ManTech Center Updates

2019 NSRP All Panel Meeting

Tim Bair

Institute for Manufacturing and Sustainment Technology

PennState
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and Sustainment Technologies

NAVY MANTECH
manufacturing technology program

Penn State Applied Research Laboratory

Institute for Manufacturing and Sustainment Technologies

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Agenda

NAVY MANTECH
manufacturing technology program

- ARL Penn State Overview
- iMAST Overview
- Example Projects & Quad charts

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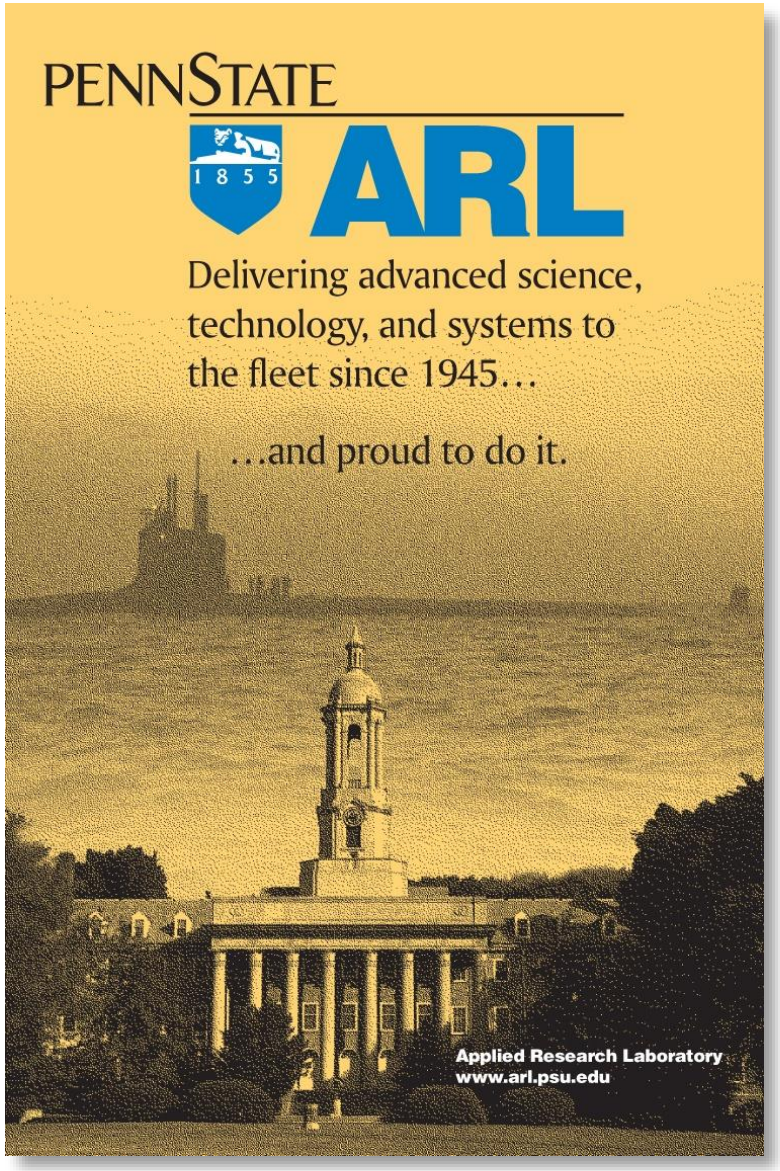
ARL Penn State Overview

NAVY MANTECH
manufacturing technology program



As a DoD designated University-Affiliated Research Center (UARC) ARL Penn State…

"…maintains a special long-term strategic relationship with DoD."

Characteristics of this relationship include:

- Responsive to evolving needs
- Comprehensive knowledge of needs and problems
- Access to information and proprietary data
- Corporate knowledge and technical memory
- Objectivity and independence from commercial interests
- Quick response capability
- Current operational experience
- Freedom from real and perceived conflicts of interest

UARC: 10 USC 2304 (c)(3)(b) "…to establish or maintain an essential engineering, research, or development capability to be provided by an educational or a federally funded research and development center and are designed UARC by the Director, Defense Research and Engineering (DDR&E)."

