NAVWAR

NAVWAR DIGITAL ENGINEERING (DE) STRATEGY

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THE URGENCY TO CHANGE

Digital Engineering addresses two key challenges critical to Naval superiority for the Nation. First, our ability to leverage technology at the pace of change in our methods and practices as well as in the products we provide at speed to the Navy. Second, as a method of managing the complexity associated with interconnectivity of our information and warfighting systems which continue to grow at an exponential rate.

Information Warfare (IW) is a key to success for the Department of Defense. IW mission complexity is growing faster than our ability to manage or address it using traditional engineering methods. IW requires the coordination of traditional warfare areas with the addition of cyber effects to create and close kill chains or disrupt adversaries' kill chains faster than our adversaries can disrupt our kill chains. The majority of our projects deal with interdependent systems that were not envisioned to be connected when they were first designed and built. We experience substantial knowledge and investment losses between projects and at project life cycle phase boundaries. We are also losing valuable time trying to locate and maintain technically accurate and relevant documentation and make it available to the warfighters and policy makers when and where they need it. All this results in significant waste and a reduced ability to deliver and sustain IW solutions that will enable warfighter mission success.

The **Naval Digital Systems Engineering Transformation (DSET) Strategy (2020)** provides the approach the Navy and Marine Corps will pursue to "design, deliver, and sustain increasingly complex system of systems, platforms, sensors, information and weapons that are responsive to rapidly changing operational and threat environments...under increasingly restrictive budgets and aggressive delivery schedules." The Naval DSET strategy serves as the Department of the Navy's (DoN) response to the **DoD Digital Engineering Strategy (2018)**, which focuses on the formalized use of modeling, leveraging an authoritative source of truth, improving our engineering practices, establishing DE-enabling infrastructure and transforming our workforce to adopt DE across the lifecycle.

In an increasingly competitive near-peer environment, Digital Engineering offers a means to outpace and outperform our adversaries with its four-fold focus on people, process, tools and data. This NAVWAR DE Strategy establishes a foundational vision for applying the formalized use of modeling across the spectrum of engineering disciplines in order to increase acquisition speed and agility and drive predictable outcomes for the warfighter. Annual execution plans will be published to establish explicit goals, metrics and priorities to orient and organize enterprise-wide DE implementation.

DIGITAL ENGINEERING DEFINED

Digital Engineering (DE) is an integrated digital approach that uses authoritative sources of system data and models as a continuum across disciplines to support lifecycle activities from concept through disposal. DE focuses on improving technological infrastructure and engineering practices to promote innovation and increase rigor. It requires an evolution toward modern practices, methods, and tools, and its adoption is a pivotal step towards digital transformation.

A key theme of DE is integrated, reusable data that can be leveraged across engineering disciplines, lifecycle stages, and stakeholder groups. This concept is often referred to as the digital thread, which is the use of authoritative data to provide an integrated view of a system throughout its lifecycle.

Figure A: Digital Engineering Wheel

Given the breadth of initiatives currently targeting software improvements, this strategy does not explicitly address software or related disciplines. Instead, this strategy opts to prioritize disciplines seeking to virtualize the real-world in hopes of endowing physical systems with benefits normally afforded to digitally native domains (i.e., rapid experimentation/iteration, continuous feedback, etc…). However, software tools, integrations, and processes are fundamental to this transformation and should be considered when developing execution plans to achieve this Strategy's objectives.

MODEL BASED ENGINEERING (MBE)
Centers around the development and use of models to improve engineering speed, reduce costs, and address mission, business and system complexity.

The **DIGITAL THREAD** ties MBE practices together. A single NAVWAR program may leverage several disciplines across its lifecycle in order to deliver optimal IW capabilities to the warfighter.

* RAM: Reliability, Availability & Maintainability
LVC: Live, Virtual & Constructive

**CAD: Computer-Aided Design
BIM: Building Information Modeling

DIGITAL ENGINEERING (DE)
Encompasses the various MBE disciplines and the connection points and data shared between them.

