NAVSEA
WARFARE CENTERS
Carderock Division

CURRENT ENGINEERING for REDUCED MAINTENANCE FLEET COMPOSITE APPLICATIONS

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Technical Issues

Topside Applications:

- Over 50% of shipboard labor is dedicated to maintenance
- Major part of maintenance is corrosion control
  - DoD invests $15B / year in corrosion control
- The weather decks are well known to be the worst corrosion environment
  - Common use of cadmium plated and poorly painted carbon steel
    - OSD Directive to reduce/eliminate use of cadmium
  - Common use of anodized aluminum
    - Passive coating is easily damaged
- Application of noble alloys are not always ideal due to galvanic couples

Technical Issues

Topside Applications (continued):

- High solids and edge retaining paints are not in wide use
  - Widest use inboard
- Composites have to be fire hardened in and around flight OPS and ventilation areas
  - Consideration toward V-22 & JSH
- Powder coats are not the panacea!
  - Not all equal
- Composites are not the panacea!
  - Sensitive to application
  - Not to be installed like metallic components (black aluminum)

Technical Issues

Waterborne Applications:

- Designs for hull and propulsion equipment that need to extend service life to meet 12 year dry docking goal
- Designs for hull and propulsion equipment that lend to waterborne or pier side maintenance
- Hull features that support diver activities such as:
  - "Disappearing" rigging hard points
  - Portable or removable equipment by common hand tools
  - Noble fasteners with locking elements to prevent in-service loss but are diver workable (costly)
  - Light weight for diver rigging & handling
  - Noncorrosive
- Simple inspection accesses

Composite Applications

Current Applications:

- Deck Grating (CVN & LSD)
- Vent Screens and Louvers (CVN, L-ships and DDG classes)
- Composite Running Gear Fairings
- Stern Gate Control Panel (LSD)
- Composite IC and Electrical Systems Enclosures
- Composite Stanchion (CVN ACE, radar platforms & sponsons)
- Composite Shaft Cover (MIL-PRF-2199)
- Composite LED Lighting Enclosures (proposed SYM 92)
- Composite Twisted Rudder (Developed for DDG51 class)

Level of Deployment

Composite Deck Grating

Installed Composite Deck Grating

LSD Wing Wall

CVN Catwalk

Benefits

- 45% weight by reduction on CVN class catwalk (14 ton reduction)
- ~40,000 sq. ft. installed on CVN & LSD class

Objective

- Qualify COTS composites that can be implemented to replace high PMS deck grating
- Develop low cost fire resistant composite solutions for reduced maintenance

Payoff

- Fire hardened pultruded decking qualified for high traffic areas (Grade-B shock)
- Developed installation procedures and design guidance drawings for institutionalization of product
- Molded product qualified for radar platforms

