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MISCOMMUNICATION IN SIMULATION: SAME TERMS, DIFFERENT MODELS

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ABSTRACT

The simulation industry has its own terms that are often used inconsistently between professionals. For example, much time is spent trying to define what makes a digital twin different from a simulation model. Inconsistent use of simulation terminology often leads to project dysfunctions, such as scope creep, misaligned expectations and solutions that fail to meet business objectives.

In this presentation, we will present a wide range of terms representing the most common modeling techniques. The focus is to provide simulation professionals with varying definitions of the same term, so they can be prepared to ask the right questions to ensure project success. While this presentation focuses on clarifying framework terminology more than ideal framework selection, attendees will gain a better understanding of various frameworks being used in simulation modeling.

1 INTRODUCTION

Simulation modeling comes with its own terminology. Like most industries, simulation professionals do not always use the same terms to mean the same things. For example, much time has been spent trying to define what makes a simulation model a digital twin versus just a normal simulation model. These debates often take away focus from the core business problem and increase risks of suboptimal modeling choices.

In this presentation, we will present terms representing the most common modeling techniques. The focus of this presentation is to provide simulation professionals with varying definitions of the same term.

The basis of this presentation is a qualitative synthesis of 20 years of simulation work and will solicit audience discussion. The goal is not to argue what the definitions should be, but to enable the simulation community to recognize potential, significant differences in perspectives.

2 MODELING APPROACHES COVERED IN PRESENTATION

Simulation professionals often assume *their* definition of an approach is *the* definition of an approach. In this presentation we will discuss how some of the following terms can be used very differently.

2.1 Discrete Event

Many professionals are surprised when they find out a peer has a different definition for discrete event simulation. Many professionals define a discrete event simulation as any simulation that relies on a discrete event calendar. Others are steadfast in their definition that a discrete event simulation is one that uses process flow blocks. That is, the entities are relatively un-intelligent objects trying to seize-delay-release capacitated resources.

2.2 Agent Based Modeling

For a period of approximately 10 years, beginning in the late 2000s, agent-based modeling was described by many as the new and correct way to model systems. Many people put agent-based models in completely separate buckets from discrete event models, while others viewed agent-based modeling as a programming

approach to be used within a discrete event simulation package. As we discuss agent-based modeling, we will present the various criteria we have heard our customers and peers use over the years. This includes:

- Agents must be spatially aware of each other and the system they are in.
- Agent based modeling is the same as object-oriented programming.
- Agent based modeling should be used instead of discrete event modeling.
- Agent based modeling is a good way to approach building discrete event models.

2.3 System Dynamics Modeling

Many people associate system dynamics modeling with causal loop diagrams and stock and flow diagrams. However, you should verify that is what your customer is referring to with this phrase. In many cases, a customer may just mean they have a system that changes over time. That is, they have a dynamic system, so wouldn't system dynamics be the appropriate approach? As with all the terms covered in this presentation, it is often better for the simulation analyst to understand what problem the customer is trying to solve, versus being willing to blindly program a specific modeling approach.

2.4 Emulation

The authors have found the term emulation to be used in two very different ways. Without ensuring what your customer is looking for, you may generate a very wrong solution. In our experience, emulation most often refers to the simulation model being integrated into the control system. That is, when making a routing decision, the model calls the *actual* system code. Some stakeholders refer to very detailed simulation models as emulators. For example, if the exact sequencing algorithm is replicated within the simulation code-base, some consider this an emulation of the algorithm.

2.5 Digital Twin

The phrase digital twin has seen its usage explode over the past 5 years. As companies seek to capitalize on marketing and individuals seek to enhance their resumes, the term is applied to more and more situations. Promoting the popularity of this term has created confusion with simulation practitioners as to what the term actually means.

The National Academies of Sciences, Engineering, and Medicine (NASEM 2024) defines a digital twin as:

> *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.*

The NASEM paper proceeds to clarify that the interaction between the model and the physical system is key to making it a more specialized type of simulation model. In this presentation, we will discuss how we see customers define digital twins differently.

3 SUMMARY

This presentation will seek to give the attendee a breadth of definitions for several common modeling terms. Attendees will be surprised to learn a term they always assumed had a single meaning is used in multiple ways. As time allows, the audience will be asked to share their definitions of these modeling terms.

REFERENCES

NASEM (National Academies of Sciences, Engineering, and Medicine). 2024. "Foundational Research Gaps and Future Directions for Digital Twins."