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ARL Penn State
Core Competencies

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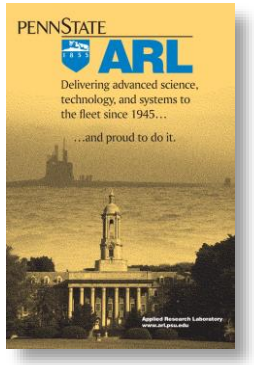

- **Guidance, navigation and control** of undersea systems, including simulation and modeling for design and performance prediction of undersea platform guidance and control systems.
- **Advanced thermal propulsion** concepts and systems for undersea vehicles, including systems modeling and dynamic simulation for torpedo propulsion systems.
- **Advanced propulsors** and other fluid machinery for marine systems, and submarine/surface platforms, including the hydrodynamic, hydroacoustic and structural acoustic analysis, performance prediction, noise prediction, testing and evaluation, and specification of such devices.
- **Materials technology and manufacturing technology** to meet unique requirements of Naval systems and components.
- **Atmosphere and defense communications** systems research that supports and complements maintained capabilities**.**
- **Mission related and public service** oriented research, technology development, test evaluation and systems analysis required to provide a quick response to rapidly evolving DOD and other government agency requirements, along with the complementary capabilities of the other divisions of The Pennsylvania State University.

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ARL Sponsors and Projects

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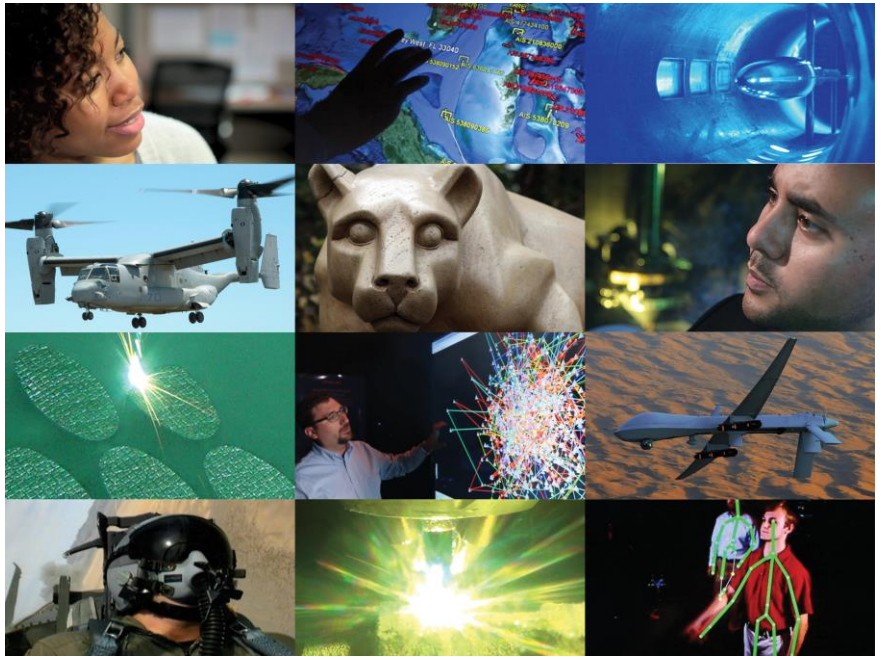
manufacturing technology program



- **U.S. Navy**
  - Submarine propulsion and navigation
  - Undersea Autonomous Vehicles
  - Defensive undersea weapon prototypes
  - Advanced Manufacturing and Component/Material reconditioning processes
  - Advanced communications
- **Other DoD, U.S. Government**
  - Information and Situational Awareness Tools
  - Radio Frequency domain
  - Complex Defense Logistics Systems Optimization
  - Major Defense System Design Optimization
- **Industry Technology Transfer**

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iMAST Overview

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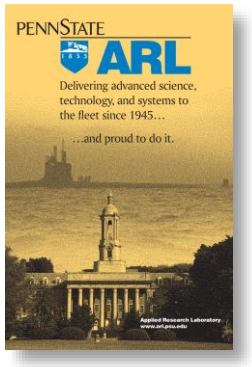
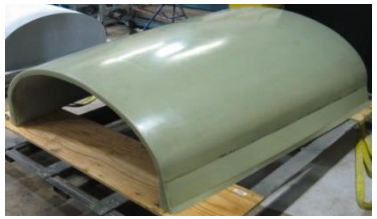
manufacturing technology program



Institute for Manufacturing and Sustainment Technologies (iMAST) established February 1995 as one of the Navy ManTech program's Centers of Excellence

Located at Penn State's Applied Research Laboratory, iMAST partners with industry, DoD, and OEMs to solve advanced weapon and systems issues.



iMAST provides a focal point for the development and transition of cost saving ***Manufacturing Technology*** innovations, processes and hardware,

iMAST supports the Navy with life cycle cost reduction projects within the ***Repair Technology*** (RepTech) in support of shipyards and DON depots.

iMAST is also supporting ***Accelerated Capability*** projects aimed at maintaining the Navy's technical superiority

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manufacturing technology program

Below charts are a sample of iMAST projects that are currently active or recently completed.

