Newport News Shipbuilding
A Division of Huntington Ingalls Industries

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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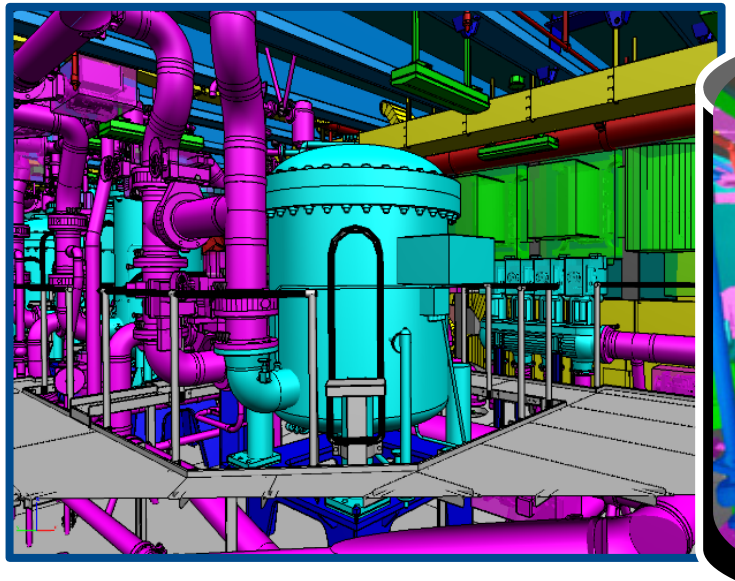
Maintaining Alignment of the Virtual & Physical Ship

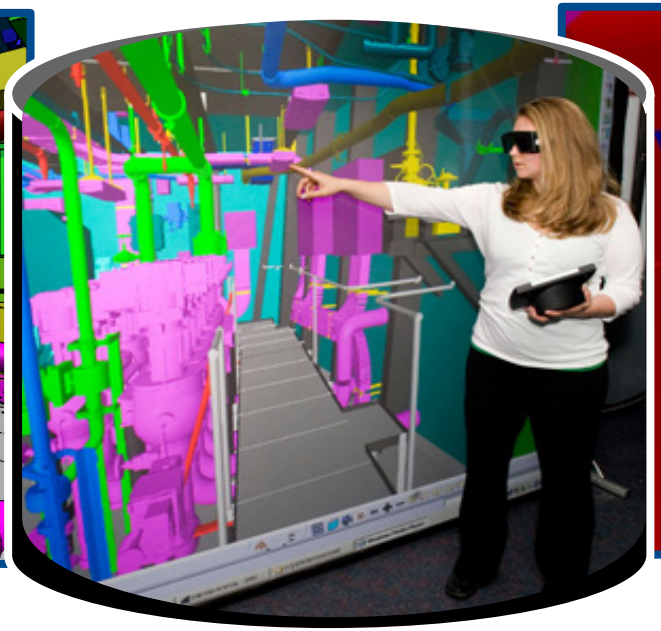
Newport News Shipbuilding - Overview

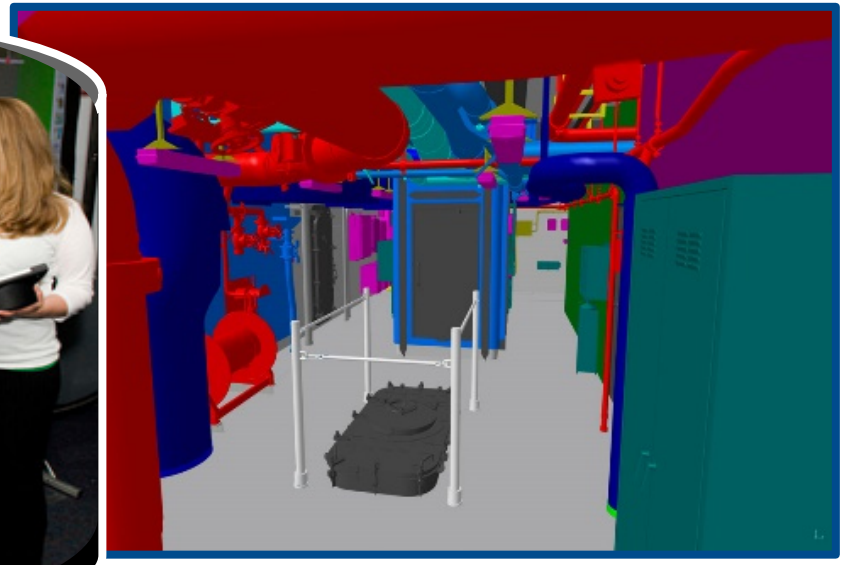
- Largest industrial employer in Virginia, employing about 20,000 people, many of whom are third- and fourth-generation shipbuilders
- Only company capable of designing, building, refueling, overhauling and inactivating nuclear aircraft carriers for U.S. Navy
- One of only two companies capable of designing 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

