SYSTEMS ENGINEERING & ARCHITECTURE

TECHNICAL HIGHLIGHT:

ENGINEERING of DEFENSE SYSTEMS

MAY 2023

ENGINEERING DECISIONS

The Department of Defense (DoD) uses data-centric approaches to inform decision making. Modernizing the traditional approach to developing systems (systems engineering) requires digital methodologies, technologies, and practices (digital engineering). This fusion of traditional engineering rigor with digital data strengthens the comprehensive engineering process, as digital models and the underlying critical data advance the Department's ability to design, develop, deliver, operate, and sustain systems.

System Development

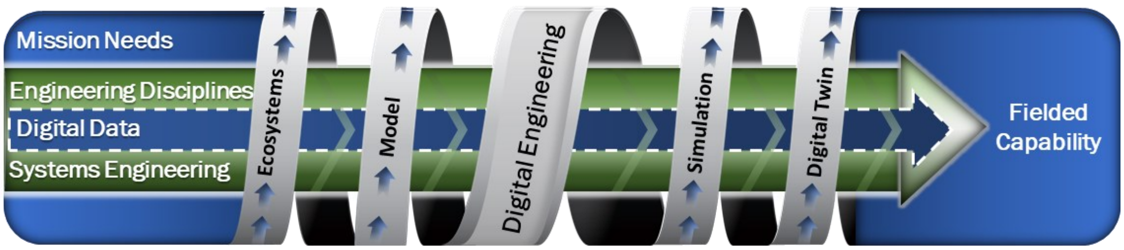

Figure 1. Digital Engineering throughout System Development

Digital engineering does not replace systems engineering but moves the activities into the digital realm.

Digital engineering moves the primary means of communicating system information from documents to digital models and their underlying data.

❖ DATA IS KEY

Data is recorded information, regardless of its form or the media on which it is recorded. Data is a strategic asset and DoD's primary source for making well-informed and fact-based decisions. Data standards are the specific rules by which users describe and record data. Standards facilitate interoperability, data sharing, and open systems approaches. For example, data consumers may include humans or machines, so creators should format data as machine readable so a computer can process the data without human intervention while ensuring no loss in meaning.

❖ SYSTEMS ENGINEERING

DoD systems engineering (SE) establishes the technical framework for delivering capability to the warfighter by ensuring a balanced approach to cost, schedule, performance, and risk. SE uses integrated, disciplined, and consistent processes and activities regardless of when a program enters the acquisition life cycle. SE enables development of resilient systems that are trusted, assured, and easily modified.

SE provides the end-to-end, integrated perspective of the technical activities across the system life cycle, including how the system fits into a larger system-of-systems construct. SE activities reduce risk while maturing and managing the technical baseline. The final product baseline forms the basis for production, sustainment, and upgrades. SE provides insight into a system's resource requirements and its impacts on human health and the environment.

❖ DIGITAL ENGINEERING

Digital engineering allows the SE practice to take full advantage of powerful computation, visualization, and collaboration capabilities to enable faster, smarter, data-driven decisions throughout the system life cycle.

Digital models become predominant and central in how programs perform engineering activities (Figure 1). Digital models, developed and maintained with modern modeling languages and tools, are verified, validated, and accredited for their intended use across life cycle activities.

Digital models capture system representations and, together with their underlying data, provide an authoritative source of truth for stakeholders. A digital thread allows connection and interaction among digital models as they extract data for different activities.

SYSTEMS ENGINEERING & ARCHITECTURE

TECHNICAL HIGHLIGHT:

ENGINEERING of DEFENSE SYSTEMS cont'd

❖ MODELS AND SIMULATIONS

Models and simulations are engineering tools used by multiple disciplines (engineering, test, logistics, etc.). A digital model represents an actual or conceptual system that involves physics, mathematics, or logical expressions. A simulation is a method for implementing a model over time.

Models and simulations can predict how the system might perform or survive under various conditions or in a range of environments. The results of models and simulations form a digital record of the activities, phases, and system baseline, providing information for decision making.

❖ FROM MODEL TO DIGITAL TWIN

In digital engineering, models mature and increase in fidelity during the SE process. Early digital models tend to focus on a specific aspect or component of the system. During system development, digital models increase in fidelity and become more integrated into a virtual digital system model. As the system matures through development into production, the virtual digital system model forms the basis for a digital twin (Figure 2).

A digital twin is a dynamic virtual representation of a physical system that is continually updated using data from the real-world operational system.

A digital twin is an integrated set of models (multi-scale, multi-physics) used to simulate performance of a system. The digital twin is a dynamic virtual representation of the physical system, continually updated using data from the real-world operational system.

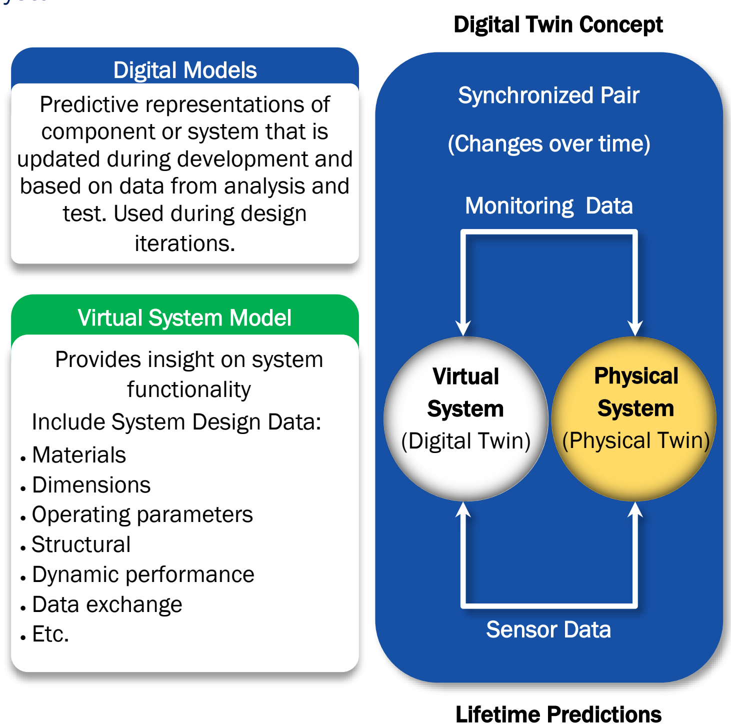

Figure 2. Digital Twin

❖ DATA SHARING

DoD is implementing policies and processes to facilitate data sharing. Data producers are making data accessible for broader consumption while also maintaining data configuration control, security, and quality. Data standards facilitate exchange of technical data in non-proprietary formats, improving interoperability.

❖ RESOURCES

OUSD(R&E) SE&A: https://www.cto.mil

MOSA Community of Practice: https://www.dau.edu/cop/mosa

DEBoK: https://de-bok.org

Email: osd.r-e.comm@mail.mil | Subject: Attn SE&A

Digital engineering enhances engineering efficiency, accuracy, and speed.