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Sustainment

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False Deck Panel

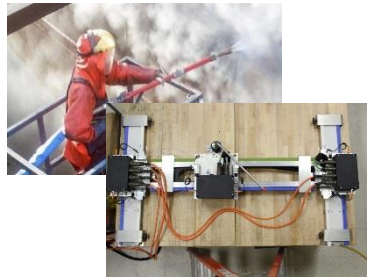
Identification of a new false decking material based on COTS or modified COTS products to improve performance and the installation process through modern metrology tools

Team: iMAST, CMTC, BIW, HII=NNS & Ingalls
Achievements: Milperf updates complete, testing alternate materials, evaluating metrology tools
Implementation focus: DDG and CVN
Status: Active Jan 17-Sep 19
Goals: reduce fabrication & installation labor, less susceptible to installation damage, reduced acquisition cost

UHP Dual-Track Crawler System for Coating Removal

Develop, test, demonstrate, transition and implement a dual-track UHP water jet system for removal of underwater materials from submarines

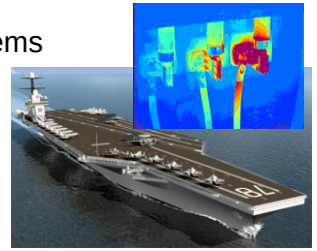
Team: iMAST, Puget Sound Naval Shipyard, NAVSEA 04
Achievements: Prototype complete and in use. All 4 shipyards funding one system with technical data, drawings, maintenance requirements and training
Implementation focus: Submarines
Status: Implemented
Goals: Significantly improved removal rates, decreased hazard and strain of UHP, better surgical precision



Acoustic Sensing Through Electrical Enclosures

Technology evaluation, modification and insertion of a handheld acoustic sensor capable of detecting air-borne frequencies unique to early electrical component failure

Team: iMAST, PEO Carrier, PSNSY, NAVSEA 04/05
Achievements: Testing of COTS system in lab, pier-side and onboard successfully completed. Acoustic signature of progression of connection release and impending failure proven at NNSY and onboard ships
Implementation focus: All high power systems
Status: Transitioned, awaiting final 05 approval and shipboard authorization
Goals: Early detection of progressive failure, eliminate requirement to shut down high power systems prior to visual inspection



Improved Low Loss Launch Valve

Improve valve sustainment and extend useful life through the deposition of 0.050 inch of ceramic wear coating to increase overhaul potential of existing valves through life of Nimitz Class

Team: iMAST, NAVAIR ALRE (PMA 251), Lakehurst NAS
Achievements: Evaluated and implemented an increased thickness of plasma spray wear coat to extend life of valve from ~2 overhauls to life of ship class
Implementation focus: Nimitz Class Carriers
Status: Implemented
Goals: Evaluate new bond and ceramic coating materials, improved application processes, prove positive wear and spalling characteristics

Sustainment

SPS-48E Radar Waveguide Refurbishment

Development of new refurbishment techniques to reduce costs and improve system and component reliability

Team: iMAST, PEO IWS-2.0, NSWC Crane
Achievements: Improved radome removal process proven and implemented at vendor site, material changes approved to reduce susceptibility to corrosion
Implementation focus: Surface Ships
Status: Implemented
Goals: reduce condemnation rate for slats undergoing overhaul/modification, improved quality and consistency in radome performance, reduce cost

Diagnostic Monitoring of Equipment & Capacity Planning

Incorporation of advanced machinery health monitoring technologies for critical facilities equipment with integration of CBM data into OEM planning systems

Team: iMAST, GD-EB, PEO Subs
Achievements: Evaluation of current maintenance practices, supporting data focuses on identification of candidate capital equipment for implementation of a Reliability Centered Maintenance solution.
Implementation focus: Submarines
Status: Active
Goals: Early detection of critical systems or infrastructure breakdown with input into the yard planning system to allow early accommodation

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Materials & Manufacturing

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manufacturing technology program

Fire Safe Resins

Evaluation and development of a composite binder capable of passing Navy requirements for Fire-Smoke-Toxicity in shipboard structures

Team: iMAST, CMTC
Achievements: Successfully developed and tested FST acceptable resin. Tested by independent testing house
Implementation focus: Ships & Subs
Status: Complete
Goals: Project successfully demonstrated a FST acceptable resin. Application and implementation to be completed with follow-on ManTech projects under CMTC

Retractable Bow Plane System Improvements

Develop, test, demonstrate, transition and implement an improved process to apply highly adhering ceramic coating via plasma spray to correct hydraulic seal failures

