

Survival, Memory, and Viscoelasticity

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Abstract: This lecture follows viscoelasticity into two worlds that could not seem further apart yet are bound by the same physics. In the primal rainforests of Panama, a frog embryo fights to survive a predator while still in its egg. The frog embryo and its many siblings are attached to the underside of a tree leaf in a clutch, made of a gelatinous extracellular matrix that is both viscoelastic and hydrated. This viscoelastic material damps vibrations very well, thereby allowing frog embryos to detect the dangerous rhythms of a predator attacking its siblings. When a danger threshold is crossed, the embryo creates its own birth to escape death. I will discuss the fascinating survival secrets of the frog embryo, which were revealed over two decades of highly convergent research conducted by biologists and me. I will describe a novel sensor that was inspired by the escape hatching of the frog embryo. Leaving the theme of survival, I turn to the theme of memory in the world of numerical simulations. A viscoelastic material “remembers” its strain history, giving it the power to reduce unwanted noise, vibration, and harshness in the built world. However, achieving these benefits requires efficient and accurate inclusion of material memory in the transient simulations used to understand and design complex dynamic systems. We trace historical threads from over a century ago that still tempt researchers to chase analytic representations of memory. I present a new and radical solution to this problem that replaces analytic representations of memory with measured material data.

Bio: Greg McDaniel is an Associate Professor of Mechanical Engineering at Boston University, where he has been a faculty member since 1996. He received his MS and PhD degrees from the Georgia Institute of Technology. His research focuses on structural acoustics, vibrations, viscoelastic materials, and the biomechanics of complex natural systems. His research is primarily supported by the Office of Naval Research and the National Science Foundation. He is a Fellow of the Acoustical Society of America and has served as Associate Editor for the Journal of the Acoustical Society of America and JASA Express Letters. At Boston University, he teaches courses spanning vibrations, acoustics, structural dynamics, and engineering mechanics. He is also deeply engaged in mentoring students, including serving as Faculty-in-Residence.

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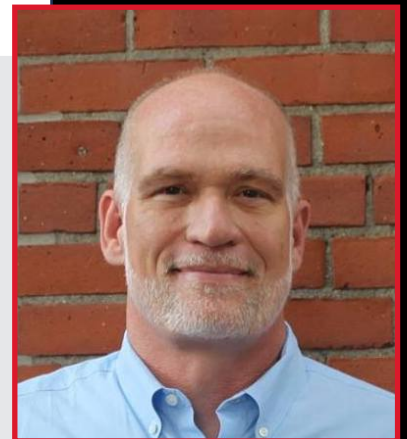
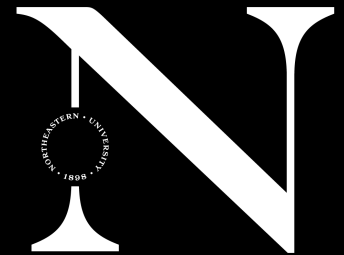


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