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Why Should We Care about Buckling?

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This is a question that I often hear when a graduate student joins my group. Buckling has been observed, undoubtedly, since prehistoric times, and described quantitatively, in some form or another, since the late 1700's. Therefore, it seems quite apparent that we might know everything that we need to know regarding buckling. Is this true?

The short answer is no. Yes, we have a formalism to describe the critical buckling condition for a given material and geometry. Yes, we understand how certain boundary conditions define the most likely post-critical state. But beyond these generalities very few exist. This level of current understanding has developed over the past two centuries, but it's only been over the past decade that scientists and engineers have begun to push the limits and understand the wealth of questions related to buckling that still remain unanswered.

Buckling is generally associated with the onset of an elastic instability, in which an in-plane compression gives rise to an out-of-plane deformation. For most of its quantitative history, knowledge related to buckling has been developed in the context of structural failure and its prevention. But buckling has also been long associated with the formation of morphological and structural features in the Natural world.

For example, in the late 18th century, Kollmann¹ related the formation of fingerprints to folding, which occurs due

to compressive stresses at the interface of the basal layer of the dermis in a developing epidermal layer. At a critical point, folds develop with dimensions defined by the tissue length scales and material properties. Although this allusion is traced back over 100 years, there are still many aspects of the pattern formation and its changes across species, which are not understood. Beyond fingerprints, Nature provides numerous examples of similar elastic instabilities, which are quite ubiquitous in defining both beautiful and functional structures, yet they are presently only understood at a cursory level.

Whether inspired by these unanswered questions in Nature or only following its inspiration indirectly, a significant community within science and engineering has emerged recently to increase the depth and breadth of our knowledge of buckling and how we may use this knowledge for societal benefit. In this issue, we have compiled both original research contributions and review articles to provide a snapshot of the current state of the art in the physics of buckling.

This issue covers topics ranging from surface instabilities to the buckling of fibers and molecules to the applications of instabilities in advanced technologies. Readers will find answers to questions, such as: What are the differences between a wrinkle and crease? How does the balance of elasticity and surface energetics define functional morphologies? How can simple swelling techniques be used to access a wealth of well-controlled surface morphologies? How can buckled ribbons advance the field of flexible electronics? and What insight can be gained

by using buckling transitions in the metrology of geometrically confined materials?

Buckling and the control of buckling-induced patterns is a rich field that epitomizes the advances that can be realized when classical disciplines share knowledge. Physics, mathematics, chemistry, materials science, and biology all come together to harness the power and simplicity that Nature has used to its advantage for millennia. I hope that you enjoy this issue, learn from the lessons that are shared, and are inspired to contribute to this exciting field of synthetic morphogenesis.

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† This paper is part of a *Soft Matter* themed issue on The Physics of Buckling. Guest editor: Alfred Crosby.