Team: iMAST, NSAM, GD-EB, PMS 450
Achievements: Developed new bond coat and improved application process, developed new QA spray process, tested system to equivalent of 70 years of wear successfully
Implementation focus: Submarines
Status: Implemented
Goals: System reliability improved beyond original design requirements, helped return favored vendor as a quality performer

3-D Tape Measure

Development of a three dimensional tool to facilitate, fast, adequately accurate measurement by non-metrology trades for use in shipbuilding and maintenance

Team: iMAST, PSNSY, NAVSEA 04, HII-Ingalls
Achievements: Early testing and development verified the potential and accuracy in bread board terms. Working to complete alpha prototype design and then integrate for live testing.
Implementation focus: All large scale shipbuilding, maintenance depot level tasks
Status: Active
Goals: Facilitate common trades uses to verify, validate and streamline metrology processes

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Metals

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Additive Manufacturing Repair

Evaluation and development of and Additive Manufacturing repair process for geometry critical and obolete aircraft engine components

Team: iMAST, NAVAIR
Achievements: Successfully developed and tested AM as a method to add material to otherwise unrepairable parts
Implementation focus: AV-8C
Status: Complete
Goals: Successfully demonstrated repair of geometry critical components. Previous attempts using conventional weld/clad processes failed for distortion. First approved AM repair for NAVAIR

Cold Spray Technology for Ship Components

Evaluation of Cold Spray as a method to repair ship's components of various metals and with no previously acceptable repair authorized.

Team: iMAST, PSNSY, NAVSEA 04/05
Achievements: Developed, tested, demonstrated and implemented an improved process to restore geometric form of otherwise unrepairable ship's components for reuse
Implementation focus: Surface Ships
Status: Implemented
Goals: Prove viability of Cold Spray as an economical means to repair parts. Test and characterize repair to satisfy TWH requirements and build standard

Portable Hatchable Cold Spray Repair

ManTech partnership with SBIR and Tactical Innovation and Implementation programs to develop Cold Spray systems and components capable of shipboard use

Team: iMAST, PSNSY, NAVSEA 04, SBIR, TII
Achievements: Development of an enclosure with flexible design to facilitate transport to and use within tight ship and sub spaces
Implementation focus: Ships and Subs
Status: Active
Goals: Develop and integrate a system to conduct Cold Spray repair of ship's components that are difficult to remove for in-ship repair.

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Advanced Manufacturing Enterprise

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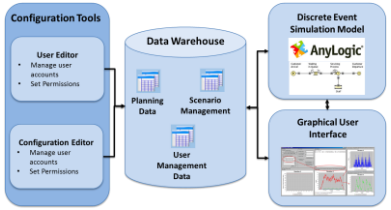
manufacturing technology program

Submarine Factory Simulation and Capacity Planning

Submarine IRR processes are extensive and include many unique planning challenges. Active (higher priority) ship overhaul requirements = frequent replanning for IRR.

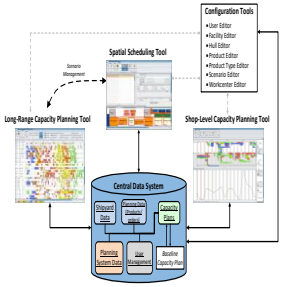
Team: iMAST, PSNSY
Achievements: Successfully developed and implemented a schedule replanning capability to rapidly adjust to changing shipyard priorities and availability of critical skills/tools
Implementation focus: Subs
Status: Complete
Goals: Build project replanning system to rapidly adjust to current and near future work plans with integration into yard planning systems



Shipyard Capacity Planning at BIW

Commercial enterprise tools fall short of accommodating many of the yard and shipbuilding planning requirements needed to facilitate workload planning.

Team: iMAST, BIW
Achievements: Developed new planning capability to integrate into existing yard long-range and shop-level workload planning processes.
Implementation focus: DDG-51
Status: Implemented
Goals: Develop a shipyard-wide planning system that results in more robust and achievable plan/schedules while meeting ship delivery requirements



Marine Corps Depot Workflow Modeling

Development of an automated and enterprise integrated planning tool to facilitate workload planning for overhaul of USMC armored vehicles

Team: iMAST, Marine Depot Maintenance Command, PP Albany
Achievements: Identified critical data, (both existing and needed) and identified critical nodes in the depot overhaul process to facilitate programming for simulation and planning.
Implementation focus: Ground Combat Vehicles
Status: Active
Goals: Improved planning tool integrated into LOGCOM and PP Albany enterprise planning system.

CREATING 21ST CENTURY SOLUTIONS FOR NAVAL MAINTENANCE

Tommy Gill, Jr.

