Newport News Shipbuilding
A Division of Huntington Ingalls Industries

Shipyard Experience with Advanced Construction Approaches for Naval Nuclear Ships

MIT Topical Workshop

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Newport News Shipbuilding (NNS)

- Founded in 1886, Headquartered in Newport News Virginia
- Facilities span more than 550 acres along 2 miles of waterfront on the James River
- Largest industrial employer in Virginia, employing nearly 21,000 people
- Has served the nuclear industry since the 1950s

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Newport News Shipbuilding (NNS)

- Sole builder and refueler of U.S. Navy aircraft carriers, the world's largest warships
- One of two builders constructing nuclear-powered submarines
- Home of the Western Hemisphere's largest dry dock and crane
- Largest non-governmental provider of fleet maintenance services to the Navy
- Has safely and securely managed the nuclear fuel for 270 reactor cores and has removed the spent nuclear fuel from over 90 reactors
- Supply Chain – Vendors from 49 states

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NNS Manages Two Distinct Modular Construction Programs

- Submarines
  - Historically, ships were built on inclined shipways and launched via sliding down the incline into the water. All construction activities had to account for the degree of inclination.
  - During construction of LOS ANGELES-class, construction evolved towards modular construction using ring modules in a level facility. Extensive internal outfitting was still required.
  - Construction of VIRGINIA-class has used more extensive pre-outfitting of ring modules and use of skid-mounted subassemblies

- Aircraft Carriers
  - Historically, keels were laid and frames constructed. Construction basically went from the bottom upwards, laying in decks and major components as construction went upward.
  - During construction of NIMITZ-class, construction evolved towards building large pre-fabricated sections to minimize the numbers of crane lifts.
  - Construction of FORD-class utilizes more extensive pre-outfitting of sections

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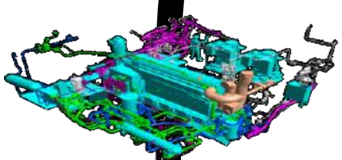
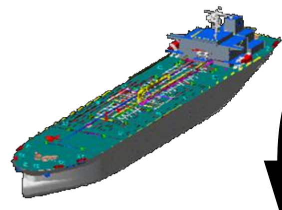
Evolved to an Integrated "Design/Build" Culture

Los Angeles Class Submarines- *Back-loaded portions of the existing design to develop modular construction concepts*



Seawolf Class Submarines- *New ship design developed within 100% electronic environment. Construction plan integrated into multi-discipline construction drawings*



Commercial Tankers - *Refined product modeling process for new design. Emphasis on steel fabrication automation and pre-outfitting of the ship units. Accuracy control established. Valuable lessons learned in designing for manufacturing and construction*

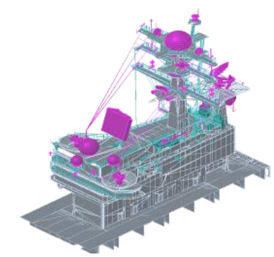
1980 *1990* *2000* *2015*

CVN 76 - *Applied lessons learned in past programs to CVN76 Island Design Gallery Deck Ops Area, and modulized 2nd Platform Piping banks allowing for additional pre-outfitting in these areas of change*

CVN 69/70 –*Reused CVN 76 Gallery Deck Ops area design to support CVN 69 overhaul*

CVN 77 - *Incorporated the improved JP-5 System, Vacuum Collection MSD system into ship allowing for additional pre-outfitting in these areas, especially in Double-bottom tanks*

CVN 79



CVN 78 Class – ***Developing full product model in an integrated, single digital data-centric environment utilizing 20+ years product modeling design experience.***

- Product Model is an Enabler to Implement the Design Build Process
- Over 30 Years of Step Process Improvements Across 7 Programs

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Historical Perspective: 1-3-8

- A task that takes 1 hour in a shop environment
- Will take 3 hours in an assembly / outfitting area
- Will take 8 hours in-hull during final fabrication

Due to factors such as access, services, ergonomics

1-3-8: One of the Initial drivers towards increased modular construction

May not translate from shipyard experience to commercial nuclear plant construction

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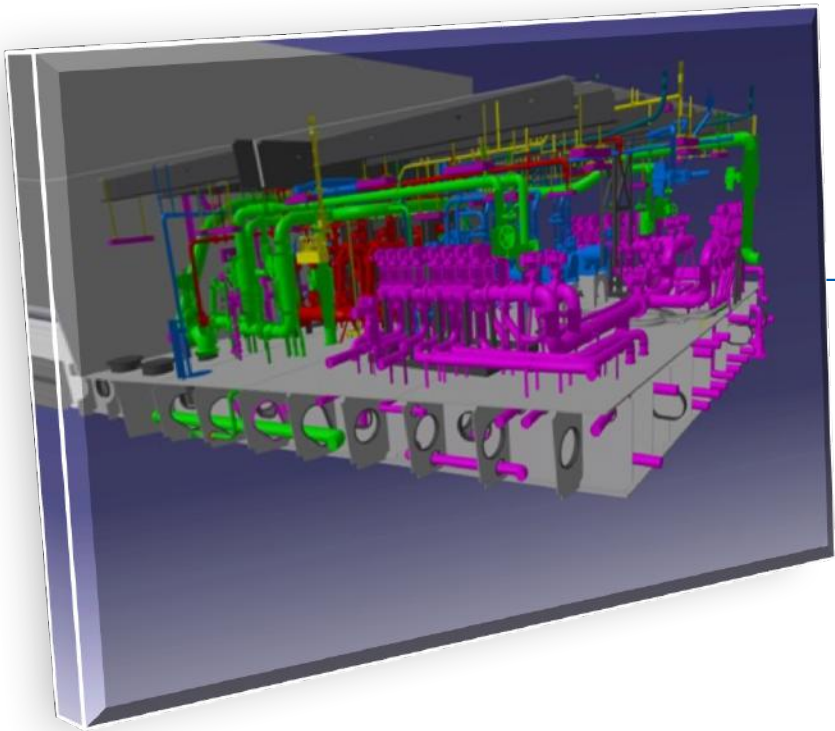
Maximization of Modular Construction Benefit via 3D Product Model

Electronic Products…



Physical Products

"Like putting Legos together..."

