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Morphoelastic Rods and Birods: Theory and Applications

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In many engineered or biological structures long thin elastic filaments are bundled together. Due to heating expansion, growth, or remodelling, the reference configuration of each filament can evolve independently and become incompatible with respect to its neighbours leading to internal stresses, deformations and, possibly, instabilities. A simple example of these structures is the bi-metallic strip first described by Timoshenko in 1925. To capture these phenomena in space and for large deformations, we have developed a general theory of growing elastic rods and birods. The theory provides a natural framework to consider the shape and dynamics of a single or multiple elastic rods with evolving reference configuration. In this talk, I will present the general theory and apply it to a number of interesting situations commonly found in engineering and biology. I will also describe new analytical methods to determine the shape and stability of growing birods. This work is done in collaboration with Thomas Lessinnes and Derek Moulton.