Electronics Manufacturing Productivity Facility

National Shipbuilders Research Program

Electronics Manufacturing Productivity Facility (EMPF)

Tommy Gill
Director, EMPF

13 March 2019
DCN# 43-5075-19

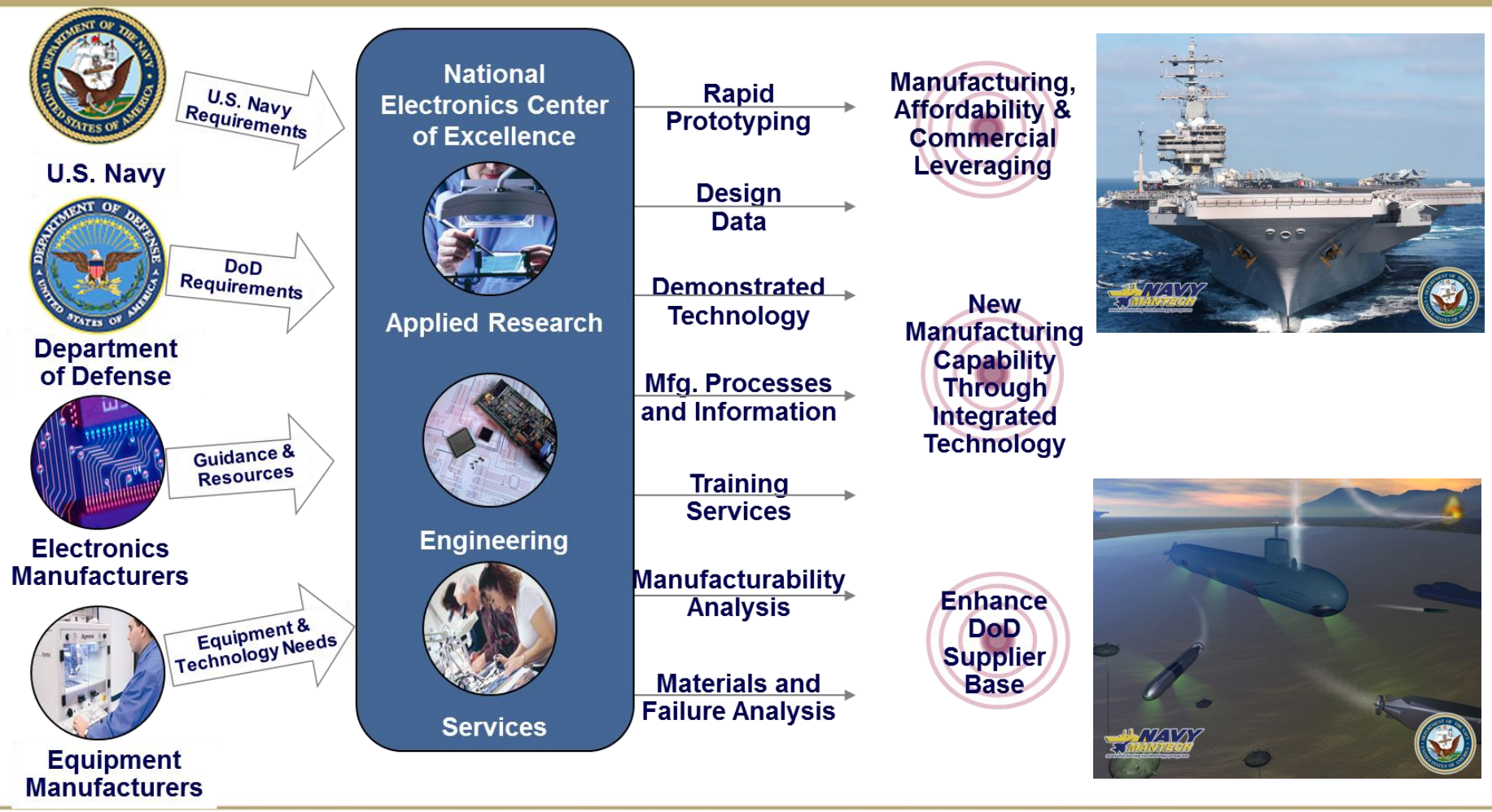
EMPF Capability Overview

ACI Technologies is a Science and Technology Company that Integrates Innovative Technology and Provides Effective Solutions to Enable Transformational Benefits to Defense and Commercial Customers