Design, Build and Product Support in a Single Environment

Postured for Alignment with Laser Scanning, Augmented Reality & Paperless Engineering Products

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Program Continues to Evolve, Rapidly

- Cost Reductions within Current Ship Design for Each Hull
  - Reduce numbers of lifts
  - Increase pre-assembly of complex assemblies
  - Increase digital laser match-marking ("Intelligent Marking")
  - Increase pre-outfitting
  - Supply chain improvements
  - Test program improvements
- Cost Reductions Requiring Design Changes
  - Redesign of superlifts / complex assemblies
  - Component rafting
- Facility Modifications Specific to Improving Advanced Construction
- Equipment Upgrades
  - Dimension & Coordinate Measuring
  - Cranes
  - Welding
- Training

From the FORD to the KENNEDY, 30% less work is being done on the ship and 20% has moved to the shops

One superlift on the Kennedy will combine 19 individual sections on the FORD

- Incorporation of Modeling & Simulation techniques with design

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Next Steps

- Integrated Digital Shipbuilding
  - Paperless
    - Goal is to be fully paperless for CVN 80
  - Model Based Manufacturing & Visual Build Management
  - Visual Work Instructions using Augmented Reality
- Manufacturing / Supply Chain Upgrades
  - Additive Manufacturing – moving from rapid prototyping for design validation and shipyard tooling to actual production items
- Continued Internal and Collaborative R&D

http://nns.huntingtoningalls.com

http://www.thefordclass.com/build/index.html

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VIRGINIA-Class Submarine Modular Construction

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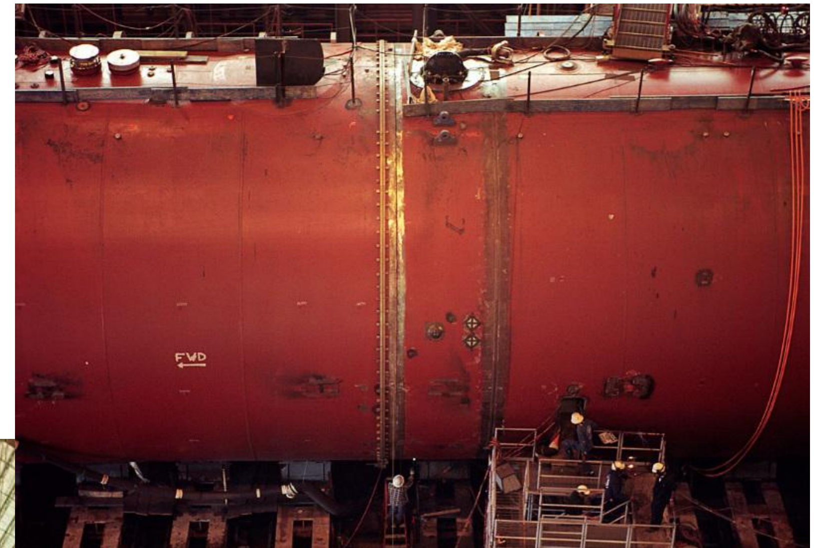
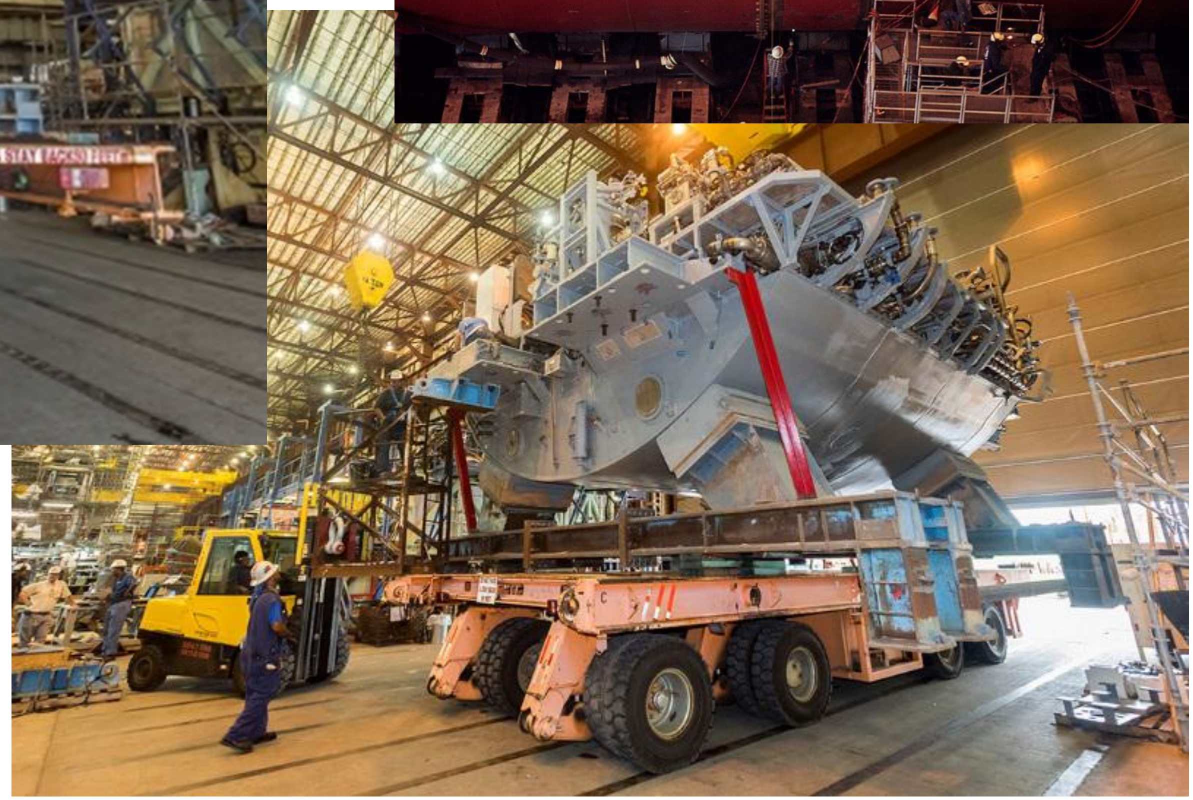
VIRGINIA – Class Submarine, Modular Construction





