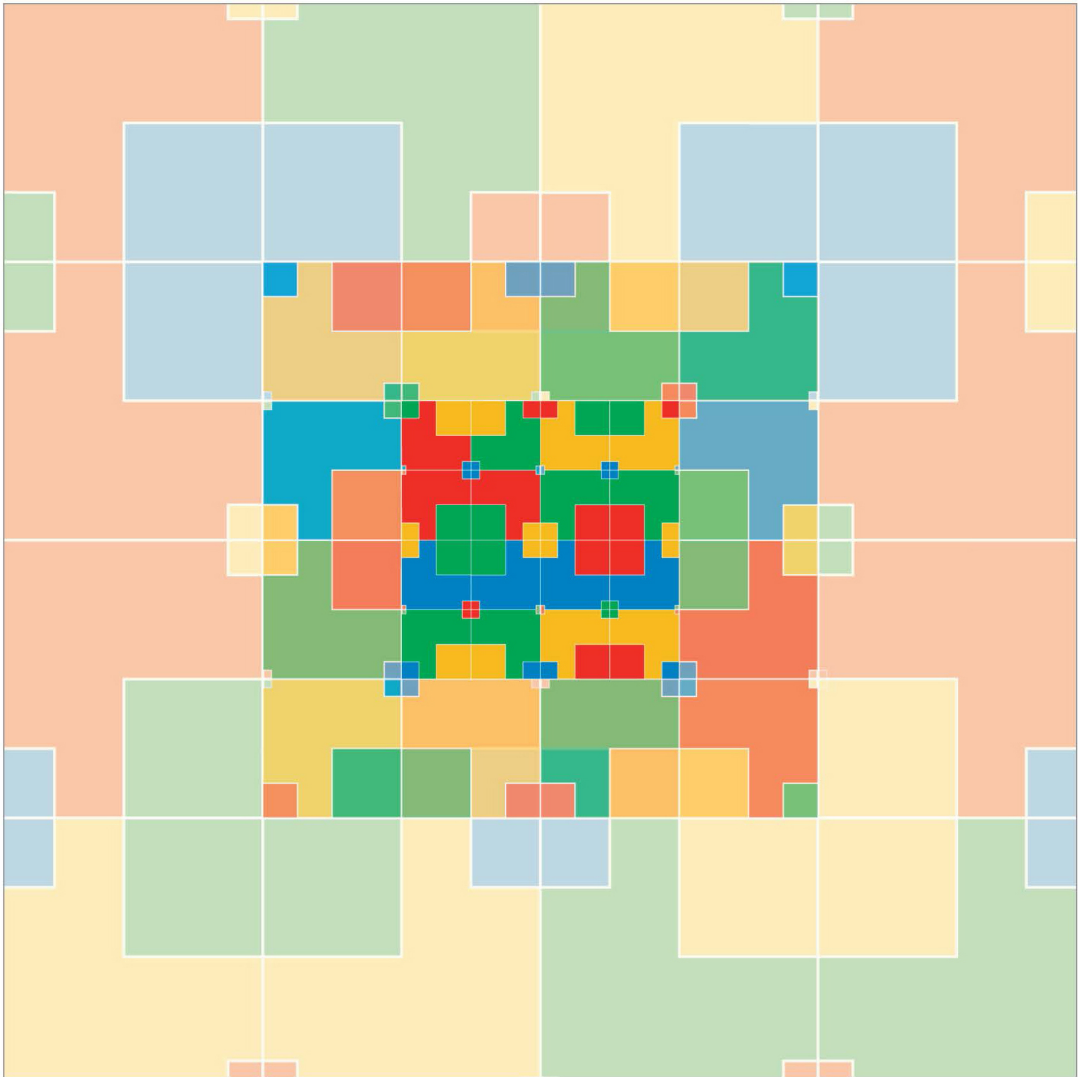


Symmetry: Culture and Science

GEOMETRY AND ARCHITECTURE

The journal of the
Symmetrion

Editor: György Darvas
Volume 31, Number 3, 2020



Officers and Boards

Honorary Members of the ISA

Reiko Kuroda (Tokyo, Japan)
Haresh Lalvani (New York, U.S.A.)
Koji Miyazaki (Kyoto, Japan)
Joe Rosen (Rockville, MD, U.S.A.)
Dan Shechtman (*Nobel Prize*, Haifa, Israel)
Gerard 't Hooft (*Nobel Prize*, Utrecht, The Netherlands)
Steven Weinberg (*Nobel Prize*, Austin, TX, U.S.A.)

Chairman of the *Advisory Board*

Sergey V. Petoukhov Institute of Mechanical Engineering, Russian Academy of Sciences, Malyy Hariton'evskii per. 4, 101830 Moscow, Russia <spetoukhov@gmail.com>

Chairman of the *Editorial Board*

Laurence I. Gould Physics Department, University of Hartford, 200 Bloomfield Avenue, West Hartford, CT 06117, U.S.A. <lgoald@hartford.edu>

Chief Executive Officer (CEO)

David Banney School of Mathematics and Physical Sciences, University of Newcastle, NSW, Australia, 2305. <David.Banney@newcastle.edu.au>

Honorary CEO

György Darvas Symmetrion, 29 Eötvös St, Budapest, H-1067 Hungary <darvasg@iif.hu>

Editorial Board

Bonch-Osmolovskaya, Tatiana Sydney, Australia <tbonch@gmail.com>
Fenyvesi, Kristóf University of Jyväskylä, Finland <fenyvesi.kristof@gmail.com>
Gould, Laurence I. Physics Department, University of Hartford, West Hartford, CT 06117, U.S.A. <lgoald@hartford.edu>
Petitjean, Michel Université de Paris, BFA, CNRS UMR 8251, INSERM ERL U1133, 75013, France <petitjean.chiral@gmail.com>