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







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

Our Challenge is Managing Complexity while implementing Disruptive Technologies.

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

Strategy for an Intelligent Digital Twin – Navy & NNS Objectives Alignment

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).

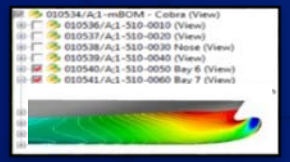
These NNS and Navy strategies can be related through the five DES foundational elements (listed below, NNS related efforts in BLUE) necessary for a Digital Engineering Ecosystem to thrive:

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)

We will align Navy and Shipyard Strategic Goals

Digital Thread

New Design



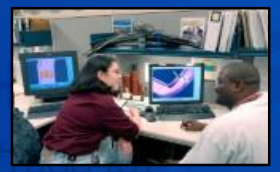
Set Based Design

Arrangement Design

Detail Design

COLUMBIA

Production Planning

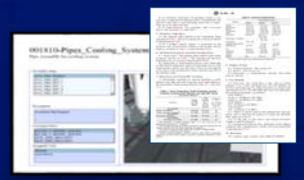


Manufacturing Engineering

CVN80 / 81

Supplier Integration

Information Architecture backbone



Requirements

3D Model

PMI

EBOM

PBOM

PMI

Digital Twin (Ship)

Visual Work Instructions

Digital Twin (Factory)

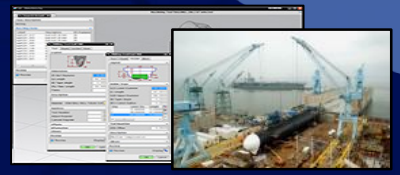
Ship Specifications

Design

Build

Sustain

Maintenance, Modernization & Repair



Execution Work Documents

Availability Planning

Provisioning & Technical Manuals/Documents

Requirements Validation

Close-Out Work Certification

Fabrication, Assembly

Test & Inspection

Ship Delivery

In-Service Operations

"Ship"

"Shore"

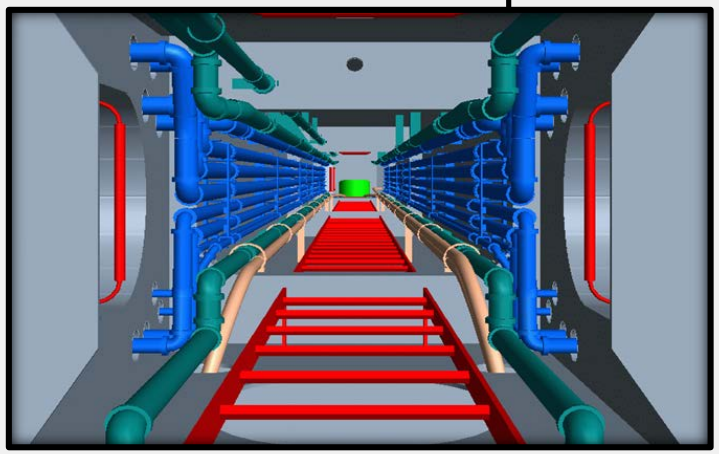
We are Here:
Fleet Sustainment
Lead Yard Services

Lifecycle Digital Twin: Physical – Virtual Alignment

(Create Data)