Composite Vent Screens and Louvers

Corrosion Before

Objective

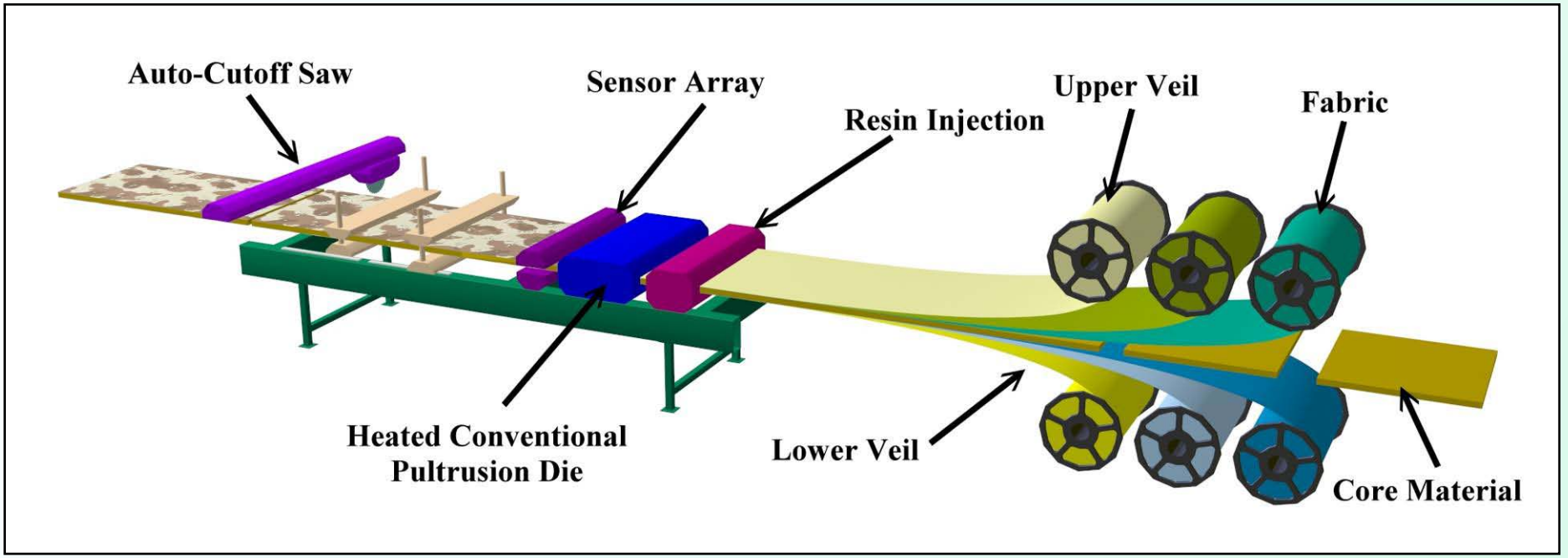
- Replace high maintenance metallic equipment
- Develop fire resistant, low smoke, nontoxic combustion out-gassing solutions for reduced maintenance

Composite Vent Screens and Louvers Installed

Payoff

- Fire hardened composite materials developed.
- No corrosion products and no galvanic couples
- Uncounted square footage installed on CVN, L-ships and DDG classes

Composite Stanchion Pultrusion Manufacturing Overview



- **Pultrusion of large and unusual structures is a unique capability**
- **Virtually hands-off composite manufacturing automation**
  - **Labor and tooling become negligible fraction of material cost**
- **KaZaK focus - engineering intensive, high value added, complex materials and/or large / unusual pultruded structures**

Composite Deck Stanchions

USS Nimitz Installation Jan 2007

Damage Resistant CVN retractable stanchions for elevator platforms

Benefits

- 15% reduction in acquisition cost
- 50% reduction in maintenance cost
- Enables elastic deformation of structure under extreme structural loading

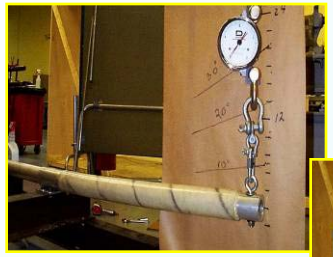
Objective

- Develop and qualify a non-metallic stanchion for use on CVN elevator, radar platform, sponsons, & MOB causeway which is lighter & portable

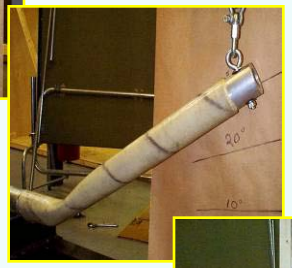
Payoff

- Fire hardened composite materials developed.
- No corrosion products and no galvanic couples

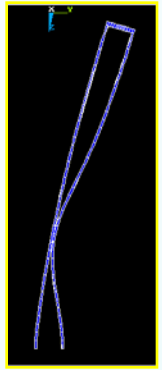
CVN Damage-Resistant Pultruded Stanchions

