the Springer team who accepted to publish these Proceedings, and provided their help to the editor.

Claude-Paul Bruter

Table of Contents

Presentation of the Colloquium. The ARPAM Project	1
<i>Claude-Paul Bruter</i>	
Solid-Segment Sculptures	17
<i>George W. Hart</i>	
Visualizing Mathematics – Online	29
<i>Konrad Polthier</i>	
The Design of 2-Colour Wallpaper Patterns Using Methods Based on Chaotic Dynamics and Symmetry	43
<i>Michael Field</i>	
Machines for Building Symmetry	61
<i>Maria Dedò</i>	
The Mathematics of Tuning Musical Instruments – a Simple Toolkit for Experiments	79
<i>Erich Neuwirth</i>	
The Garden of Eden	89
<i>Charles O. Perry</i>	
Visualization and Dynamical Systems	91
<i>John Hubbard</i>	
Solving Polynomials by Iteration	95
<i>Scott Crass</i>	
Mathematical Aspects in the Second Viennese School of Music	105
<i>Carlota Simões</i>	
Mathematics and Art: The Film Series	119
<i>Michele Emmer</i>	
Guided Tours of Buried Galleries (Inside a Computer)	135
<i>Jean-François Colonna</i>	
A Mathematical Interpretation of Expressive Intonation	141
<i>Yves Hellegouarch</i>	
Symbolic Sculptures	149
<i>John Robinson</i>	

FORUM: How Art Can Help the Teaching of Mathematics?	153
<i>Claude-Paul Bruter</i>	
Forum Discussion	155
<i>Ronnie Brown</i>	
Forum Discussion: Presentation of the <i>Atractor</i>	160
<i>Manuel Arala Chaves</i>	
Forum Discussion	166
<i>Michele Emmer</i>	
Forum Discussion	168
<i>Michael Field</i>	
Getting Out of the Box and Into the Sphere	173
<i>Dick Termes</i>	
Constructing Wire Models	179
<i>François Apéry</i>	
Sphere Eversions: from Smale through “The Optiverse”	201
<i>John M. Sullivan</i>	
Tactile Mathematics	213
<i>Stewart Dickson</i>	
Hyperseeing, Knots, and Minimal Surfaces	223
<i>Nathaniel A. Friedman</i>	
Ruled Sculptures	233
<i>Philippe Charbonneau</i>	
A Gallery of Algebraic Surfaces	237
<i>Bruce Hunt</i>	
The Mathematical Exploratorium	267
<i>Richard S. Palais</i>	
Copper Engravings	273
<i>Patrice Jeener</i>	
Appendix: Color Plates	275
Index	335