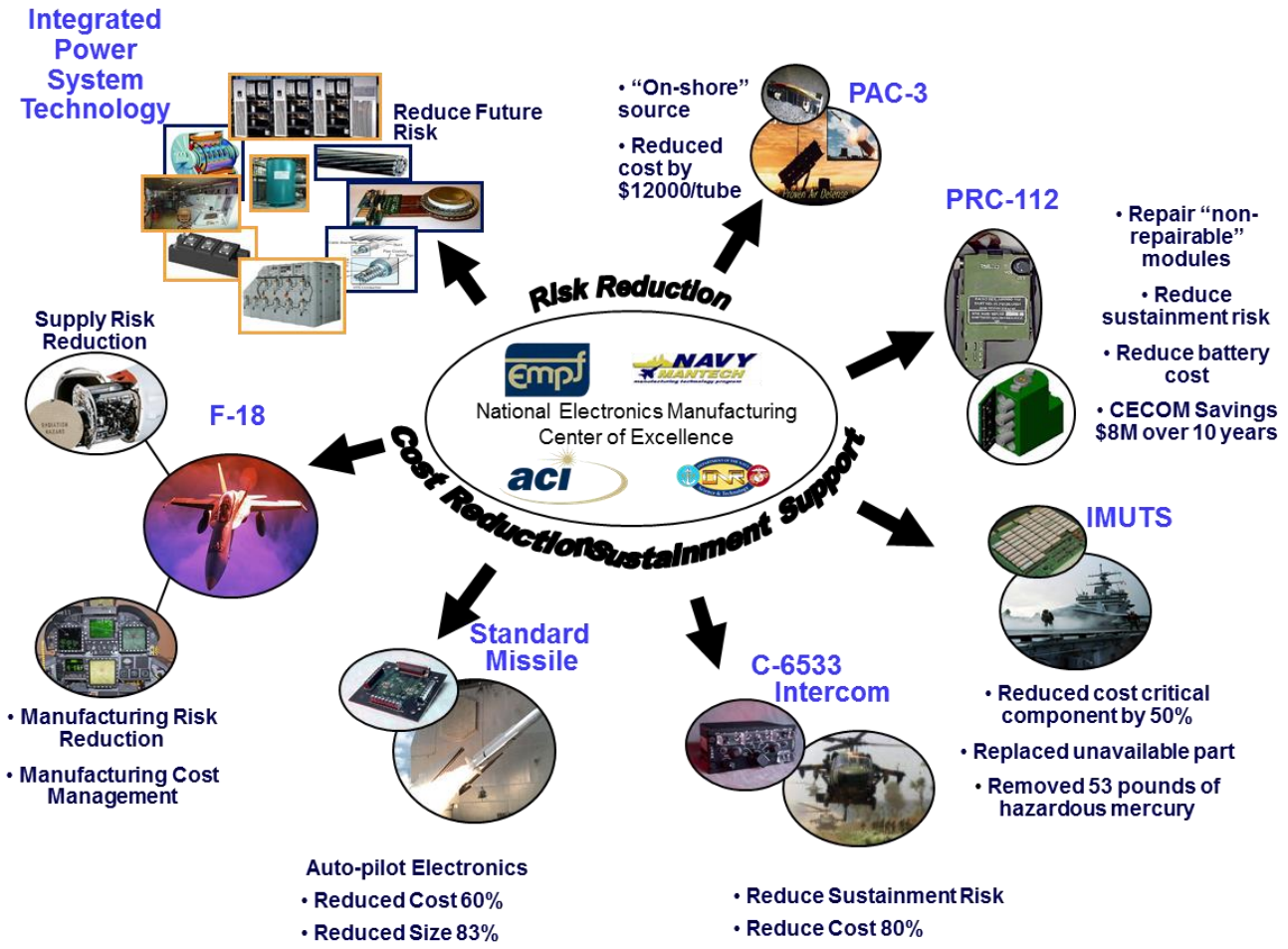
Diverse design-for-manufacturing talent pool:

- Experience gained from both the commercial and defense industries:
- Degrees from B.S. to PhD
- Up to 35 years of professional industry experience
- In-house disciplines: Applied Physicists, Mechanical Engineers, Material Scientists, Manufacturing specialists, and Electrical Engineers (Digital, RF, Analog, Firmware, Design)