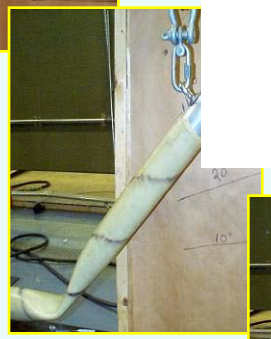


25th cycle to 30 Degrees

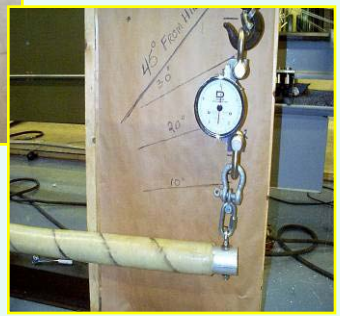


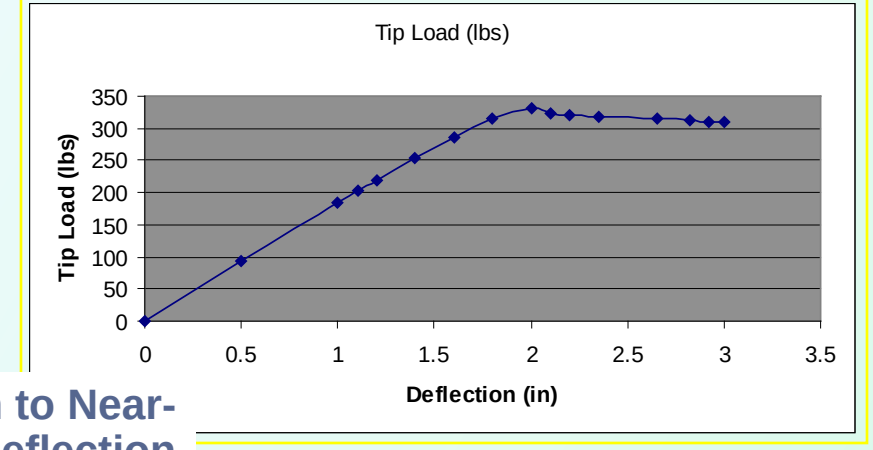
300 lb





26th cycle to 45 Degrees





Return to Near-Zero Deflection after 45 Degree Overload

Polyurethane Pultruded Stanchion Fatigue Cycling and Overloading

Composite IC & Electrical System Enclosures

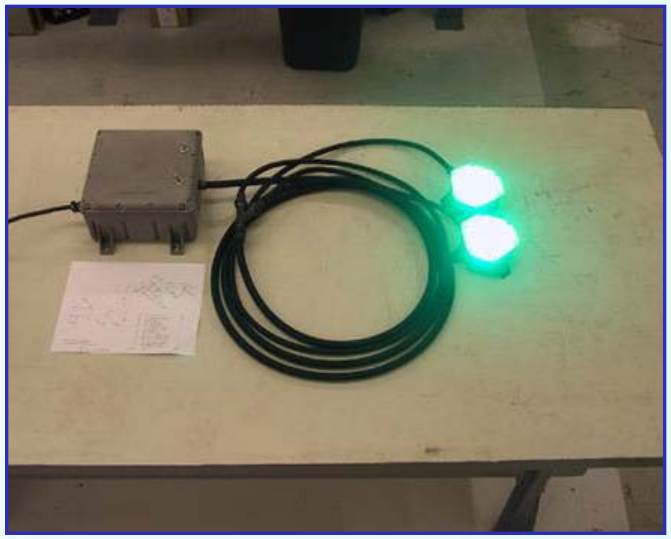
Objective

- Eliminate chronic internal & external corrosion issues
- Develop technologies that are corrosion free by eliminating galvanic couples internally & to the surrounding areas
- Product is fire hardened & provides extended service life from current systems
- Eliminate current antiquated designs

Payoff

- Mounting scheme employs 316L CRES studs that stand-off of the side-shell or bracket
- True watertight design and reduced thermal cycling reduces internal moisture
- Eliminates the solar thermal cycling that is problematic of steel, brass, and titanium boxes
- Spring loaded lid design adds to corrosion and water resistance
- Greater system reliability and significantly reduced maintenance (happy sailors)
- Evaluate installations on CVN, DDG, CG & LSD classes