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JOHN F. KENNEDY (CVN79) Construction, October 2016

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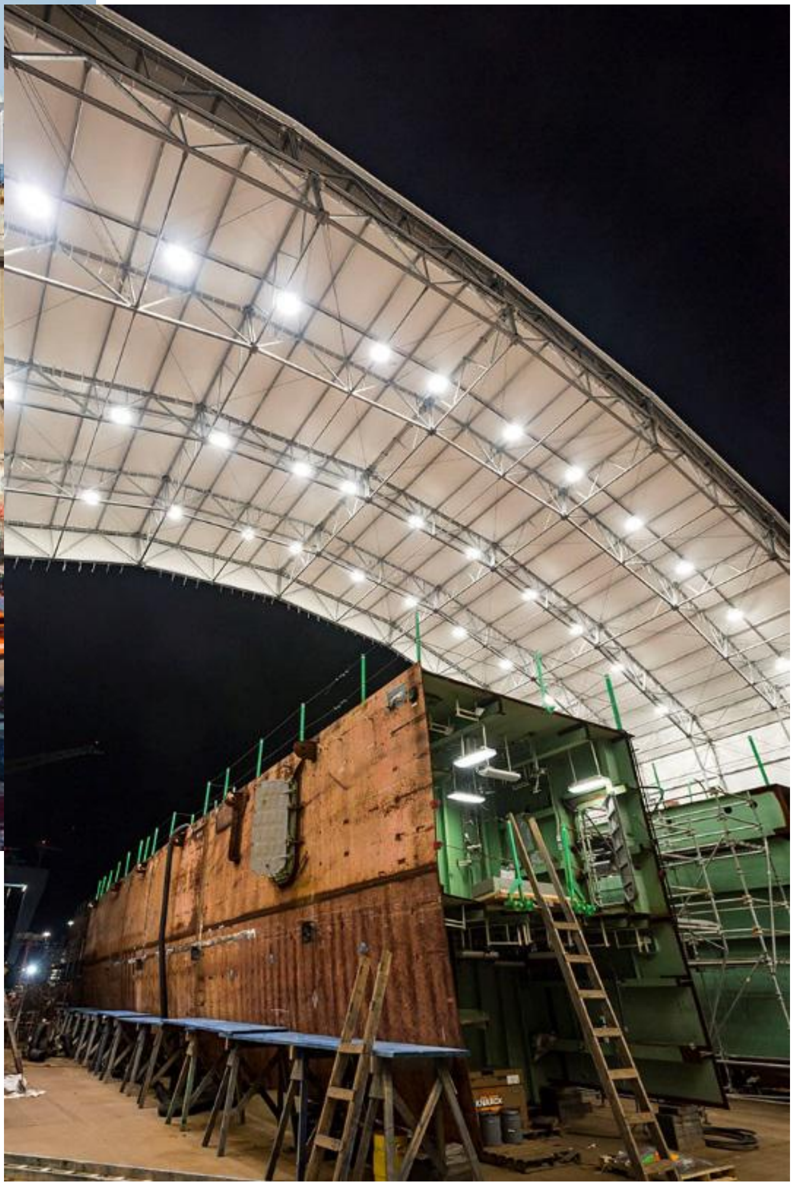
JOHN F. KENNEDY (CVN79) Modular Construction