Design

Virtual Ship



3-D CAD

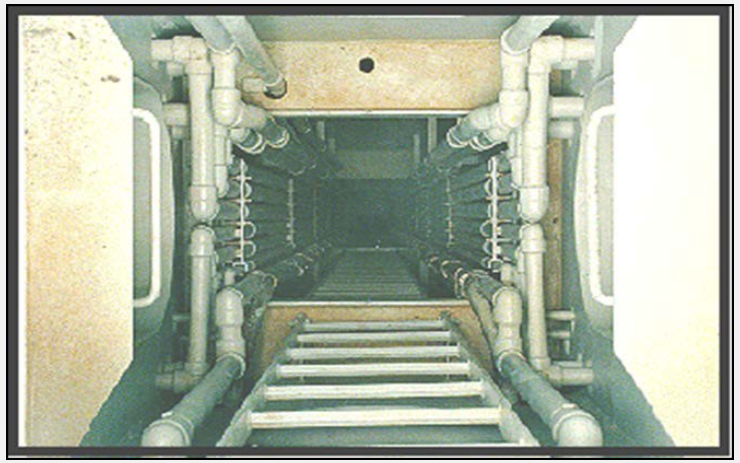
- Requirements
- Product Definition
- Customer Approval

Manufacturing & Assembly

(Consume Data)

Build

Physical



Ship Photo

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

Delivery

This is what we are figuring out:

(Leverage/Maintain Data)

Sustain

Intelligent Digital Twin

- Maintenance & Repair
- Modernization
- Operational State

Lifecycle

Intelligent Digital Twin (IDT) – Focus on Improving Data Availability

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

IDT Information Availability replaces Wasted Resources & Reduces Operational Costs

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 authoritive 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)

Intelligent Digital Twin (IDT) – CM & Data Profile

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

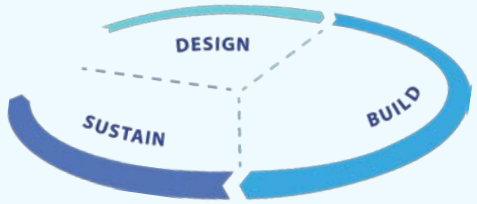
Define On-Board IDT Infrastructure/Application profile early in the development processes:

- 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, authoritive 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



Advancing Collaboration

Navy Stakeholder Access | Cultural Change & Training | Direct Share | Direct Exchange | Navy DB Connectivity | Ship Connectivity | Smart Ship App's | Ship Force Multiplier

Managing Security & Information

Cloud Services | DoD Directives | Multi-Layer Authentication | CUI | NNPI | Advanced C.M. | Advanced Recognition

