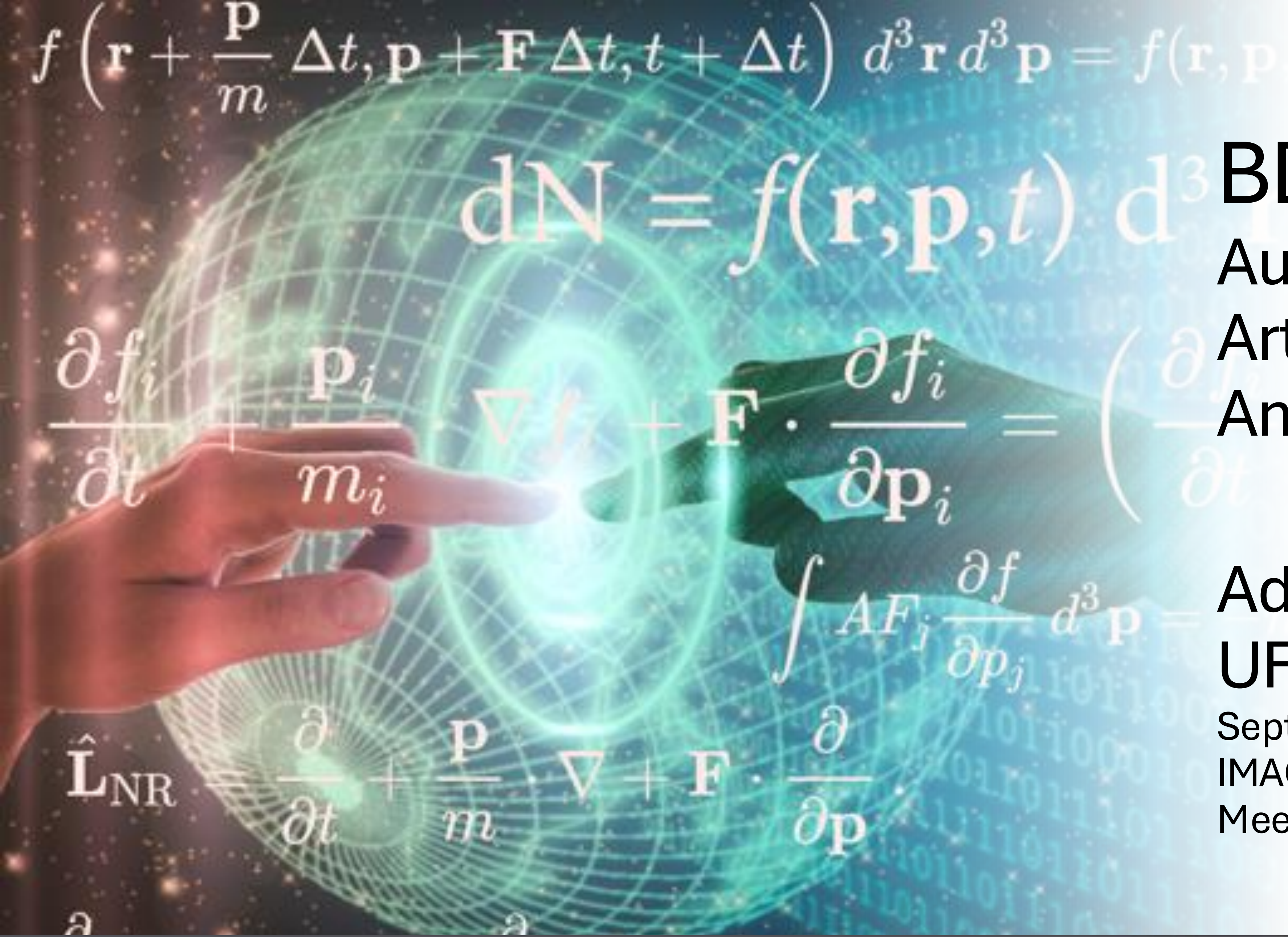


BDT Project:

Autonomous Artificial Anesthesiologist

Adam Knapp, UFL

September 30, 2024

IMAG/MSM Teaming4BDT Meeting

Instructions to Speakers

Please delete this slide after completing your presentation

BDT Project Speakers (Day 1 morning),

As you record your talk please think about the presentation as an exercise in helping others understand what you did, how you did it, and what challenges you encountered so they can learn from your experiences as they take on their own projects. Please use only the slides attached, as we have limited presentation time

Please begin your thinking by reviewing the NASEM definition, found here: https://www.imagwiki.nibib.nih.gov/content/nasem-definition-digital-twin

We would like you to use this definition as a benchmark to describe your BDT project. Even if only a small percent of your project pertains to the NASEM definition, the "mapping to the NASEM Loop" should provide you and the audience a consistent context to consider a digital twin solution to the problem you wish to solve.

Specifically,

Explain to the audience how you designed your digital twin in the context of the NASEM definition.

- What was easy about this? What made it challenging?

We want people to understand the realities of conceptualizing a digital twin. Please convey where your design does NOT fit the NASEM definition (yet).