Though DE is an expansive concept, the NAVWAR DE strategy focuses initially on the various Model Based Engineering (MBE) disciplines and the connection points (data) shared between them.

MBE centers around the development, use, and reuse of models to improve engineering speed, reduce costs, and address mission, business, and system complexity. While there is no single set of discrete MBE disciplines defined across the DoD, this Strategy addresses Mission Engineering, Model Based Systems Engineering (MBSE), Physical Model Based Engineering, Modeling & Simulation, and Model Based Logistics Engineering. The DE "wheel" (Figure A) provides a subjective characterization of MBE and digital threads within the DE space and is intended to illustrate the focal points of the NAVWAR DE Strategy.

In each of the MBE disciplines discussed, NAVWAR seeks to strengthen its engineering capabilities across its practices, workforce, tools/technology and data. However, to gain full benefit from the adoption of DE practices, NAVWAR teams must learn to effectively integrate stakeholders, practices, tools and data across a digital thread. A single NAVWAR program may leverage several MBE disciplines across its system's lifecycle in order to deliver optimal IW capabilities to the warfighter in a streamlined fashion.

Table 1: MBE Disciplines Definitions

Mission Engineering	An interdisciplinary approach spanning the effort to analyze, design, and integrate current and emerging operational needs and capabilities to achieve mission outcomes.
Model Based Systems Engineering (MBSE)	Application of formalized methods and tools to perform engineering activities which create representations of systems within a data-driven environment.
Physical Model Based Engineering (PMBE)	Application of formalized methods and tools to perform activities which create physics-based/physical materials and systems within a data-driven environment. They are of a fidelity which enables deterministic analysis as well as blueprinting for physical system creation and management.
Modeling & Simulation (M&S)	Dynamic use of models, including emulators, prototypes, simulators, and stimulators, to develop data for making decisions.
Model Based Logistics Engineering (MBLE)	Application of digital models across the logistics, sustainment and overall lifecycle stages.

WHERE WE ARE TODAY

Since the DoD DE Strategy was released in 2018, NAVWAR has made significant progress toward adoption of DE practices across all five major MBE disciplines. MBSE adoption, in particular, has increased steadily in recent years with help from targeted MBSE-related initiatives in the areas of tool access, tool adoption, training opportunities, industry certifications, community engagement, innovation pilots, knowledge management, lexicon establishment and model data schema refinement.

Despite advances in the MBSE discipline in recent years, there are several growth opportunities to further MBSE maturation/adoption and even more room to grow in the adoption of other MBE disciplines, as well as in the integration among them. Many NAVWAR teams have been resistant or slow to adopt new engineering practices. Several DE-related communities of practice exist across NAVWAR; however, there is a lack of organized mentoring and access to DE subject matter experts across the various MBE disciplines. DE knowledge bases are lacking (especially outside of the MBSE world) and are inconsistently organized.