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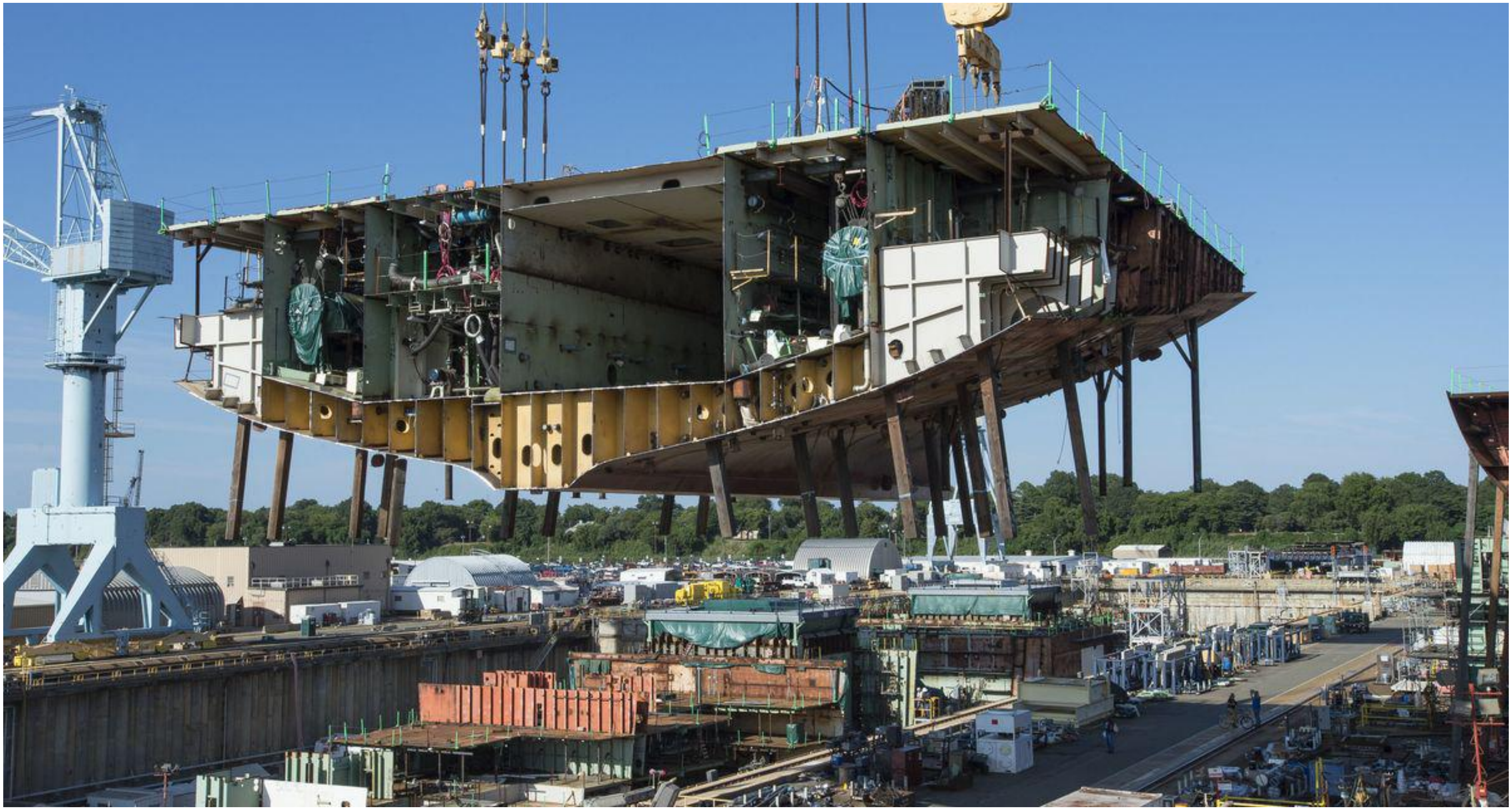
JOHN F. KENNEDY (CVN79) Modular Construction



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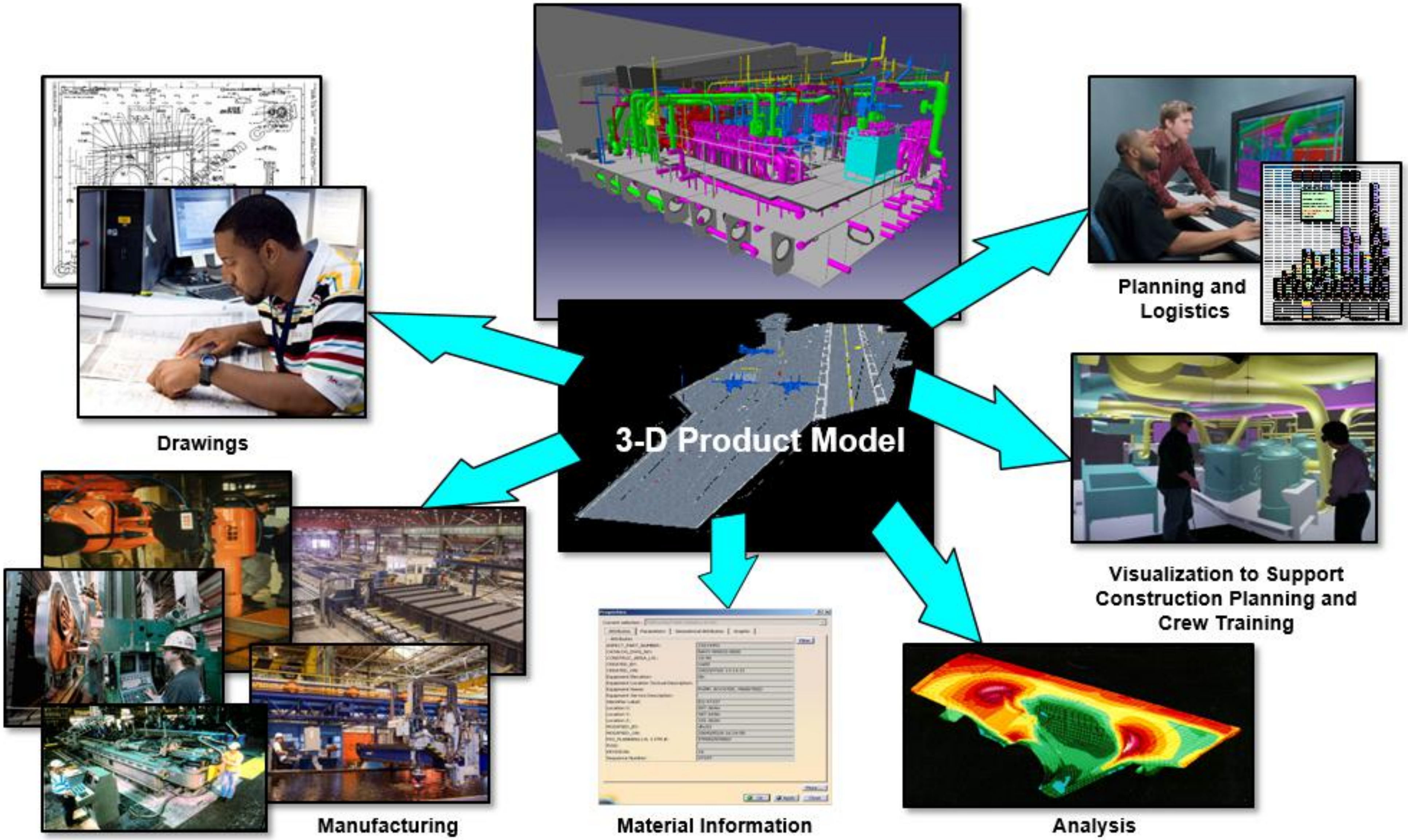
Integration of 3-D Product Model is Crucial



