

Failures and Future Directions of Phenomenological Relations for Biological Tissues

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ABSTRACT: Failure in experimentally determining the mechanical constitutive behavior of high strain, elastic materials and tissues is due to inadequate theory as opposed to inadequate experimental techniques or material tests. To demonstrate this, let us pose the existence of an ideal testing apparatus that can measure the stress completely and prescribe any permissible value of strain. Even with this idealistic experimental situation, material response functions cannot be determined because the condition number of the system of equations is infinite when using conventional constitutive theories. With a change in constitutive theory, however, it becomes possible to determine material response functions with ideal and real world material tests. Phenomenological relations forthwith can be measured or verified if assumed rather than measured. Admittedly, these advancements in constitutive theory will not yield phenomenological relations that are significantly more accurate because conventional relations are already accurate enough for most applications. The primary difference here is philosophical. Conventional approaches are ill-conceived experimentally; whereas, the approaches of this author are well-conceived. It is a difference of non-uniqueness versus uniqueness, respectively. In this plenary lecture at The Society of Natural Philosophy, these philosophical ramifications are expanded, and the critical role of phenomenological relations in biomechanics is discussed.