US Navy Center of **Excellence** Model

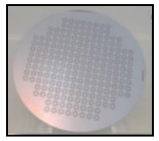


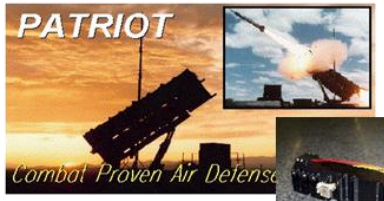
EMPF Outcomes



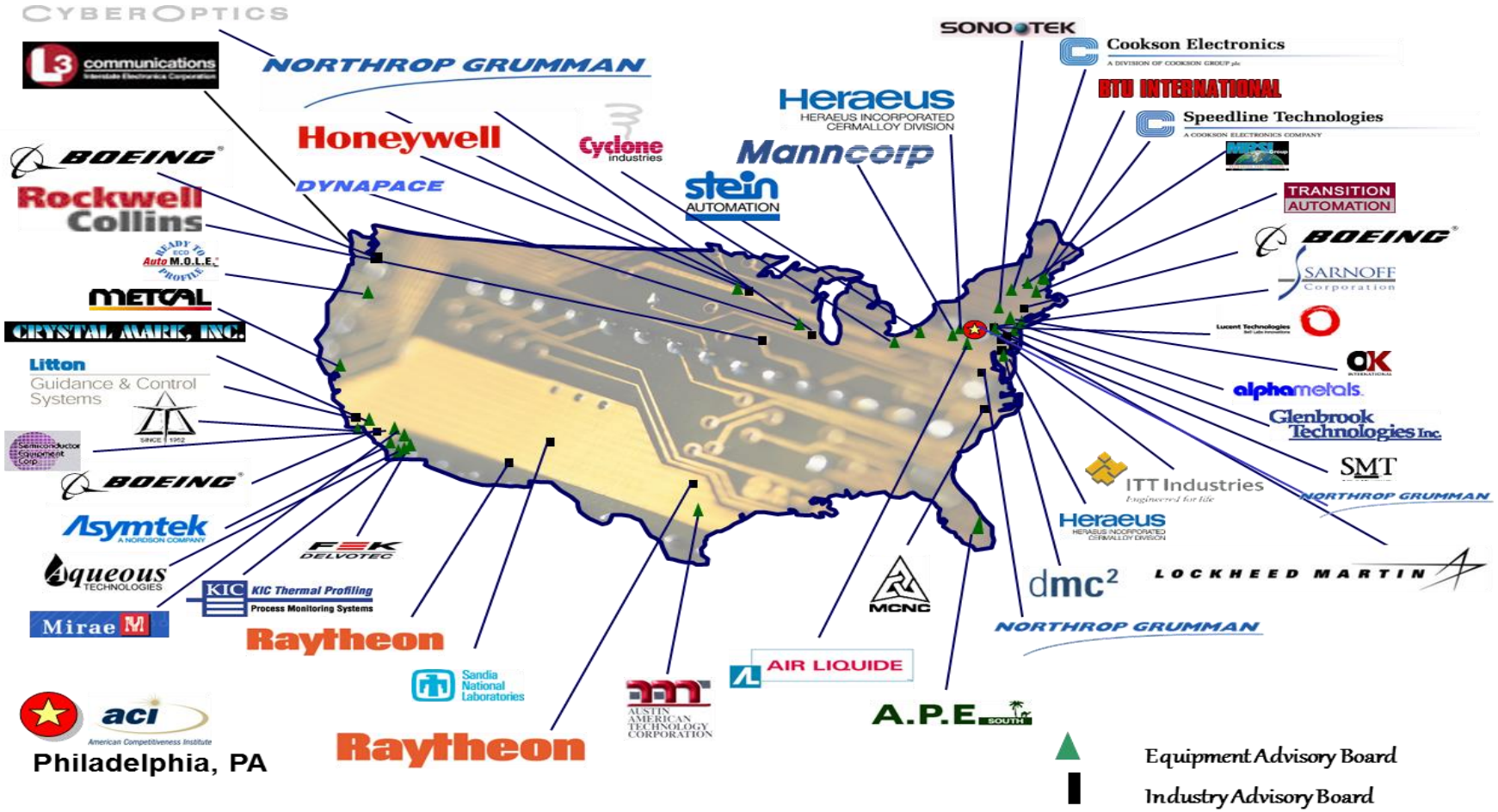
empf aci NAVY MANTECH Office of Naval Research ONR Science & Technology

EMPF Supported DoD Combat Systems





EMPF Partnerships



EMPF Mainstay

- Historical Emphasis on Acquisition Affordability
  - Risk Reduction
  - Manufacturing improvements into production phase (e.g., FRP)
  - Obsolescence Drivers
    - Acquisition programs often deliver platforms with obsolete electronics, impacting both platform capabilities and Navy In-service resources
    - Requirements continue to change, often outpacing initial design capabilities
- New Accelerated Capabilities Project Focus
  - Enhanced Performance
  - Fast Fielding

EMPF ManTech Project Focus

- **Combat Systems (Kill Chain):** Surveillance sensors, fire control sensors, weapons, battle management, command and control, battle damage assessment, etc.
- **Mission Systems:** Electronics that support platform locomotion, environment; operation, and security
- **Platform Power:** Electronics that support complex power generation and distribution throughout platform and associated combat / mission systems.