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Some Realities Must Be Addressed

- Component changes may impact the space envelope around them in a “ripple effect,” sometimes into the next ship compartment. Use of 3-D visualization supports “fact of life” impact reviews of component changes.
  - Component changes over the life of the ship
  - Changes from hull to hull
- The changes in environment must be addressed. For example, metal growth due to higher temperatures. A unit built to exact dimensions in a cool shop environment in the winter may not match up perfectly out in the drydock in the summer heat.
- Numerous lessons-learned in the areas of joining. In addition to error margin regarding pipe stub ends and cable splicing, the optimum location of the final joint must be considered. For example, from a logistics & schedule standpoint, it may be better to move the pipe joints away from the area of the ring weld (submarine) or structural welds (carrier).
- Ultimate end-of-life disposition / final disposal considerations must be integrated into 3-D Product Model. Pre-characterization of waste should start during design work.

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Maximized Benefit Requires Commitment to Facility Upgrades

Presently

Labor Intensive

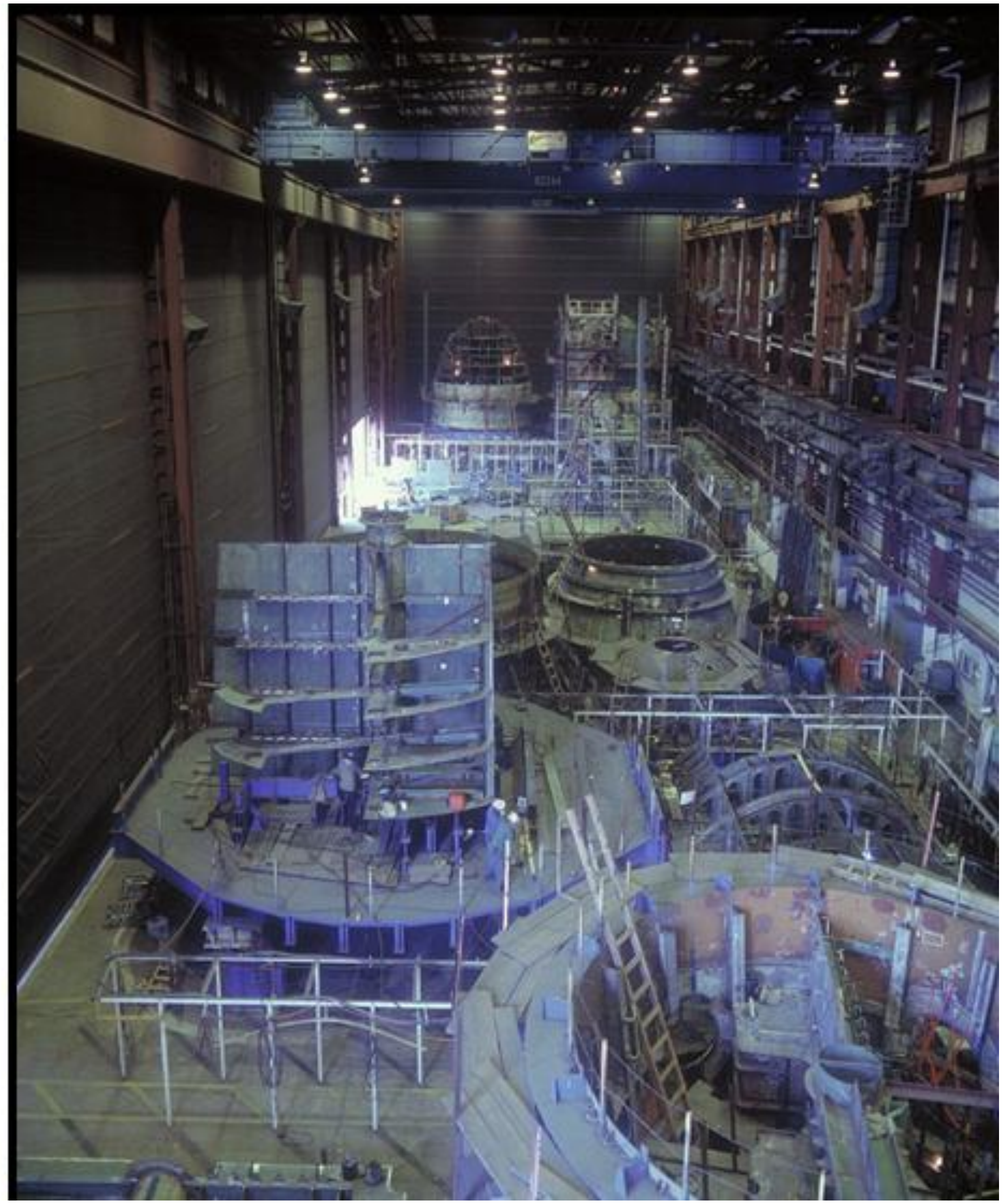
Multiple Welding Positions

Multiple Jigs and Fixtures

Automated Advanced Fixturing

- Flat welds
- Increased quality
- Reduced welder requirements
- Reduction in accidents
- Reduction in injuries