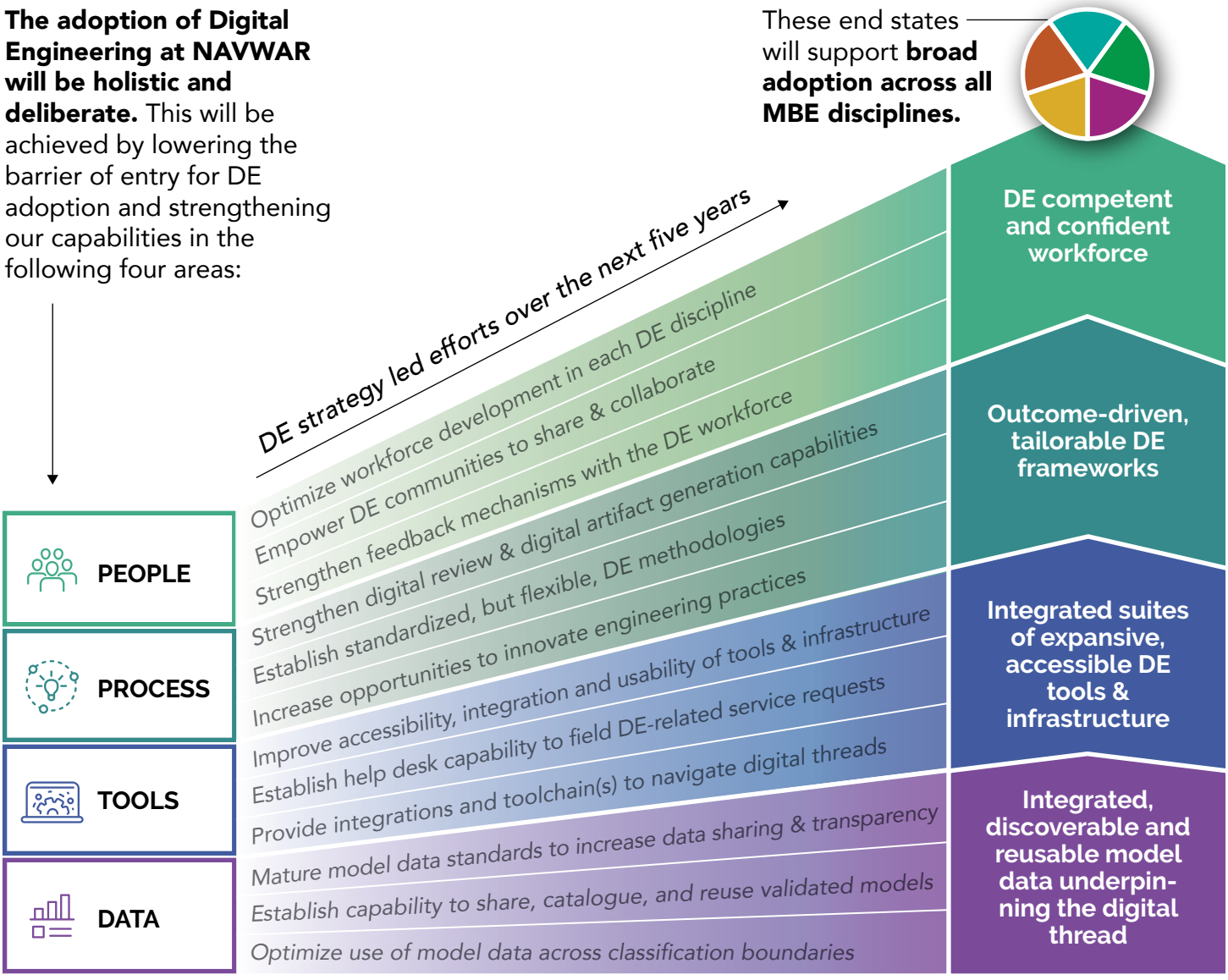
DE-related methodologies are often an afterthought for NAVWAR teams that continue to rely heavily on processes centered on the production of traditional technical documentation. DE-related technical authority roles are ill-defined and there is general lack of DE resources and enterprise standardization guidance.

Although there have been a number of successful digital thread-themed pilot projects, there is largely a lack of integration of model data across DE toolsets. Furthermore, enterprise DE tool access is severely limited outside of MBSE tool access on NIPR and SIPR. Data schemas and data flow across the digital thread are immature and not well prepared for handling model data traversing classification levels effectively and securely.

There is a general lack of model data transparency across NAVWAR and there has yet to be a published model catalog for model reuse across teams. Additionally, there are too many "sources of truth" for NAVWAR technical data, leading to an exorbitant amount of waste and lost opportunity. And although there have been dozens of DE success stories across the NAVWAR enterprise, the organization still lacks a consistent means of capturing and communicating DE return on investment data and success stories.

