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Guest Editorial

Special Issue: Folding-Based Mechanisms and Robotics

Over the past few decades, the centuries-old art of origami and the centuries-old practice of engineering have been mixing in ways that have proven to be both fruitful and surprising, resulting in structures and mechanisms that fold, deploy, and transform. While the term "origami" captures the general sense of these forms, it should be interpreted broadly, as folding, in which multiple components rotate with respect to one another around reasonably well-defined axes of rotation: the "folds." Unlike traditional origami (mostly paper), origami mechanisms are made from the materials of engineering: metals, polymers, plastics, and exotics, such as carbon fiber. The user of such mechanisms in the engineering domain requires the exploration of properties and parameters not considered in traditional origami: kinematics, effects of thickness and bending, stresses and strains, and methods of actuation far more sophisticated than the hands of a craftsman.

This special issue on folding-based mechanisms and robotics is complementary to a series of ASME symposia in which origami—or rather, folding, as broadly interpreted—plays a central role in the area of investigation. Origami forms, viewed through the lens of mechanical engineering, constitute a rich trove of coupled linear and spherical mechanisms—in some cases, highly complex mechanisms—that, once cast within the language and formalism of engineering, enable the development of devices that are compact, can be fabricated from planar sheets, and can perform complex tasks within limited space. Origami has become a source of inspiration for next-generation mechanisms and robotic systems.

Origami provides the conceptual raw material, but research and development refine those concepts into tools that address societal needs in definitive and robust ways. The papers in this special issue address topics of practical import, including the following:

- deployables and shelters,
- bistable mechanisms,
- self-folding methods and actuation,
- kinematics of complex folding mechanisms,
- dynamic behavior of folded mechanisms,
- manufacturing methods for highly complex fold patterns, and
- design tools for folded forms.

The societal benefits of origami-based mechanisms are diverse and unexpected: such mechanisms are to be found in microscopic surgical tools—joints, stents, and retractors—and macroscopic space structures—booms, arrays, and occultors—and at all scales in between. The papers in this issue, its predecessors, and in related origami-focused technical conferences, provide the foundation for these and future engineering accomplishments. The field of origami-based engineering has a long history, but it has experienced a notable acceleration in recent years, thanks, in part, to the support of funding agencies, including the U.S. Air Force Office of Scientific Research (AFOSR) and the National Science Foundation's Emerging Frontiers in Research and Innovation (EFRI) program with its "Origami Design for Integration of Self-Assembling Systems for Engineering Innovation (ODISSEI)" research topic area and related research programs in Europe, Japan, China, and elsewhere.

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