Performance Enhancements



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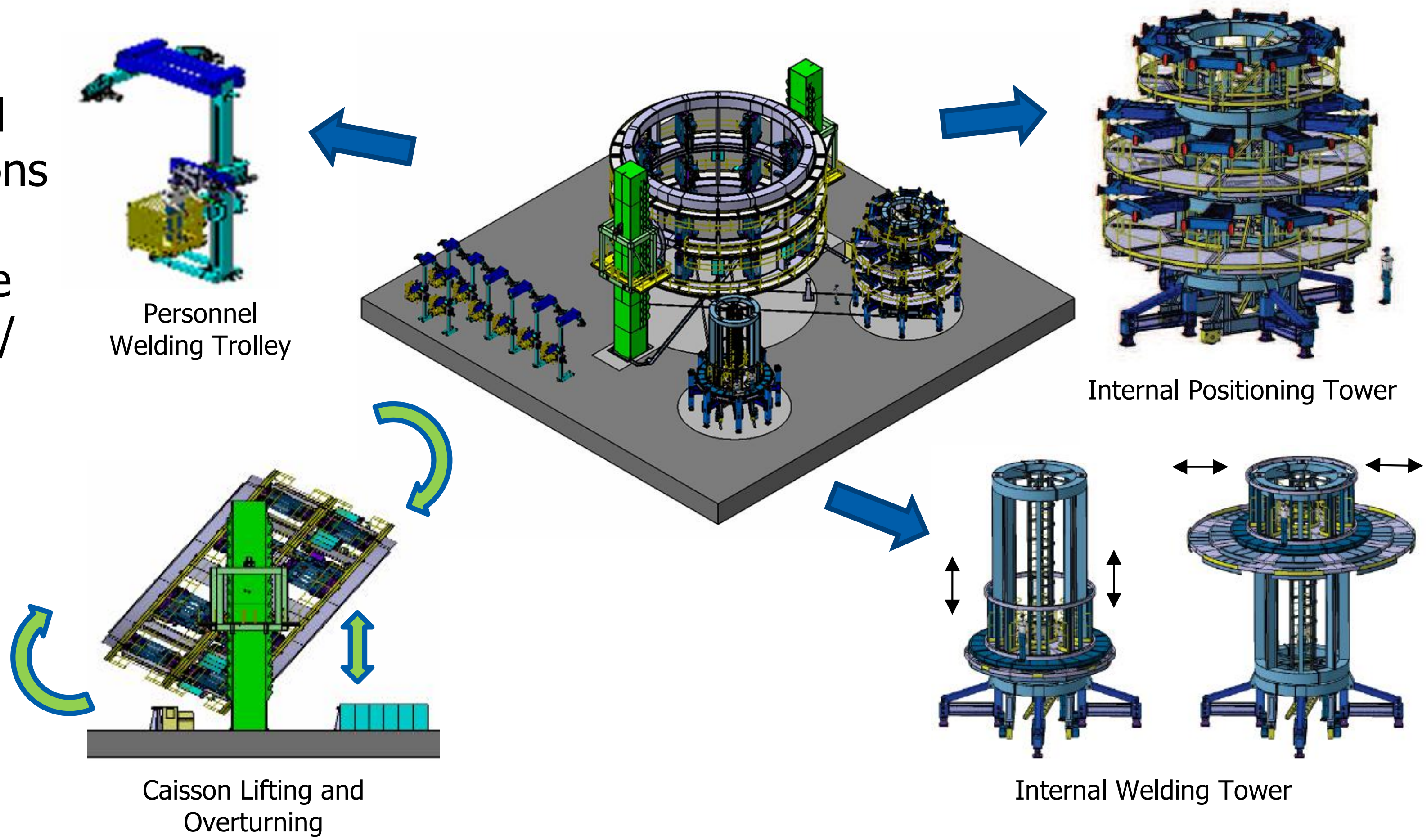
Automated Advanced Fixturing for Heavy Steel Production

Innovative Solutions Increasing Efficiency

- ✓ Reduction of Labor Intensive Processes
- ✓ Safety, Cost and Schedule Benefits
- ✓ Increasing 1st Time Quality
- ✓ Reduce Services and Support

- Customized Fixturing and Mechanizations
- Multiple Plate Geometries / Shapes and Thicknesses
- Integrates Mechanized Processes



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Joint Manufacturing Assembly Facility (JMAF) – Construction is in Progress

Includes spaces for:

- CVN unit outfitting
- VCS & ORP construction and outfitting
- Blast & coat capability

Five phases of construction planned
Estimated completion date of the final phases: early 2023

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Integration of Quality Assurance Requires Modernization of Techniques

Investing in Advanced Dimensional Control Hardware, Software, Training

- Laser Trackers
- Total Stations
- Digital Photogrammetry
- Portable CMM (Coordinate Measuring Machine)
- Small and Large Volume Scanners
- Traditional Optics
- SpatialAnalyzer ® Metrology Software
- Incorporation of data cloud techniques, including intelligent & colorized cloud data

Advantages of 3-D Metrology

- Computer Aided Manufacturing
  - Enables manufacturing in the absence of the component on site
  - Structural precut package
  - Early inspection of parts streamlines installation process
  - Enables early detection of potential issues
- Reduction in Man Hours
  - Utilize the as-built data for machining and assembly operations
  - Early part or assembly inspection reduces re-work
- Reduction in Materials Cost
  - The technology enables the customer to reduce needed fixtures.
  - Inspection of As-built data to 3D Design
  - Reduce material replacement

Modular Construction Requires Emphasis on Dimensional Control

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Integration of Updated Techniques

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Updated Techniques Ubiquitous Through-out Yard, both In-Shop and In-Hull

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Integrated Testing and "Build-to-Test" Strategy

