Digital Twins in Healthcare: An Overview
W Andrew Pruett and Marc Horner
Department of Physiology and Biophysics, University of Mississippi Medical Center, Jackson, MS 39216
ANSYS, Inc., Evanston, IL 60201

Introduction: Modeling and simulation is currently used across a wide range of healthcare activities, including the design and regulation of new products and processes. We ask models to reflect certain aspects of the real world in some dictated context and then draw conclusions from the simulations generated by these models. In this paradigm, the role of modeling and simulation is finished before the technology is deployed to end-users. In another paradigm, modeling and simulation might be used to augment the utility of a technology via an integrated feedback loop.

A digital twin realizes the second paradigm by pairing a mathematical model with a physical asset, be it a device, process, or even a live subject. The mathematical model may be mechanistic, geometric, statistical, informatic, or any combination of these. Sources of real-world data are equally diverse, including sensor data, historical information (health records), and expert opinion. The resulting digital twin can be wrapped with artificial intelligence, combined with ensembles of similar twins, or used in tandem with other predictive tools to analyze and diagnose operational states and to optimize performance under real-world operating conditions. This enables companies to make predictions about future performance, improve operation and productivity, and reduce the risk of unplanned downtime. The digital twin concept is flexible and can be implemented in many ways to fill a variety of needs.

Essential to the digital twin concept is a two-way connection between the physical asset and its virtual representation. This connection ensures that the virtual twin remains a faithful representation of the physical asset and provides a platform to predict the physical asset’s immediate future. Conversely, the virtual twin may inform the activity of the physical asset by changing the physical conformation of the asset or deploying a pharmaceutical agent.

Building on the success of other industries, the digital twin concept is now appearing in the healthcare industry. In this domain, the physical assets of digital twins may be devices, patients, healthcare delivery systems, information flow through health records, or any other aspect of patient care. In each case, the purpose of the twin is faster, safer, and more efficient healthcare delivery to patients. In this presentation, we present examples of digital twins in healthcare and non-healthcare domains in order to build intuition about this burgeoning technology, and to foster a clear discussion of how it might be useful in the future.

Translational Impact: This technology may transform how medical devices are deployed, unifying existing monitoring technologies into an integrated platform that can rapidly diagnose an individual’s disease state and then evaluate treatments options based on knowledge of not only characteristics of the various therapeutic options but also estimates of the patient’s current and future pathological condition.

No Disclosures.