2010 Delaware Biomechanics Priorities Conference
Personal Statement

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By definition, “biomechanics” is the application of the principles of mechanics and dynamics, as derived from physics, to the study of biological systems. The laws of physics can be applied to understanding biological function broadly at the cellular, tissue, joint, limb, and/or whole body level. Biomechanists as a group include researchers working at each of these levels, and some who work across levels.

A recent focus area for federal funding has been that of “multi-scale modeling”. The goal of such efforts is to promote new and more advanced approaches to developing mechanistic and predictive models that cut across at least two or more of the different physiological levels discussed above. Researchers in biomechanics are ideally suited to taking advantage of such initiatives. After all, whether we work at the cellular or whole body level, we should all speak the same language: that of Newton’s Laws.

Although much of the focus in “multi-scale modeling” has been directed towards integrating research from the sub-cellular / cellular levels up to the tissue / organ levels, I also see enormous opportunities to adapt these ideas far beyond this level. We are beginning to understand how cells and tissues respond to external loads, and about how different forces generated at the muscle level cause limbs and bodies to move in certain ways. However, we still know far less about how the nervous system *controls* the movements we observe or about why people choose to move certain ways and not others.

<u>So my primary recommendation is</u> to think about how to better integrate ideas from *neuroscience* and *motor control* into biomechanics and vice versa. To do this, we must think *mechanistically*, but we also need to think *conceptually* and *theoretically*.

On the mechanistic side, we need to develop modeling paradigms that do a better job integrating neuronal commands and sensory feedback mechanisms driving the musculoskeletal models we have. On the conceptual and theoretical side, we need to identify the fundamental underlying *principles* around which different types of movements are organized. On both counts, we need to use these ideas to generate *specific testable hypotheses* about motor control that can then be tested experimentally.

Such a process would have to call not only for “*inter*-disciplinary” efforts, but also for truly “*trans*-disciplinary” efforts involving not only biomechanists, but also scientists working in neurophysiology, experimental motor control, computational motor control, and even theoretical biology, etc.

The results of these efforts will allow us to gain a deeper understanding not just of *what* movements different people and patients perform, or of *how* those movements are generated and coordinated at the muscular and/or neural levels, but also of *why* it is both healthy and impaired humans perform certain tasks in certain ways and not others.

These insights could potentially provide immediate impact on patient care by truly *predicting* how their movement patterns should be altered as a result of their impairment and how their movements will then change as a result of intervention. Such predictive models are critical for optimizing treatment outcomes and ultimately for guiding treatment decision making at the clinical level. Achieving these objectives could ultimately have a potentially huge impact on improving functional outcomes and quality of life (QOL) in a wide range of patient population.