- Establishing key events and test schedule early in program development will more logically guide the procurement and construction sequence
- Test program impact to overall schedule can be significantly reduced by integrating it properly with the construction sequence
- Modular strategies applied to the conventional build will compress the schedule
  - Construction is driven to **completion of testable sections**
  - Component and system testing is commenced as soon as isolable portions are completed
- VCS – 40% reduction in schedule over 6 years/4 ships

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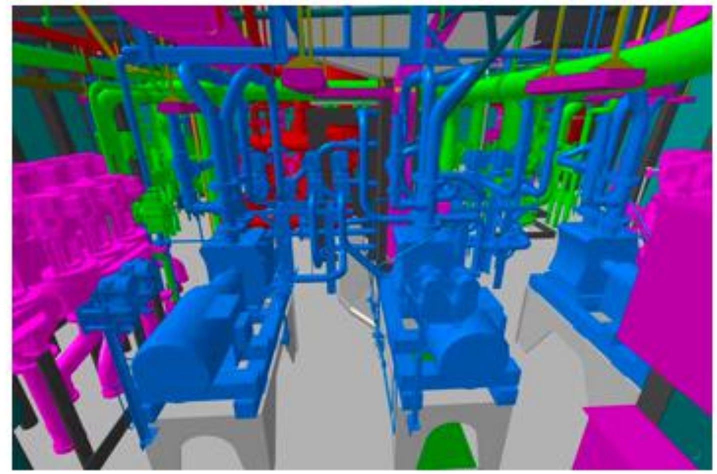
Benefits of “Build-to-Test” Strategy

1 hr shop test

3 hr module test



8 hr integrated system test

Our experience with modular construction shows that a test that would take one hour in a shop, will take 3 hours in a module/test section application, and take 8 hours in a fully installed application

Simplifies critical path for compartment turnover

Requires full integration with Schedule and Work Control Process

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Final Thoughts

1. We're still evolving the modular construction concept and adapting new technologies & equipment

2. Integration of 3-D Product Model to schedule, work control, and management of the supply chain is crucial

3. Implementation of advanced construction techniques requires a commitment to upgrading training at all levels

4. Planning is driven towards completing and testing of discrete modules / sections of the ship ("units"), as opposed to building a shell and then running systems through the spaces and testing the completed system

5. Degree of modularity may be limited due to factors involving transport or on-site capabilities. This needs to be accounted for in the final 3-D Product Model
   1. Address during EPC adaptation of Final Design from the Certified Design
   2. Address module transport paths through construction area

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Questions?

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Backup Slides

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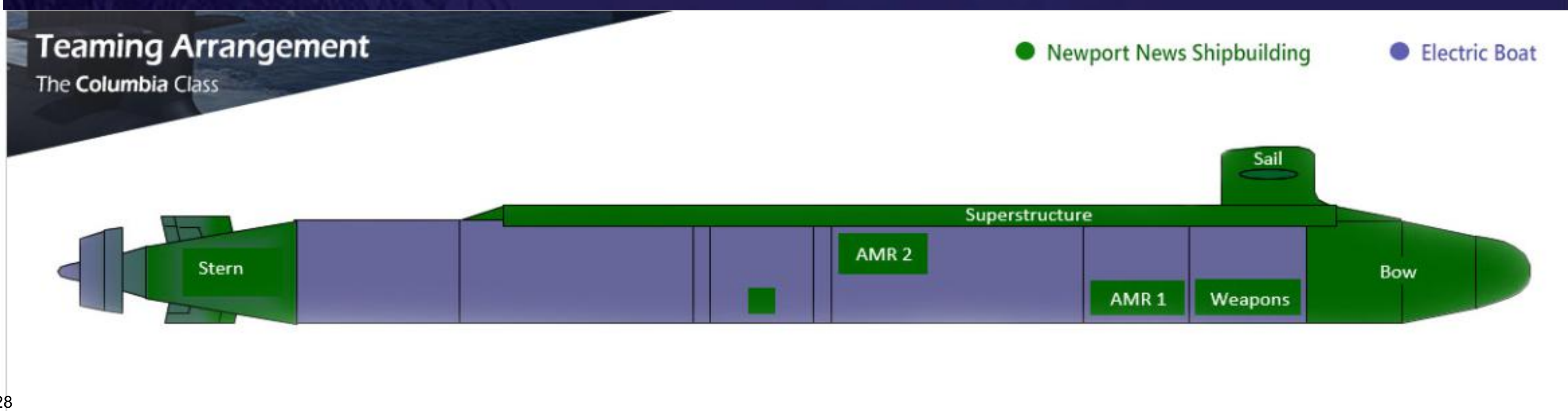
Teaming Approach for Submarine Construction

NEWPORT NEWS SHIPBUILDING is teamed with **GENERAL DYNAMIC ELECTRIC BOAT** to build *Virginia*-class submarines. Newport News Shipbuilding builds the stern, habitability & machinery spaces, torpedo room, sail and bow. Electric Boat builds the pressure hull, engine room and control room. Newport News Shipbuilding and Electric Boat each perform work on the reactor plant as well as alternate on the final assembly, test, outfit and delivery.



