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PLANES, TRAINS, AUTOMOBILES.... AND CELLS?

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ABSTRACT:

Two areas that have always interested me are the mechanics of machines and the wonders of nature. My interest in mechanics, first beginning as a youth taking apart machines like lawn mowers, has intersected with my fascination with nature at the cellular and molecular levels. Here I will present how my lab has been merging mechanical engineering with biology. My lab approaches this intersection by envisioning cells and molecules as "systems" that can be investigated with some of the same fundamental approaches used on machines such as planes, trains, and automobiles looking for unifying principles. The biological systems range from mammalian cells to microorganisms to developmental biology systems (e.g. neurons, magnetic bacteria, energy generating bacteria, Xenopus laevis, stem cells) and we apply principles from mechanical engineering fields (e.g. solid mechanics, control theory, fluidics, heat transfer, design) to understand how these principles may apply across diverse nature-based systems. In addition, I will present in this talk our approaches of using solid mechanics in areas such as cell mechanotransduction. We pursue these goals through developing and utilizing unique custom-built systems as well as nanotechnology, microtechnology, and computational biology. These intersections are especially fascinating to me as biological systems have evolved for distinct reasons (the "initial and boundary conditions" are different). In addition, as an engineer, I truly am interested in building new systems from the knowledge that we obtain in a similar thought process as we use information to build new machines. Thus, I will also present how our lab thinks about nature-inspired design principles at the molecular and cellular levels to work toward generating novel approaches for contributing to technology development and medical applications. My goal for this talk is to present some of our work and thoughts about how one mechanical engineer approaches these nature-based systems at the cellular and molecular levels.

BIOGRAPHY:

Philip LeDuc (Ph.D. Johns Hopkins University; post-doctoral fellow, Children's Hospital and Harvard Medical School) is a Professor in the Mechanical Engineering Department at Carnegie Mellon University with appointments in Biomedical Engineering, Computational Biology, and Biological Sciences. He has received the National Science Foundation CAREER Award, the Beckman Foundation Young Investigators Award, while also being selected as a faculty member for the Sloan Foundation minority Ph.D. Program. He has also been funded by other organizations including the Bill & Melinda Gates Foundation, Office of Naval Research, Department of Energy, National Institute of Health, and Keck Foundation. During his career, he has published articles in many journals, including Proceedings of the National Academy of Sciences, Nature Nanotechnology, PLoS ONE, JACS, Applied Physics Letters, Methods in Cell Biology, Advanced Materials, Nano Letters, Nature Protocols, and Nature and has given seminars across the world including South Africa, India, and Brazil. He has be on and helped organize many scientific meetings including for the National Academy of Engineering, the National Academy of Sciences, the Institute of Medicine, and the United States Congress as well as being elected to the Board of Directors for the Biomedical Engineering Society and American Institute for Medical & Biological Engineering. He is also a Fellow of the Biomedical Engineering Society, the American Society of Mechanical Engineers, and the American Institute for Medical & Biological Engineering.