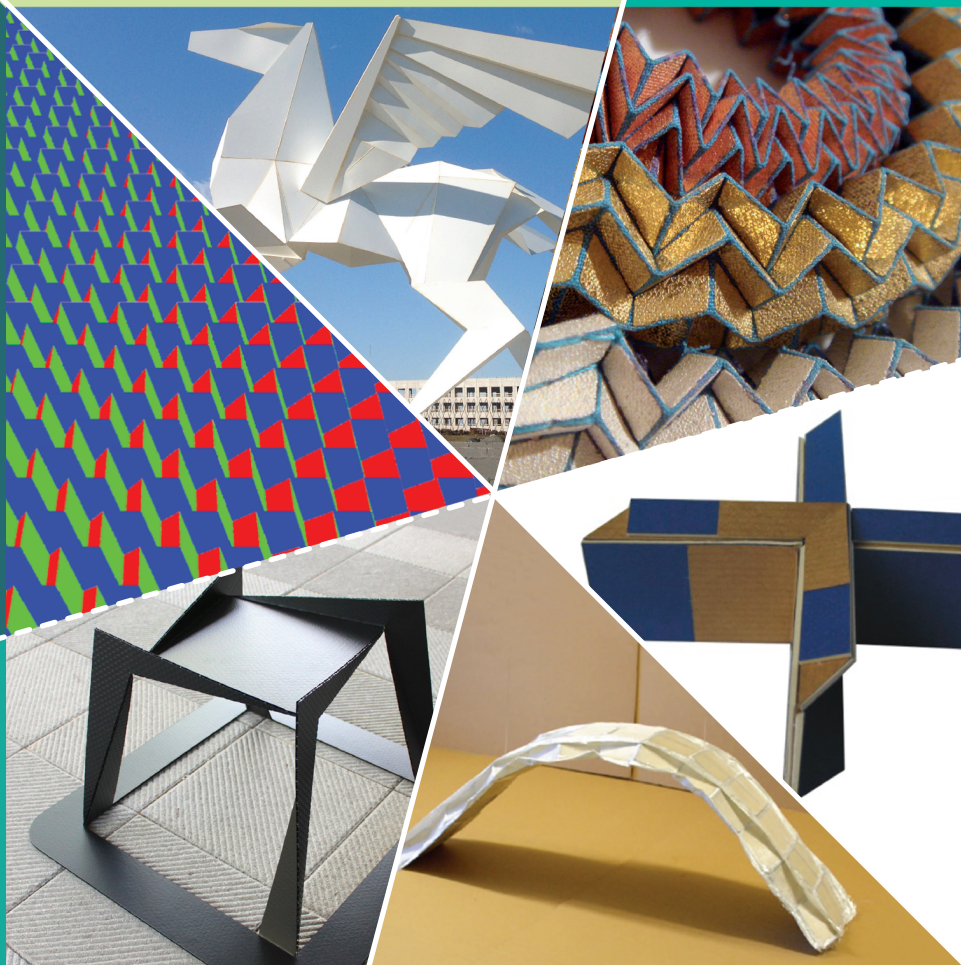


# Origami 6

II: Technology,  
Art, Education



Koryo Miura  
Toshikazu Kawasaki  
Tomohiro Tachi  
Ryuhei Uehara  
Robert J. Lang  
Patsy Wang-Iverson  
Editors

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# Origami <sup>6</sup>

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Art, Education

Proceedings of the Sixth International  
Meeting on Origami Science, Mathematics, and Education

Koryo Miura

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*Origami*<sup>6</sup> is dedicated to the memory of Klaus Peters (1937–2014), founder with Alice Peters of A K Peters, Ltd., publisher of *Origami*<sup>3</sup>, *Origami*<sup>4</sup>, and *Origami*<sup>5</sup>, among many other genre-crossing books. His vision informed and explored the relationships between mathematics and many other fields, not least of which is the mathemagical world of origami.