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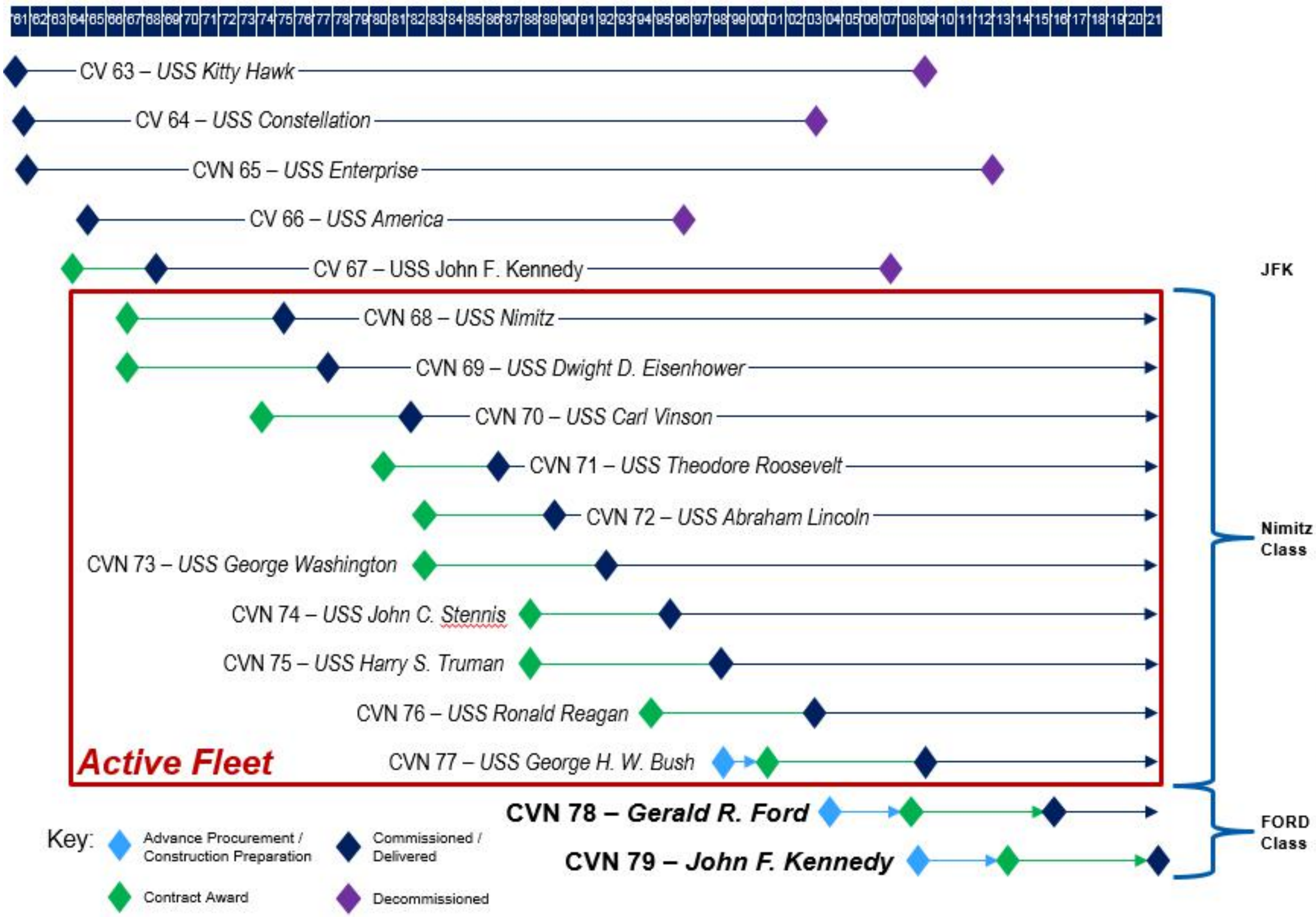
US Aircraft Carrier Fleet



CVN 80 will be the *USS ENTERPRISE*

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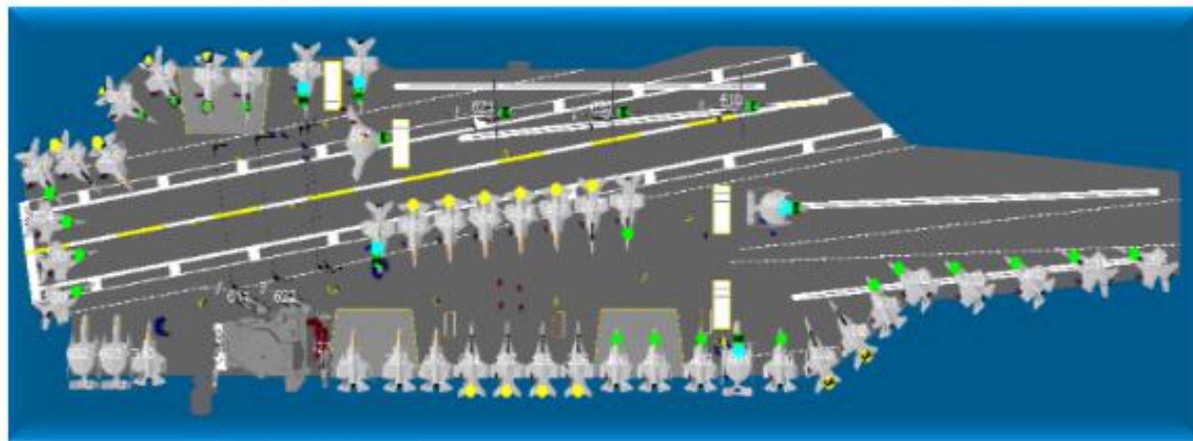
Comprehensive Capabilities – Simulation, Testing, Training…

Allows proof-of-concept before engaging in expensive builds…

- Visualization
- Time Motion Study
- Capacity Planning
- Removal and Maintenance Proof of Concept
- Dynamic Simulations for System Analysis



FORD Class design changes from NIMITZ Class managed through the 3D Product Model included;

- 3 vs. 4 Aircraft Elevators
- Island House relocated further aft
- Increased sortie rate, impacting flight deck and Hangar Bay arrangements and moving of aircraft
- EMALS vs. Steam Catapults
- Conglomerate Galley, improving crew movement

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- **Bridges the gap between university research and industry**
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