- What has the challenge been? How are you thinking of addressing/solving it?

What about your approach, tool, method, technology, etc…at the various steps. Could they help other digital twin developers in creating a biomedical digital twin (BDT)?

- What can people "take away" from your talk that will empower them in taking on their project?

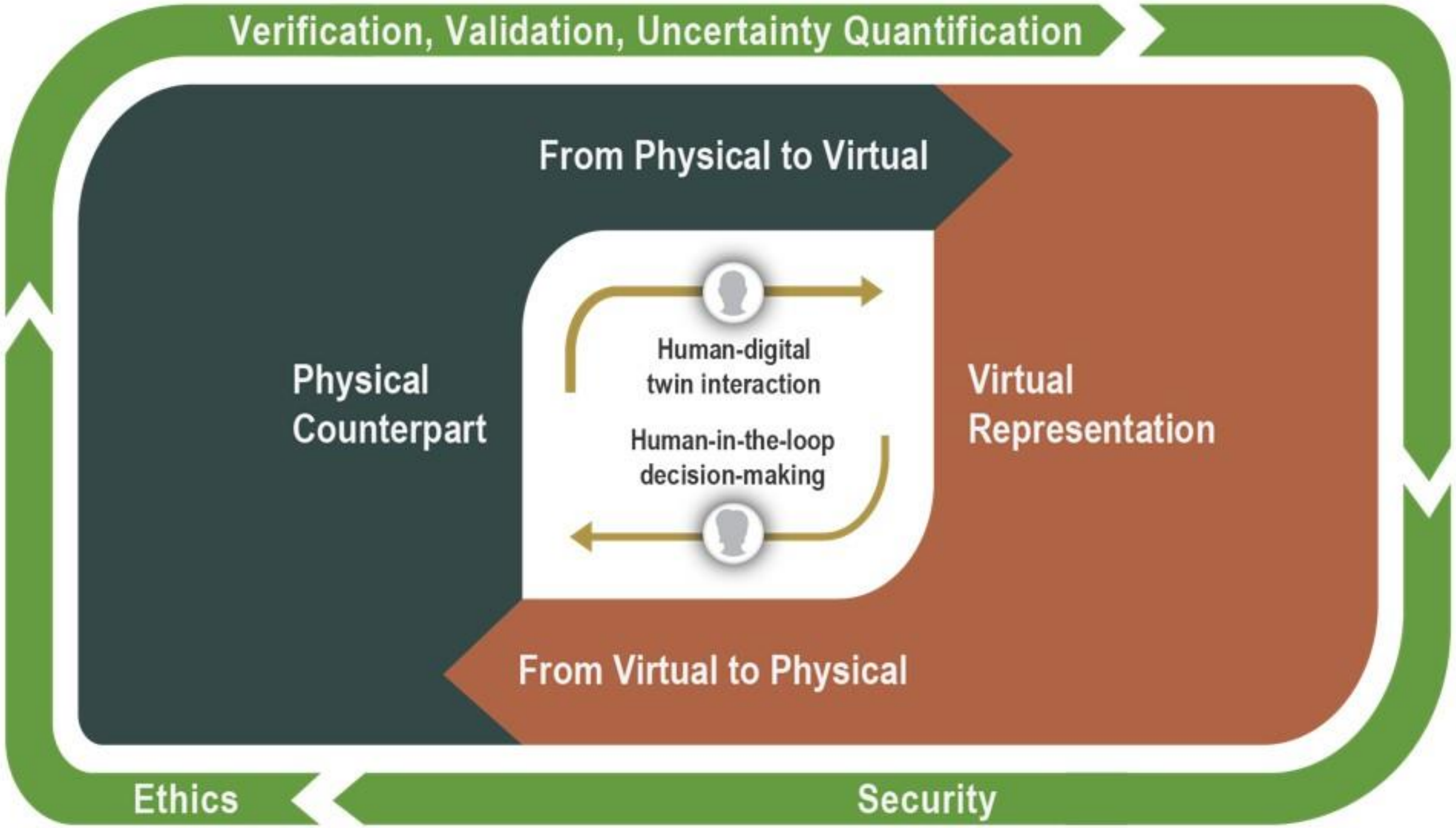
Explain how you are thinking about the ethical implications as part of your design, build, test, deployment culture of this project?

- What leads ethics to come into play? And what should people be thinking about?

Digital twins are commonly referred to as a "system of systems" – how has this impacted your approach to your BDT?