Figure B: Digital Engineering Transformation

The adoption of Digital Engineering at NAVWAR will be holistic and deliberate. This will be achieved by lowering the barrier of entry for DE adoption and strengthening our capabilities in the following four areas:



WHERE WE WANT TO BE IN FIVE YEARS

> **A single NAVWAR program may leverage several MBE disciplines across its system lifecycle in order to deliver optimal IW capabilities to the warfighter in a streamlined fashion.**

The future of DE at NAVWAR can be characterized in a number of ways spanning various disciplines and perspectives. Most importantly, the adoption of DE at NAVWAR must be holistic and deliberate. In 2028 and beyond, NAVWAR employs a DE workforce that is confident and competent at the appropriate levels of skill for the role(s) assigned. The workforce embraces collaboration and is open to sharing and reusing validated models and model data in a secure fashion. DE subject matter experts provide meaningful feedback into the various DE communities.

In the future, NAVWAR has easily tailorable DE processes/methods that are seamlessly executed across the digital thread. Model data is the center of focus for digital reviews (vice document-based artifacts). DE best practices are readily shared and easily discoverable. Sound and helpful guidance is published for DE tool-data use combinations.

Value is clearly seen across disciplines in the DE world. DE knowledge bases are highly utilized and offer great value. The barrier of entry to the adoption (and continued practice) of DE is minimal. DE-related positions and roles are well understood. ROI/value metrics are consistently captured and communicated to reinforce positive behavior.

A robust DE storefront exists where tools are connected and used intentionally and purposefully. DE tools and infrastructure are treated as services and available at an enterprise level, at and across appropriate classification levels. DE tooling infrastructure is widely accessible, scalable and available.

A limited set of authoritative sources of truth are agreed upon and established for particular sets of technical data. The data within the authoritative sources is well maintained and actively used by program and projects. Model data reuse guidelines are established and followed. Stakeholders embrace data-driven enterprise decision making.

HOW WE PLAN TO GET THERE

In order to get from where we are to where we want to be in the future with DE transformation, we will need to increase our commitment to lowering the barrier of entry for the adoption of DE practices. NAVWAR's ultimate goal is to make the right thing to do the easy thing to do when it comes to engineering.

The DE Transformation (Figure B) graphic provides an overview of the projected lines of effort to transform DE practices from our current state to our future state.

A NOTE ON GOVERNANCE

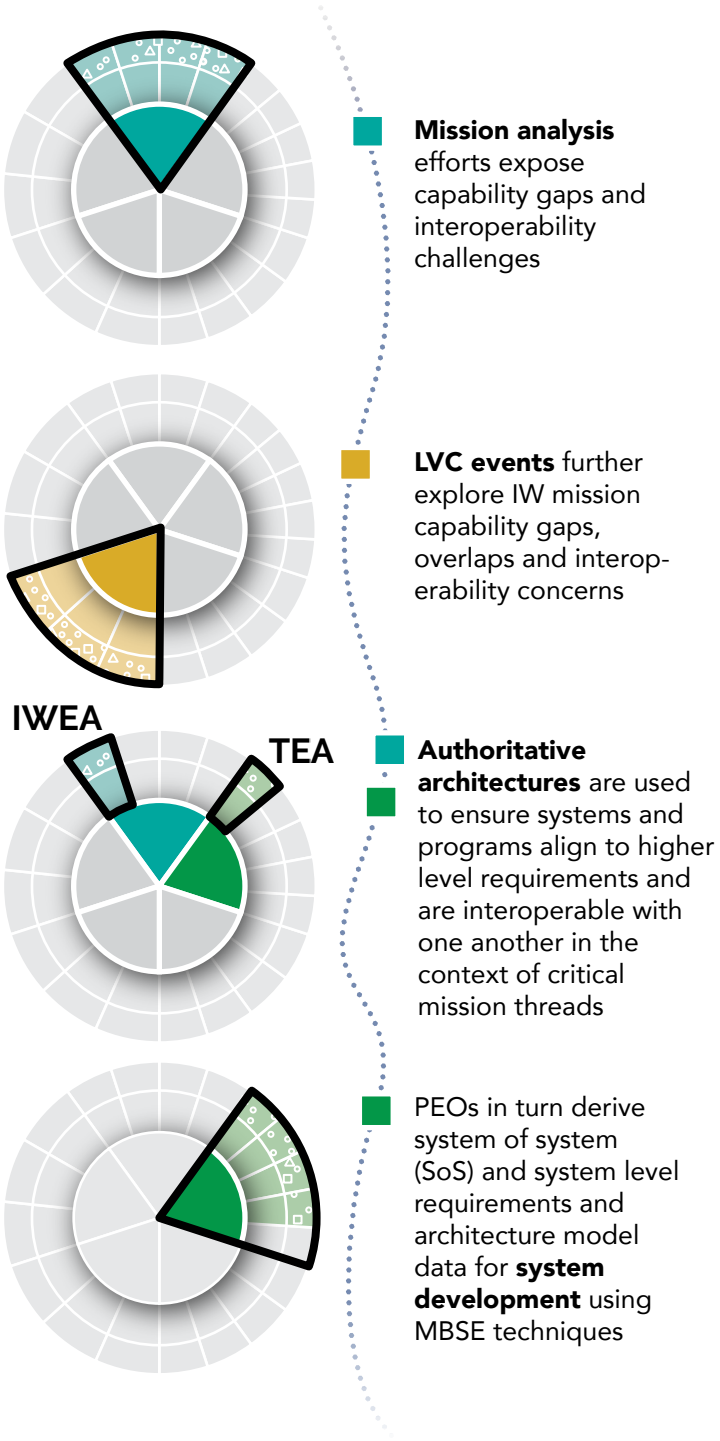
To successfully achieve DE transformation at NAVWAR, we must strike a balance between levying top-down DE governance and allowing individual teams and programs the flexibility to tailor DE practices to maximize value to their efforts. NAVWAR HQ, in partnership with NIWC Atlantic and NIWC Pacific, will develop an annual execution plan that seeks to honor this balance and optimize DE practices throughout the Enterprise.

