Digital Twin – exploring the basics

The concept of digital twins is not new, but rather built on ideas that have been explored for the last couple of decades. The technology (compute power, data management & analytics, etc..) and thinking (increasing regulatory and community acceptance of digital approaches to science) have finally hit an inflection point that makes in silico modeling attainable in a cost effective manner.

What this now unlocks is a new opportunity set in the form of machine accessible data, as well as integration of the data sets / ontologies across the target systems / interactions. The need to get to a standardized mechanism to make these data available is tied to the FAIR Data work, and an important dimension to Digital Twin.

> Digital twins vs. simulations
> Although simulations and digital twins both utilize digital models to replicate a system's various processes, a digital twin is actually a virtual environment, which makes it considerably richer for study. The difference between digital twin and simulation is largely a matter of scale: While a simulation typically studies one particular process, a digital twin can itself run any number of useful simulations in order to study multiple processes.
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> SOURCE: IBM , WHAT IS A DIGITAL TWIN

At it's heart, the idea of a digital twin is to reproduce a system in a "runnable" computer model. This oversimplifies the idea, but is a useful construct to think about the problem space and the opportunity it presents. If you can take a scientific instrument, and fully model it in silico, you can then run data sets through it virtually – this makes the assumption that both the inbound and outbound data are available in a machine usable format – something that is tied to this work.

> Digital twin is an interdisciplinary research field which includes engineering, computer science, automation and control, and so on. But due to the multidisciplinary nature of the field, it also touches on materials science, communication, operations management, robotics, medicine and other disciplines. A keyword analysis indicates that digital twin, 'smart manufacturing', 'big data', 'cyber-physical system', and 'digital economy' are closely related fields.
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> SOURCE: "INNOVATIONS IN DIGITAL TWIN RESERACH" FROM NATURE PORTFOLIO

The article in nature.com is an interesting piece in that it ties together the many dimensions in this field of research. We can't think of "Digital Twin" as a single entity opportunity, rather to fully realize the potential, we need to look at it as a part of an emerging "virtual capability ecosystem" with applications back to the real

world. The value is realized in lower long term costs with increased innovation driven by reduced cost and cycle times, accompanied by increases in application of AI / ML on these models to gain targeted insights that more sharply focus the bench work.

> Track the past and help predict the future of any connected environment
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> SOURCE: AZURE DIGITAL TWINS

The ability to create learning models for these Digital Twins will improve the accuracy and usefulness of the models over time, and that feedback loop will be a critical part of design. While the industry is maturing, we are seeing more vendors coming to the table with solutions in this space. One of the interesting things to watch is how we as an industry continue to drive open standards in support of these ideas to avoid the traps of “vendor lock in” that were so prevalent in the past.