FORD CLASS – Integrated Collaborative Environment

Continuous Improvement

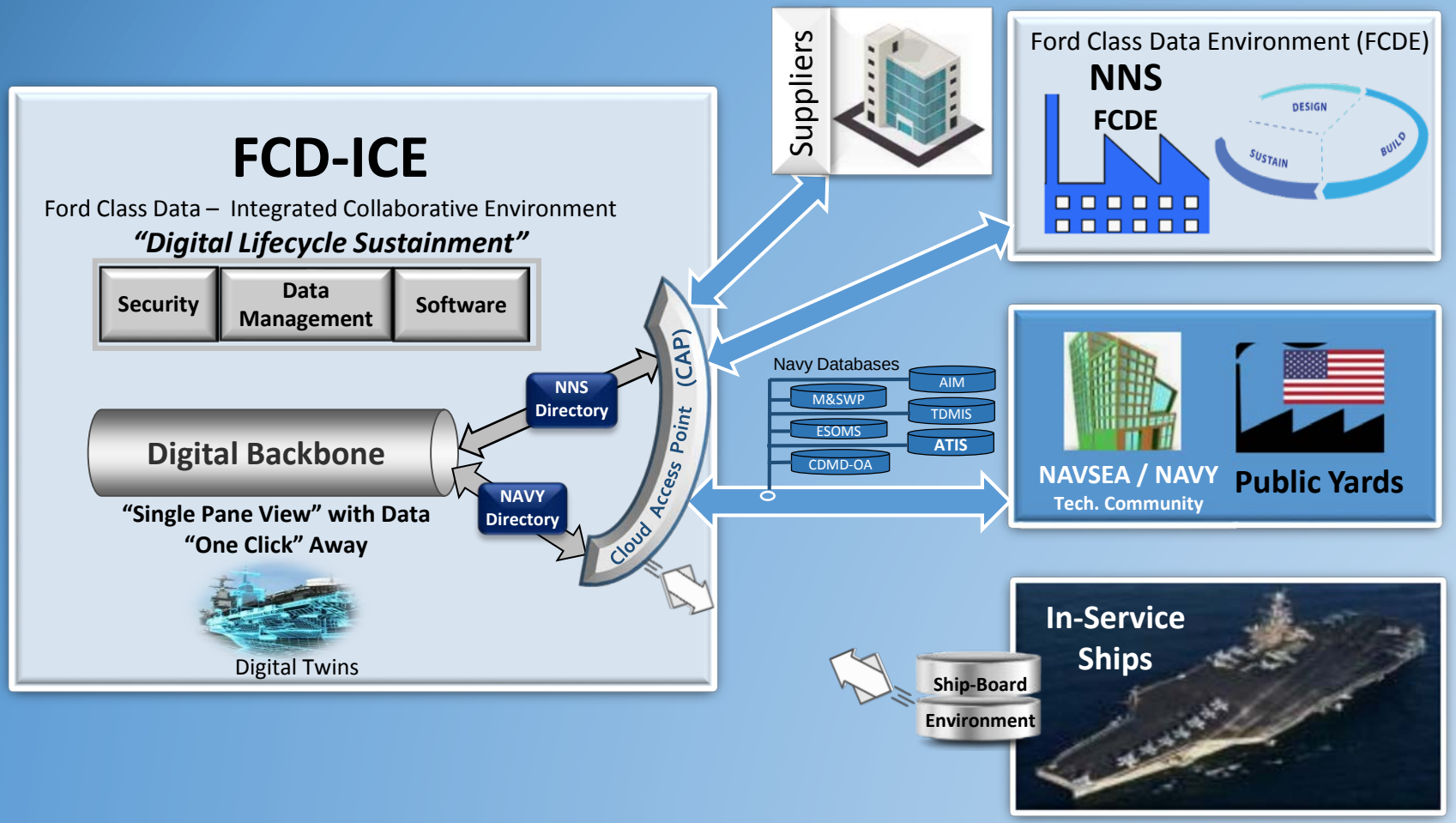
Providing Data Enrichment

Geometry Attributes | Compartment Views | On-Board Environment | Technical Information | Digital Field Devices | Sensor Data & Monitoring | Operational Dashboards | Cyber Physics Systems

Enhancing Technology Capabilities

Digital Backbone | Data CM & Refresh | Analytics & Reporting | Mobility AR/VR | Piece Part Management | Data Driven Intelligence | Artificial Intelligence | Voice Commands

CVN "FORD CLASS" Digital Environment - Architecture Vision



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)

- Baseline Processes Developed
- Visualization Capabilities Enabled

Environment Enrichment

NSRP

IRAD

MANTECH

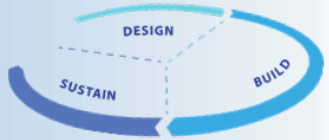
Next-Step Capabilities

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

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

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

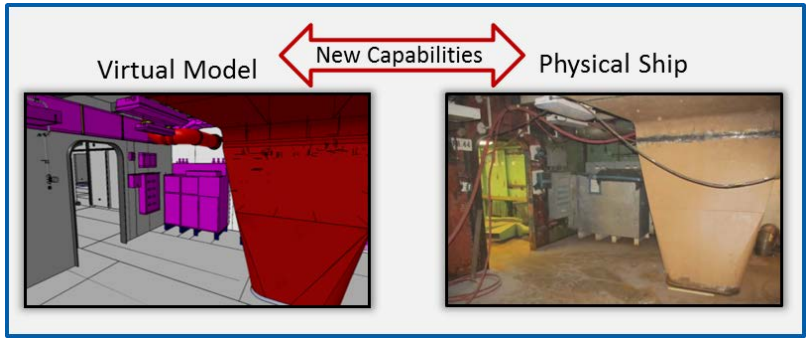
- Connectivity
- Sensing
- Translating
- Comparing
- Assessing
- Responding
- Protecting

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

Strategy for an Intelligent Digital Twin - Summary

- 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.

Digital Twin Alignment



Thank You!

Discussion…

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