Sugimoto, Takeshi Department of Information-Systems Creation, Kanagawa University 3-27-1 Rokkakubashi, Kanagawa Ward, Yokohama 221-8686, Japan <sugimt01@kanagawa-u.ac.jp>

Board of Electors

Bérczi, Sz. physicist, Department of Material Physics, R. Eötvös University, Budapest
Dárdai, Zs. art historian, Mobile MADI Museum, Budapest
Darvas, Gy. (head of the *BE*) physicist-philosopher, Symmetrion, Budapest
Farkas, T. F. graphic artist, St. István University, Budapest
Gévy, G. geometer, Bolyai Institute, University of Szeged, Szeged
Kabai, S. engineer, UNICONSTANT, Püspökladány

Advisory Board of the journal S:CS

Chairman:

Petoukhov, Sergey V. (biophysics, bioinformatics) Institute of Mechanical Engineering, Russian Academy of Sciences, Moscow, Russia

Aerts, Diederik (physics, interdisciplinary studies) Center Leo Apostel, Brussels, Belgium

Avnir, David (chemistry) Hebrew University, Jerusalem, Israel

Beke, László (art history) Hungarian Academy of Sciences and Hungarian University of Fine Arts, Budapest, Hungary

Borovkov, Victor (chemistry) Tallinn University of Technology, Estonia and South-Central University for Nationalities (China)

Caglioti, Giuseppe (physics, arts) Institute of Nuclear Engineering Enrico Fermi - CESNEF, Politecnico di Milan, Italy

Crowe, Donald (mathematics) Department of Mathematics, University of Wisconsin, Madison, WI, U.S.A.

D'Ambrosio, Ubiratan (ethnomathematics) Campinas, Sao Paulo, Brasil

Dunham, Douglas (mathematics, arts) Department of Computer Science, University of Minnesota, Duluth, MI, U.S.A.