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Koryo Miura  
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Robert J. Lang  
Patsy Wang-Iverson

## Introduction

The apparently disparate fields of origami (the Japanese art of paper-folding), mathematics, science, technology, design, and education have made tenuous connections with each other throughout recorded history, but they became firmly linked in 1989, with the First International Conference on Origami Science and Technology, organized by Humiaki Huzita and held in Ferrara, Italy. The outcome of that meeting was a book [Huzita 91]. That first conference, which brought together practitioners in origami, mathematicians, scientists, technologists, engineers, and educators, set the course for a series of meetings and subsequent proceedings books, in Otsu, Japan in 1994 [Miura 97]; Asilomar, California, USA in 2001 [Hull 02]; Pasadena, California, USA in 2006 [Lang 09]; Singapore in 2010 [Wang-Iverson et al. 11]; and, most recently, in Tokyo, Japan in 2014. Over a hundred papers were presented by speakers from 30 countries at that conference, spanning topics ranging from the mathematical fundamentals of origami to algorithms for origami design, applications in architecture, deployable structures, micro-fabrication, and the use of folding in teaching and pedagogy. With each year, the breadth, diversity, and depth of work in the field have grown. It has resulted in collaborations between scientists and artists, engineers and teachers, in numerous structures, mechanisms, devices, and artworks, and, most tangibly, in the collection of papers in the book you are holding right now.

Each Origami in Science, Mathematics, and Education (OSME) conference has grown in size and breadth, reflecting the many connections between the world of folding and diverse other fields. Traditionally, the art of origami has been one of great restriction: a single sheet of paper (usually), formed by folding only, with no cuts (again, usually). Yet, this restrictive rule set not only gave rise to vast variety in artistic forms, but the techniques that artists discovered to create their forms have turned out to have applications across technology. In addition, as the power of folding came to the attention of scientists, mathematicians, and technologists, they, in turn, brought powerful tools—abstraction, analysis, optimization, computation—to the world of folding, giving rise not just to new artworks but to new engineering applications that better the human condition. With the combination of geometric precision and physical tangibility that folding provides, it continues to serve as an educational tool, with ripple effects that extend far beyond the narrow province of paper alone.

As with previous volumes in this series, this book presents a cross section of the latest developments in the marriage between origami and scientific and technological fields. Those developments grow and expand, and there is no greater evidence of that growth than the fact that this work is now in two printed volumes.



Part 1 focuses on some of the deepest connections between origami and other fields: the mathematics of origami, whose roots go back well beyond the OSME phenomenon with developments on solving algebraic equations using origami back in the mid-twentieth century, and still older explorations of the mathematical properties of folded surfaces. Modern investigations form a rich and vibrant field; new results presented here include work on constructability, connections to graph theory and coloring, and a host of design algorithms that bring in concepts from two- and three-dimensional geometry. The mathematical underpinnings of folding and their implications remain a source of active exploration, as you will see in the many papers in this work.

Part 2 focuses on the connections between origami and more applied areas of science: engineering, physics, architecture, industrial design, and even other artistic fields that go well beyond the usual folded paper. When origami enters other fields, the medium changes: applications of origami use polymers, metals, textiles, and more as the folding medium, and they call for new developments in algorithms, manufacturing techniques, computational tools, and process development. In addition, the applications of origami are often informed and influenced by the deep roots of historical folding, and you will find history, design, and art among the rich *mélange* of interdisciplinary work explored in this volume. While origami can call upon highly abstruse mathematical concepts, it also can play a powerful role as a classroom tool at all educational levels, even the elementary grades. A number of papers explore and demonstrate the utility of origami as a pedagogical tool in mathematical education.

As is often the case in the academic milieu, the most exciting and novel developments take place at the edges of existing fields, where disparate and unexpected bodies of knowledge mix and interact—illustrated elegantly here by the interdisciplinary applications of origami.

*Origami*<sup>6</sup> contains a unique collection of papers accessible to a wide audience, including those interested in art, design, history, and education and researchers interested in the connections between origami and science, technology, engineering, and mathematics. We hope you will enjoy the works in these two volumes, both for their own interest and as harbingers (and perhaps triggers) of more exciting developments to come.

The Editors of *Origami*<sup>6</sup>:

Koryo Miura  
Toshikazu Kawasaki  
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Robert J. Lang  
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*Origami*<sup>6</sup> is a unique collection of papers illustrating the connections between origami and a wide range of fields. The papers compiled in this two-part set were presented at the 6th International Meeting on Origami Science, Mathematics and Education (10–13 August 2014, Tokyo, Japan). They display the creative melding of origami (or, more broadly, folding) with fields ranging from cell biology to space exploration, from education to kinematics, from abstract mathematical laws to the artistic and aesthetics of sculptural design.

This two-part book contains papers accessible to a wide audience, including those interested in art, design, history, and education and researchers interested in the connections between origami and science, technology, engineering, and mathematics. Part 2 focuses on the connections of origami to education and more applied areas of science: engineering, physics, architecture, industrial design, and other artistic fields that go well beyond the usual folded paper.

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