Strategy for an Intelligent Digital Twin (IDT)
(An environment where Information replaces wasted resources)

NIST Model Based Enterprise (MBE) Summit 2019

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Newport News Shipbuilding - Overview

- Largest industrial employer in Virginia, employing about 20,000 people, many of whom are third- and fourth-generation shipbuilders

- Only company capable of designing, building, refueling, overhauling and inactivating nuclear aircraft carriers for U.S. Navy

- One of only two companies capable of designing and building nuclear submarines for U.S. Navy

- Transforming our 130+ year company’s paper-based processes to the Digital Age

- Eliminating drawings and moving towards a Model-Based Enterprise (MBE)

- Adopting technologies like laser scanning, digital twin, mobile computing, and augmented reality
Aircraft Carrier “GERALD R. FORD” the Big Picture

- **Design**
  - ~ 3 Million Piece Parts

- **Purchasing**
  - Over 2,000 Suppliers
  - Over 70,000 Part Numbers

- **Manufacturing**
  - 150,000 Shop Work Packages
  - 50,000 Tons of Fabricated Steel Assemblies

- **Shipboard**
  - Over 50,000 Ship Work Packages
  - 9 Million Feet of Cable
  - 4 Million Feet of Fiber

- **Lifecycle**
  - 50 Year Life
  - Obsolescence Management
  - Continuous Modernization Throughout

- 10+ Year Build Cycle, with a 50 Year Life
- ~ 55,000,000 Man-Hours of Navy Investment
- Virtual Model to support Augmented Reality (AR)

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This presentation will discuss the direct parallels between Newport News Shipbuilding’s (NNS’s) “Product Model Centric Strategy” and the Office of the Under Secretary of Defense for Research and Engineering (USD(R&E)) “Digital Engineering Strategy” (DES).

These NNS and Navy strategies can be related through the five DES foundational elements (listed below, NNS related efforts in BLUE) necessary for a Digital Engineering Ecosystem to thrive:

1. Formalize the development, integration, and use of models to inform enterprise and program decision making (NNS-Strategy for Digital Thread and Digital Twin)
2. Provide an enduring, authoritative source of truth (NNS-Configuration Managed links between Navy Databases and Digital Product Model)
3. Incorporate technological innovation to improve the engineering practice (NNS-Implementation of AR/VR, laser scanning, IOT and other technologies into production processes)
4. Establish a supporting infrastructure and environment to perform activities, collaborate, and communicate across stakeholders (NNS-Integrated, Secure Cloud Environment)
5. Transform the culture and workforce to adopt and support digital engineering across the life cycle (NNS-integrated Digital Shipbuilding (iDS) for digital manufacturing)
Lifecyle Digital Twin: Physical – Virtual Alignment

**Design**

Virtual Ship

- Requirements
- Product Definition
- Customer Approval

**Build**

Physical

- Build schedule & Sequence
- Material & Progress
- Inspection & Test

**Sustain**

Intelligent Digital Twin

- Maintenance & Repair
- Modernization
- Operational State

This is what we are figuring out:

3-D CAD

- Requirements
- Product Definition
- Customer Approval

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IDT “Conceptual View of Benefits”: (Focus on Data Availability)

- A Configuration controlled ship “work gets safer” and there are “less failures”
- With an IDT “Uncertainty of System conditions is minimized”
- An IDT would “Reduced Execution Risks” for Type Commanders with digital functions/capabilities; visual analysis of AWP’s, to “Tell me what’s happening tomorrow, not what my problems are today”
- An IDT would provide Information that is consistent across the organization – replace wasted resources (data mining, data structure, visualization)
- An IDT would provide Operation readiness improvements based on Continuous Maintenance Strategy
- An IDT would provide Operation readiness improvements based on Planned Obsolescence Strategy
- IDT provide a Pathway to cultural change; initial implementation stages are supplemental to current processes
- IDT provides oversite of artificial intelligence (AI) applied to data mining-decision making (simulation proven)
- IDT supports additive manufacturing (AM) for part printing and new design (spare part planning)
- IDT allows Shipbuilder and Navy to change technologies together
Intelligent Digital Twin (IDT) - Use-Cases

Development of IDT Use-Cases based upon:
- Economic Value (identify and improve pain points)
- Data Control (direct access to authoritative source, traceability & validation)
- Minimum Information for the job, what do we have to produce?
- Definition of success; digital integration/automation, safety
- Operation procedures for new digital processes

Operating Benefits: (save time/energy, compress schedules, reduce material costs)
- Strategy for reduction of FORD CLASS maintenance period toward Fleet Battle Group time frame
- Time reductions for ship availability “open & inspect” activities
- Time reductions for ShipAlt activities from sensor based condition monitoring
- Connected Information from Authoritative Sources (CDMD-OA, AIM, and other Government Systems)
- Improved Spare part management
- De-confliction of work (organize work in a space)
- Reduced availability growth work (ship check capturing more information - material condition)

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IDT Identification of Data CM needs based on factors of:

- Reliability; criticality of component / system
- Cost; traceability path complexity
- Ergonomics; safe working environment
- Less failures; functioning of systems

Define On-Board IDT Infrastructure/Application profile early in the development processes:

- Data types, hardware requirements, performance
- COTS, level of configuration, complementary & augmented systems
- Definition of Technical Network & system compliance
- Develop Infrastructure Investment profile
- Plan for System Integration, authoritative source of data, traceability
- Scanning for current configuration will pay off
CVN “Ford Class” Life-Cycle Sustainment Roadmap

**Development & Integration of New MBE Capabilities:**
- Continuous Development through entire Ship Value Stream
- Providing Agility & Responsiveness to make Business Decisions
- Creating a connected Digital Enterprise is providing Real-Time information
- Leveraging the Navy Investments in a Digital Environment
- Providing Agility to Introduce New Technologies
- Developing Data Driven Intelligence

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**Advancing Collaboration**
- Navy Stakeholder Access
- Cultural Change & Training
- Direct Share
- Direct Exchange
- Navy DB Connectivity
- Ship Connectivity
- Smart Ship App’s
- Ship Force Multiplier

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**Managing Security & Information**
- Cloud Services
- DoD Directives
- Multi-Layer Authentication
- CUI
- NNPI
- Advanced C.M.
- Advanced Recognition

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**FORD CLASS – Integrated Collaborative Environment**
- Geometry Attributes
- Compartment Views
- On-Board Environment
- Technical Information
- Digital Field Devices
- Sensor Data & Monitoring
- Operational Dashboards
- Cyber Physics Systems

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**Providing Data Enrichment**
- Data CM & Refresh
- Analytics & Reporting
- Mobility AR/VR
- Piece Part Management
- Data Driven Intelligence
- Artificial Intelligence
- Voice Commands

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**Enhancing Technology Capabilities**
- Digital Backbone
- Data CM & Refresh
- Analytics & Reporting
- Mobility AR/VR
- Piece Part Management
- Data Driven Intelligence
- Artificial Intelligence
- Voice Commands

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CVN “FORD CLASS” Digital Environment - Architecture Vision

FCD-ICE
Ford Class Data – Integrated Collaborative Environment
“Digital Lifecycle Sustainment”

Security  Data Management  Software

Digital Backbone
“Single Pane View” with Data “One Click” Away

Digital Twins

Navy Databases
- ESOMS
- CDMD-OA
- M&SWP
- TDMIS
- AIM
- ATIS

Suppliers

Ford Class Data Environment (FCDE)
NNS

NNS
Public Yards
NAVSEA / NAVY
Tech. Community

In-Service Ships

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Capability Progression Opportunities for a Lifecycle Sustainment Intelligent Digital Twin (IDT)

Current-State Laser Scan Capabilities used for Lifecycle Sustainment
- Ship Check Laser Scan
- 3D Model Development
- Ship Current Configuration
- Clash / Interference Detections
- Reverse Engineering
- Damage Investigations
- Quality / Inspection / Validation Data
- Logistics Data Management (Part Inventory)

Next-Step Capabilities
- Advanced Scan/3D Model Analytics
- Advanced Hybrid Data Mgt.
- Multi-System Information Hub
- Multi-Domain Analysis (AI)
- 3D Part to (AM) Additive Manufacturing

Environment Enrichment
- IRAD
- MANTECH

Future-State Capabilities
- Provision Based Logistics
- Crew Biomechanics Integration
- Front-Running Simulation
- Real-Time (IOT) Ship & Shore Logistics Data
- Closed Loop Data Connectivity
- Predictive Maintenance Planning

Navy’s Virtual Ship
- Intelligent Digital Twin
  - Connectivity
  - Sensing
  - Translating
  - Comparing
  - Assessing
  - Responding
  - Protecting

- Behavioral Model created with Self-Populating Data
- Real-Time Information for Decision Making
- Continuous Maintenance Strategy

• Information Availability Replaces Wasted Resources
• Organization of Core Products
• Economic Value Defined

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NNS has relevant experience implementing digital ship design & build applications, and the evolution of processes from drawing centric to digital model based content. This evolutionary process has required organizational and technical agility.

Critical aspects learned from this transition to a Model Base Enterprise (MBE) are now being applied to the Lifecycle Sustainment Phase of the Shipbuilding Digital Thread.

NNS has planned for this Sustainment evolution by implementation of the initial critical infrastructure objects into our production environment. This environment is capable of meeting the Navy’s basic Lifecycle requirements.

NNS is now in the process of developing and implementing a strategy to provide advanced and innovative practices to the CVN Lifecycle Sustainment environment utilizing SIEMENS and 3rd party applications.

These new practices provide “Structure for Complexity” that allows for effective advancement of Lifecycle Product Model centric capabilities to create an Intelligent Digital Twin.

The topics discussed in this presentation will help provide the basis for successful production process transitioning and alignment with DoD “Digital Engineering Strategy” (DES) initiatives.

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