Composite LED Lighting Enclosures



Objective

- Eliminate chronic corrosion issues
- Develop technology that eliminates incandescent lighting
- Reduce maintenance
- Significant reductions in line loads
- Multicolor lighting including

Payoff

- Corrosion free mounting scheme eliminates antiquated mounting design
- No more water filled glass globe found on SYM-92
- Greater system reliability and significantly reduced maintenance (happy sailors)
- x100 life cycle of LED technology and x100 power reduction
- Switched LED technology for duplex colors & NODs compatible
- Unique heat dissipating ULTEM® composite

Composite Stern Gate Panel

Before & After

Objective

- Eliminate chronic corrosion issues
- Develop technology that surpasses the performance of the legacy brass box
- Reduce maintenance
- Increase system reliability

Payoff

- Mounting scheme is modular to the support structure
- Corrosion free enclosure & mounting
- High solid epoxy as anti-corrosion coating on structure

- Eliminates the solar thermal cycling that is problematic of steel, brass, and titanium boxes
- Greater system reliability and significantly reduced maintenance (happy sailors)
- Configuration control across 41 & 49 classes

Composite Running Gear Fairings

Objective

- Eanbles TYCOM goal for 12 year dry-docking cycle
- Supports developing technologies that permit waterborne ship hull husbandry
- Eliminate waterborne welding repairs
- Eliminate carbon steel rope guards

- Eliminate corrosion at inaccessible weld heat affected zones
  - Eliminate loss due to aggressive corrosion of weld areas
- Added inspection port in composite fairing permits waterborne bearing & zinc inspection / replacement which was previously drydock

Composite Running Gear Fairings Cont.

Payoff

- Significantly lower costs than CuNi fairings
- Portable for diver access maintenance procedures
- Corrosion free Monel metallic components for 20 years
- Iterative fastener development resulted in unique stay-fast bolt
- Meets Grade B requirements

- More accurate hydrodynamic shapes (exceeds DDS-161-2)
- Ease of replacement of damaged fairings. No waterborne hot work required
- Added inspection port (6 o'clock) in composite fairwater permits waterborne bearing & zinc inspection / replacement which previously required drydocking

Composite Shaft Cover

Before & After

Objective

- Exceeds 12 year drydocking goal
- Develop technologies allowing reliable 15+ year service life
- Better protection owing to multi-layer configuration (added rubber layer)

Payoff

- Hand applied coupling agent is suitable to prevent flash rust following grit blast => no need for cumbersome protection efforts

- Polysulfide rubber layer provides the enhanced adhesion and assured anti-corrosion protection
- Better FOD protection resulting from multi-layer configuration inn conjunction with the Philly-Clad® epoxy-glass system
- Compliant layer moves at bearing sleeve shaft surface interface preventing cracking of epoxy-glass layer
- Zero VOC system is shipyard friendly

Composite Twisted Rudder

DDG-99 Cavitation Damage PSA Docking

Objective

- Depart from labor intensive metal fabrication
- Assure corrosion free structure
- Highly accurate hydrodynamic surface to increasing up the threshold of cavitation
- Take advantage of 'castable' urethane technology

Technology

- Requires further design development taking advantage of pre-preg technology vice VARTM
- Requires tooling / mold fabrication
- Was under development for DDG-51 & 1000 classes

Payoff

- Significant increase in life cycle & reduction in repair
- Significant cost & weight reduction (40%)
- Half the fabrication cost
- Integrated polyurethane layer reduces waterborne damage