Elitzur, Avshalom (physics, biology, philosophy) Iyar, The Israeli Institute for Advanced Research, POB 651, Zichron Ya'akov 3095303, Israel

He, Matthew (mathematics, genetics) China, and Mathematics and Computer Science, Nova Southeastern University, Ft. Lauderdale, FL, U.S.A.

Hofkirchner, Wolfgang (information science, philosophy) Vienna University of Technology, and Emergent Systems, Information and Society Research Group, The Institute for a Global Sustainable Information Society, Vienna, Austria

Kappraff, Jay (mathematics) Department of Mathematics, New Jersey Institute of Technology, Newark, NJ, U.S.A.

Kostov, Ruslan I. (mineralogy, crystallography) Faculty of Geology and Prospecting, University of Mining and Geology "St. Ivan Rilski", Sofia, Bulgaria

Mainzer, Klaus (philosophy) Department of Philosophy and Theory of Science, Technical University of Munich, Germany

Marijuán, Pedro C. (information science, bioinformation) Aragon Health Sciences Institute, IACS - Bioinformation Group, Zaragoza, Spain

Molnár, Emil (geometry) Department of Geometry, Technical University of Budapest, Hungary

Négadi, Tidjani (mathematical physics, mathematical biology) Physics Department, University of Oran, Algeria

Olovsson, Ivar (chemistry) Institute of Chemistry, University of Uppsala, Sweden

Pardavi-Horvath, Martha (physics) Hungary, and Department of Electrical Engineering and Computer Science, The George Washington University, Washington, DC, U.S.A.

Pimenta, Emanuel Dimas de Melo (architecture, music, arts) ASA Art and Technology, Lisbon, Portugal

Pollack, Gerald H. (chemistry, water science) The Pollack Laboratory, University of Washington, Seattle, WA, U.S.A.

Ruffini, Remo (astrophysics) ICRA Net, Pescara, Italy

Schulte, Egon (mathematics) Department of Mathematics, Northeastern University, Boston, MA, U.S.A.

Sequin, Carlo (geometry, arts) CS Division, EECS Department, University of California at Berkeley, CA, U.S.A.

Tennant, Raymond (mathematics) State University of NY at Albany and Educational Consultant for Colleges and Universities, Roanoke, Virginia, U.S.A.

Verostko, Roman (arts) ISEA, Minneapolis, MI USA

Vitiello, Giuseppe (physics) Department of Physics "E.R. Caianiello", University of Salerno, Italia

Wegner, Bernd (mathematics) Department of Mathematics, Technical University, Berlin, Germany

Wysmuller, Thomas (climate studies) Greater Boston Area, MA, U.S.A.

Zee, Anthony (physics) Institute for Theoretical Physics, University of California at Santa Barbara, CA, U.S.A.

Zenkin, Konstantin (music) Tchaikovsky Moscow State Conservatory, Moscow, Russia

Symmetry: Culture and Science
Vol. 31, No. 3, 225-400, 2020
https://doi.org/10.26830/symmetry_2020_3

GEOMETRY AND ARCHITECTURE

Guest editor:
Vilmos Katona

A thematic issue

SYMMETRY: CULTURE AND SCIENCE is the journal of and is published by the Symmetrion, <http://symmetry.hu/>. Edition is backed by the Executive Board and the Advisory Board (<http://journal-scs.symmetry.hu/editorial-boards/>) of the International Symmetry Association. The views expressed are those of individual authors, and not necessarily shared by the boards and the editor.

Editor:

György Darvas

Any correspondence should be addressed to:

Symmetrion

Mailing address: Symmetrion c/o G. Darvas, 29 Eötvös St., Budapest, H-1067 Hungary

Phone: +36-1-302-6965

E-mail: symmetry@symmetry.hu

<http://journal-scs.symmetry.hu>

CrossRef service is sponsored by the *University Library and Archives of Eötvös Loránd University*, Budapest.

