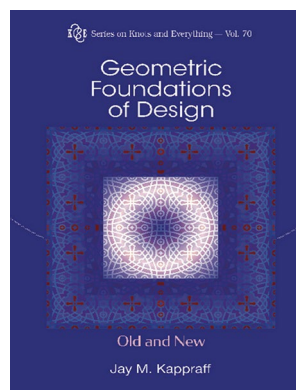# Geometric Foundations of Design: Old and New
by Jay Kappraff

Reviewed by Đorđe Baralić

World Scientific, 2021,
368 pp., £105.00

"Ma(r)thematics is everywhere," teaches Jay Kappraff's latest book, his fourth in the series on mathematics and design. Written in a vein reminiscent of Martin Gardner, this wonderful book takes the reader on a journey through the ancient and modern worlds, revealing the significance of mathematics for culture and humanity at large. It is widely known that mathematics lies at the core of technological progress, computer science, and architecture, but are we aware that artistic crafts may also reveal the secrets of rich mathematical knowledge that people possessed in the past? Mathematics and arts have always been closely intertwined as two inseparable human endeavors, and this book serves as a guide to explore their interface.

Ivo Andrić (1892–1975), a Serbian Nobel laureate (literature, 1961), once said, "The value of beauty lies in the infinite variety of forms in which it appears. There lies its uplifting power and its greatest appeal."[1] Every mathematician surely agrees on the unquestionable pulchritude of mathematics, but Jay Kappraff provides opportunities for nonmathematicians to enjoy it as well. Since one does not need to be an artist to enjoy art, the author shows that the same is true for mathematics. "Every good mathematical book should be readable with pen and paper," it is often said, but the reader of Kappraff's book will also need crayons, scissors, ribbons, and more. The author has succeeded in creating a STEAM-spirited interdisciplinary textbook on mathematics and arts that could provide inspiring learning material even for primary school students.

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The book is clearly structured and targets a wide readership. Experts in mathematics and the arts will recognize a number of classical concepts and topics of recreational mathematics, but they will still be surprised to discover how many of these ideas are derived from design, starting from prehistoric patterns and ornaments to numerous contemporary design problems. Designers, design scientists, and artists, on the other hand, have always seen mathematics as a natural source of inspiration. Readers, whether more interested in design or in mathematics, will find

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[1]Ivo Andrić, *Signs by the Roadside* (*Znakovi pored puta*), SezamBook, Zrenjanin, Serbia 2020, p. 190 (first published in 1976).

plenty of interesting and thought-provoking facts about history, science, language, and culture.

Organized into twenty-six chapters that each explain certain mathematical concepts related to design, the book opens with some historical, artistic, and bibliographical background before developing the subject matter further. Highly visual, it contains more than 450 illustrations, diagrams, and photos. The author has put considerable effort and energy into bringing together rich source material and developing ideas to address the geometric nature of design. In achieving his goal, he has drawn on long-standing collaborations and friendships with a number of colleagues.

Some of the book's content is expected. The reader encounters stylish proofs of the Pythagorean theorem and fascinating objects based on the Pythagorean triangle, such as the Tons Brunés star. It was inevitable that a considerable part of the book would be dedicated to various aspects of famous tilings, including Girih's and Penrose's aperiodic tilings, and two- and three-dimensional lattice tilings, but also to tilings involving noncongruent shapes such as zonogons and tangrams. There is, however, true freshness in the story about the geometric principles of quilt-making, originally presented at workshops given by Margit Echols.

Over the years, Kappraff has collaborated with many mathematicians and artists on the topic of geometric design. Among them are Kristóf Fenyvesi, Reza Sharhangi, the Serbian mathematicians Slavik Jablan (1952–2015) and Ljiljana Radović, the architects Kim Williams and Mary Blade, and many others. What we read between the lines of the book is the significance of friendship in our personal and professional lives and the importance of travel as a means of learning and discovery. Kappraff's own emotions and his own contribution to this subject allow us to enjoy Paleolithic ornaments from Mezine (Ukraine) and in Schela Cladovei (Romania); Neolithic ones in Tisza (Hungary), Vina (Serbia), Dimini (Greece), and Lapita (Fiji); as well as Amish quilts, Islamic geometric patterns, etc.

Topology enthusiasts may be surprised by the fascinating appearances in geometric design of the Möbius strip and the Klein bottle as well as two torus-like polyhedra, the Szilassi polyhedron and the Császár polyhedron (named after the Hungarian mathematicians László Szilassi and Ákos Császár). While we are used to encountering the golden mean practically everywhere, it is surprising to discover a multitude of geometric and artistic properties of a lesser-known ratio called the silver mean. Nonetheless, it is interesting to learn more about designs based on the logarithmic spiral, the Baravelle spiral, and the four turtle problem.

Although readers could imagine the relevance of fractal patterns and the mathematics behind them in design, many new things will be discovered in the book: how meander motifs were used to create labyrinths and knots; how the musical scale can be derived from the numbers 2 and 3; what the Modulor, an anthropometric scale of proportions devised by Le Corbusier, is; and so on. Jablan and Radović introduced versatiles, Truchet tiles, Kufic tiles, and op-tiles to modern designers who created their own pieces of optical art with their help. Curves of constant width, mirror curves, and visual illusions are all the basis of remarkable designs such as black-and-white patterns called Lunda designs.

It is obvious that this book was written with a great deal of passion and love for both mathematics and the arts, which makes it a great read. The topics are presented clearly, together with ample bibliographic and historical data, as well as references for further independent study. Each chapter is accompanied by several exercises, computer experiments, and other attractive suggestions that allow the reader to understand the subject more thoroughly and to create his or her own piece of art. Jay Kappraff has given us a new classic of recreational mathematics.

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