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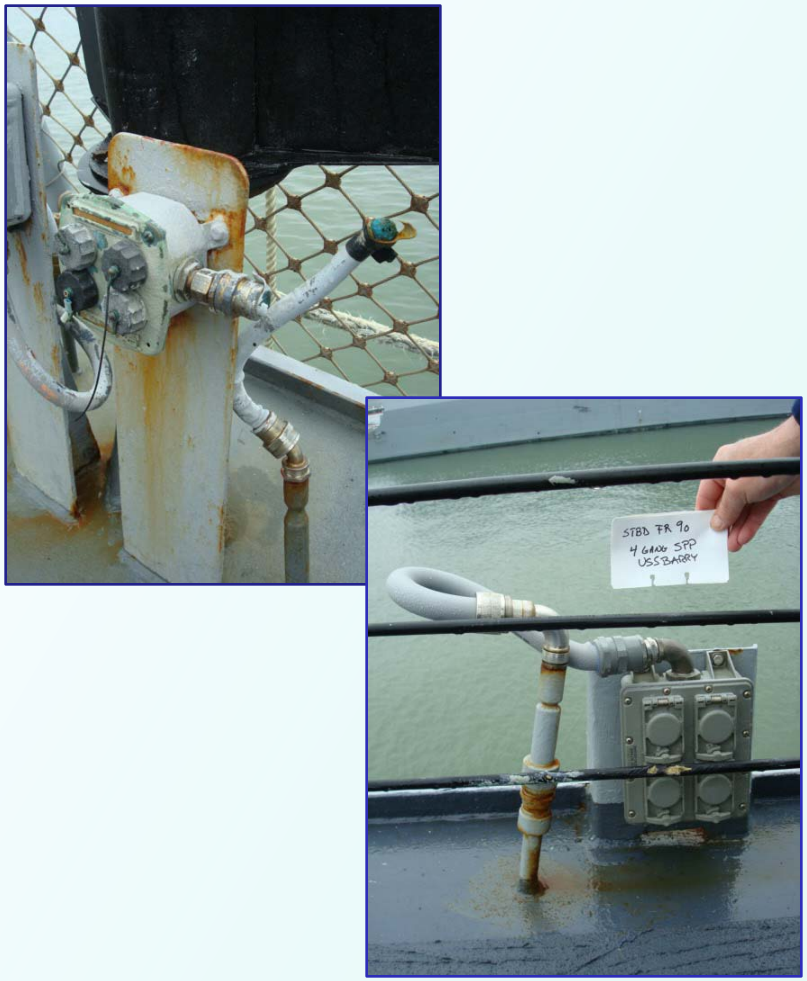
Other Initiatives

- NAVSEA SBIR Process
- ONR SBIR Process
- OSD Matching Funds
- Unsolicited Proposals

OSD / CIL-17 Composite EMP Conduit Terminations



Objective

- Eliminate chronic corrosion issues & electrical loss associated with CRES
- Develop technology that surpasses the performance of the legacy
- Reduce maintenance
- Increase system reliability

Payoff

- 75 dB attenuation via insertion loss measurement (NSWCDD)
- 1/3 the weight of 316L CRES
- Corrosion free (672 hours of SO_2 salt fog test)
- Lower acquisition costs due to improved manufacturing
- Exceeds the requirements of the new MIL-PRF-24758A

Damage-Resistant Deck Edge Safety Net System

- Deck edge safety nets currently a source of major maintenance cost from corrosion and bending damage
- Impact recovery from composite stanchion technology being applied to development of damage resistant framing
- Tests to date demonstrated ability to meet static and dynamic load criteria