Annual subscription:

Normal € 120.00,

Individual members of ISA € 90.00,

Student Members of ISA € 60.00,

Institutional Members please contact the Symmetrion.

Online subscription: <http://journal-scs.symmetry.hu/subscription/>.

Account: *Symmetrology Foundation*, IBAN: HU24 1040 5004 5048 5557 4953 1021,
SWIFT: OKHBHUHB, K&H Bank, 20 Arany J. St., Budapest, H-1051.

© Symmetrion. No part of this publication may be reproduced without written permission from the publisher.

ISSN 0865-4824 – print version

ISSN 2226-1877 – electronic version

Cover layout: Günter Schmitz;

Images on the front and back covers: János Szász SAXON: Poly-Universe Tessellations;

Ambigram on the back cover: Douglas R. Hofstadter.

Symmetry:

Culture and Science

Founding editors: G. Darvas and D. Nagy

The journal of the Symmetrion

Editor:
György Darvas

Volume 31, Number 3, 225-400, 2020

Geometry and Architecture: Parametricism, Morphology, Design Methodology

CONTENTS

<i>EDITORIAL</i>	229
<i>SYMMETRY: SCIENCE AND ART</i>	
■ Symmetry gives meaning to architecture , <i>Nikos A. Salingaros</i>	231
■ From spatial form to social sense: Symmetry in urban morphology , <i>Deborah C. Lefosse</i>	261
■ Generative interpretations of late Gothic architectural forms , <i>Zoltán Bereczki</i>	279
■ The use of regular <i>takht</i> in the geometrical system of the <i>muqarnas</i>: A case study on mosques and shrines of Kashan , <i>Ahmad Danaeinia, Bahador Erfan</i>	297
■ Empire, science and geometry at the origins of early modern architecture , <i>Joseph Cabeza-Lañez, Ying Ying Xu</i>	321

- **Ideology as geometry: A note on parametricism and its theoretical foundations,** *Almantas Samalavičius* 353
- **A methodological overview of parametricism: Lessons from a case study,** *Levente Gyulai, Vilmos Katona* 365
- **From design patterns to design machines: Will the robots take over architecture?** *Harun Ekinoğlu* 383

EDITORIAL

**GEOMETRY AND ARCHITECTURE:
PARAMETRICISM, MORPHOLOGY, DESIGN
METHODOLOGY**

Architecture has its roots in geometry, which is drawn etymologically from “earth measuring”. Geometry was originally used for drawing ground plans in order to create bases for buildings. The Pythagorean theorem furnished us with a practical way to employ the right angle, the quintessence of architecture. However, despite its benefits during planning and construction, geometry, as an independent discipline, has its own rules and possibilities that facilitate morphologies free from the ties of gravity and matter. Starting from Platonic and Archimedean solids, architecture has been applying many of the free forms of a “celestial” geometry in order to reconnect them to the physical level.

This mission became more difficult from the 1980s, when, after the controversial trend of post-modernism, contemporary architecture recognised deconstruction as its ultimate prospect. Deconstruction, folding and topography called for new methodologies no longer viable without virtual design platforms. The virtual space of computer design was first colonised by the tectonic culture, but parametricism evolved to such a level that its new methodology was capable of questioning the traditional logic of building. The virtual space of generative design has grown so autonomous that it developed new languages, applied formerly unfamiliar or unknown symmetries, and, by its computing apparatus, redefined geometry and changed construction practices.

With such a potential, architecture has reached the threshold of becoming fully algorithmic. The exploration of this area is the core purpose of our issue. We invited architects, designers, artists, software developers, architectural historians, theorists, and urbanists who researched digital morphogenesis, new design methodologies, or re-interpreted historical buildings with generative or algorithmic approaches. Authors with new and unpublished research on the application of non-standard symmetries in design were especially encouraged to share their new findings with the interdisciplinary community of the Symmetrion.

Vilmos Katona