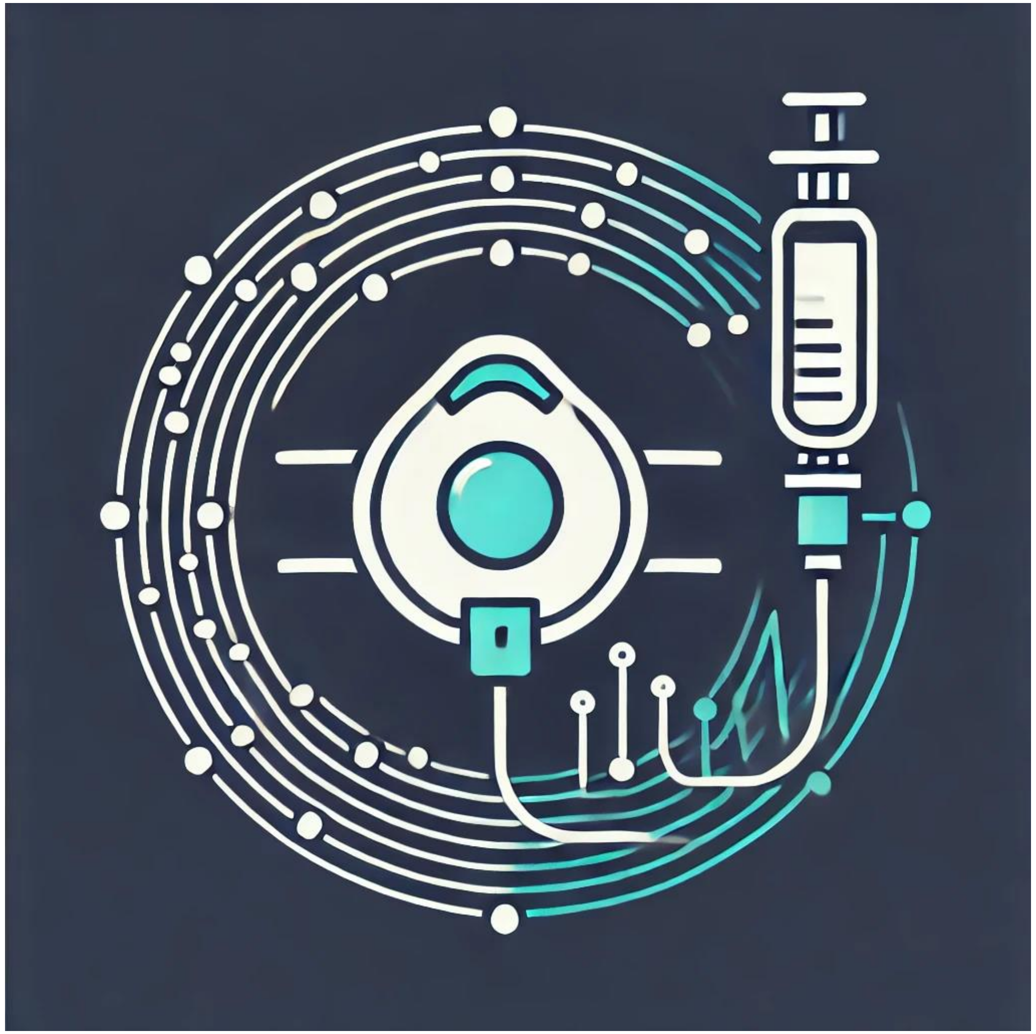
NASEM Definition of a Digital Twin

“A digital twin is a set of virtual information constructs that mimics the structure, context, and behavior of a natural, engineered, or social system (or system-of-systems), is dynamically updated with data from its physical twin, has a predictive capability, and informs decisions that realize value. The bidirectional interaction between the virtual and the physical is central to the digital twin."



A Digital Twin is More Than Just Simulation and Modeling

NASEM Loop: Autonomous Artificial Anesthesiologist



Problem and BDT Solution

What is the problem you are trying to solve, and how will a BDT solve this problem?

Safe anesthesia access in austere less well-resourced settings. (military in field, disasters, rural hospitals)

Automation of anesthesia could provide access in austere settings (military, disasters), and improve safety. How do we build a physiologic closed loop control system to administer sedatives

What makes your BDT realistic and able to mature and change over time?

Closed loop digital twin will provide safe sedation in these settings by monitoring patient's conditions to maintain homeostasis. Data collection in real world usage may allow model refinement.

Physical and Virtual Assets and Their Interaction

- Physical assets:
  - Patient
  - Clinician observer/supervisor
  - Device: multiple IV pumps
  - Drugs: propofol (sedative), remifentanil (opioid), muscle relaxant
  - Sensors: EEG (processed), ECG, BP, SpO2, CO2, etc.
- Virtual assets:
  - Patient Models: Cardiovascular, PK/PD, Neural (brain stem and higher level functions), Respiratory, Endocrine, Muscle relaxant
  - Device/Delivery models: Pump, lines, and supply. Sensors.
  - Adaptive closed loop control system
  - Patient data: Mass, other vital parameters
  - Surgical team input

Ethical Issues and Team Science Considerations

- Ethics:
  - Active time is short compared to other proposed systems
  - Could learn about habitual drug use
  - Informed consent
  - Provider acceptance and understanding of risks (e.g. should patient be transferred to human anesthesiologist and when?)

Ethical Issues and Team Science Considerations

- Team science considerations:
  - Clinicians
  - Modelers (Physiology and device)
  - Engineers (device, control, others)
  - Device manufacturers
  - Regulatory experts, FDA guidelines

Questions

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