MISSION-FOCUSED DIGITAL THREAD EXAMPLE

There are countless engineering lifecycle examples that can be explored using DE techniques. One such future state scenario (See Figure C) starts with analyzing critical mission threads using mission engineering and modeling & simulation methods (e.g., mathematical, physics-based and mission-level M&S). If mission analysis identifies gaps and interoperability challenges, then M&S may be used to conduct trade studies and obtain preliminary performance estimates. Performance and interoperability assessments may be refined during LVC events which afford the opportunity to interact with real systems and/or operators. Scenarios developed during mission analysis can inform these LVC events, which may also uncover other gaps or challenges.

Authoritative architectures such as the Target Enterprise Architecture (TEA) and the Information Warfare Enterprise Architecture (IWEA) are used by NAVWAR PEOs to ensure systems and programs align to higher level requirements and are interoperable with one another in the context of these critical mission threads. TEA and IWEA provide enterprise sets of IW-related capability requirements and operational mission thread data to PEOs who, in turn, derive system of system (SoS) and system level requirements and architecture model data for system development using MBSE techniques. Key technology concepts from various reference architectures such as zero trust, unified capabilities, cybersecurity, naval digital platform and automation are integrated with TEA to ensure that PEOs are incorporating future state technologies and warfighter capabilities in a coordinated and optimized manner.

Figure C: Mission-Focused Digital Thread



CALL TO ACTION

Complex problems in the information warfare domain cannot be solved through the use of legacy, document-based practices. It is every NAVWAR employee's responsibility to continually learn and adopt state-of-the-art practices to develop and support the systems our warfighters depend on to execute their critical missions. DE is how we fulfill that responsibility.

So it's time to stop and ask yourself, "Is my team looking for ways to leverage DE to deliver greater value to the warfighter?", and, if not, "why not?". Engage with NAVWAR DE leadership to tailor a roadmap for DE adoption so that your team can start embracing modern engineering practices and making a bigger

impact for our Naval warfighters. Adopting new ways of doing engineering is not trivial and requires our workforce to commit to new methods, tools and even communication (e.g., through modeling languages). This movement towards Digital Engineering is transformational - it will cause big shifts in every aspect of how we do business. We need support from every NAVWARRIOR to succeed! What are you waiting for?

> **This movement towards Digital Engineering is transformational - it will cause big shifts in every aspect of how we do business.**

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