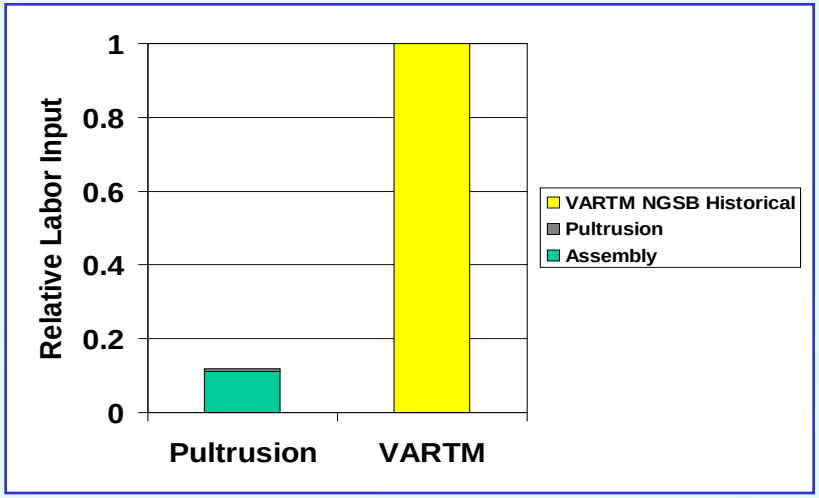
T-AKE Stanchion Production

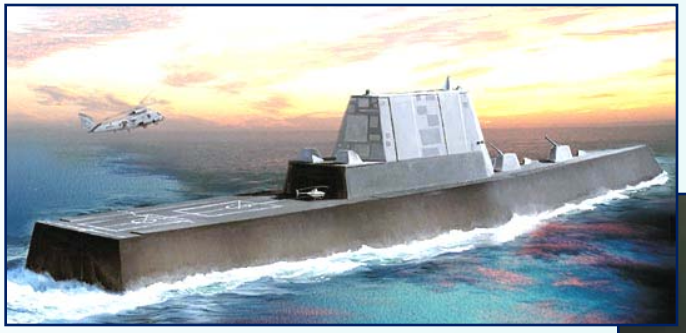
- KaZaK submits unsolicited proposal & prototype to GD-NASSCO based on SBIR developed technology
- KaZaK wins contract & supplies metal/composite hybrid stanchions for the T-AKE cargo system
- Each of 14 ships in the class requires over 9,000 stanchions

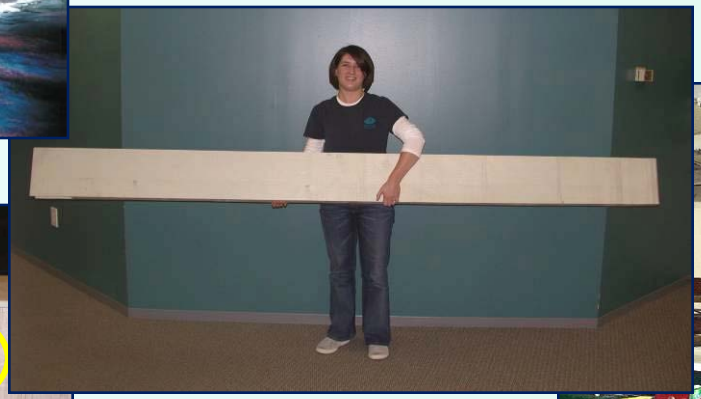
- Major SBIR Phase III commercialization successes – one of the largest in Navy SBIR program history

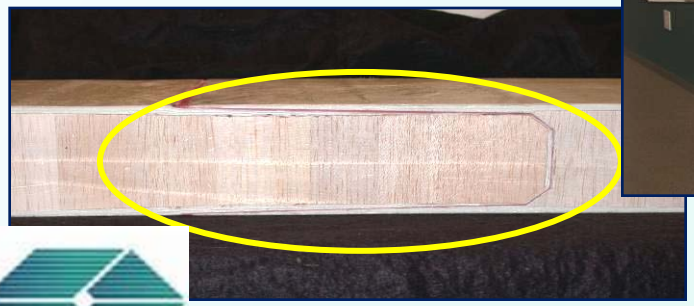
Major Composite Ship Structure Cost Reduction

- Pultruded carbon and glass composite panel structures with integrated joining features
- Up to 88% labor cost reduction demonstrated by NGSB compared to VARTM









Food for Thought

Rethink Ship Building Approach:

- Design for Maintainability/Supportability from the earliest phases of the acquisition process
- Query maintenance community to greater extent and have them as a part of the design process (Bring SCN and O&MN together!)
- Take greater advantage of the SEA 05N ERM, CI Labor, CWP lessons learned
- Incorporate the features in the new design as less maintenance translates directly into cost savings, mission readiness and “happy sailors”
- Dividends are in total ownership and operational cost.