EMPF Innovation

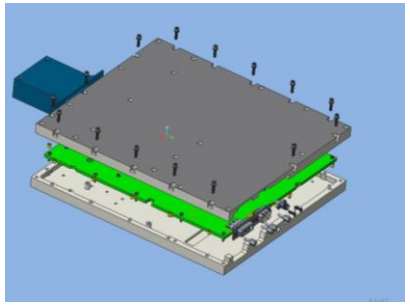
Applied R&D by implementation of design innovation; and leveraging state-of-the-art processes, materials, and resources

- Electronics Packaging
  - Ruggedization and reliability of electronic assemblies and packages
  - Packaging solutions for microelectronics RF applications
  - COTS component integration
- Engineering Materials
  - Material qualification and integration
  - Validation of environmentally safe materials
  - Analysis of RF materials
- Power Electronics / Power Semiconductors
  - Develop low/medium power control systems
  - Develop affordable manufacturing processes

EMPF Design Engineering

EMPF offers a broad range of comprehensive design and system engineering proficiencies

- Model Based design (Electrical, Mechanical, software simulation and Hardware/Technical data integration)
  - Requirements derivation from system level specifications
  - Digital/RF Simulation using variety of software packages
  - Digital/RF design to layout capability
  - Hardware/Firmware design for FPGA/ Microcontroller devices
  - Analog / Digital Hardware Development
  - 3-Dimensional mechanical and thermal modelling
  - Generation of CAD to CAM data for manufacturing and test automation

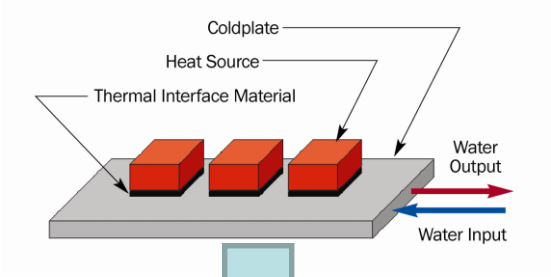


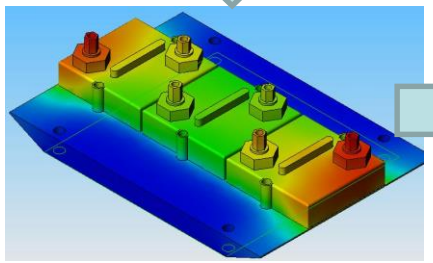
EMPF Thermal Analysis

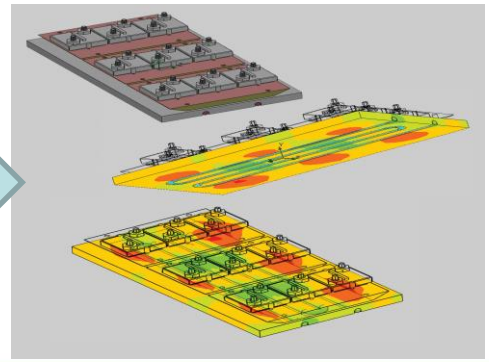
Thermal Management for Power Electronics Applications

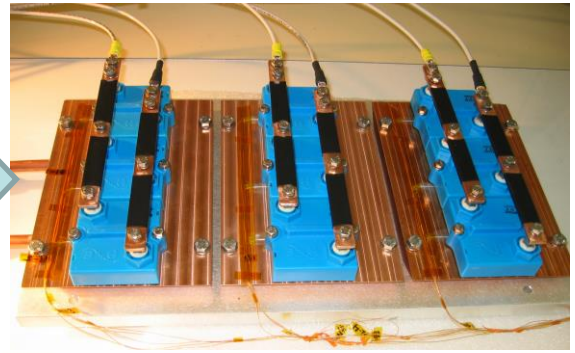
Development from concept to modeling to prototyping

- Thermal Analysis Modeling
- Thermal Interface Material Trade Studies
- Prototype Development for Evaluation









Thermal Test Facility

- Evaluate Thermal Performance
- Monitor temp, pressure, and flow rate
- Evaluate Thermal Interface Materials
- Evaluate Coldplate Technology

EMPF Production Support

- Manufacturing and process engineering
- Rapid prototyping and pre-competitive manufacturing
- Equipment, material and process specification, analysis and selection support
- Transition to advanced packaging technology
- Production planning
- Build Package support

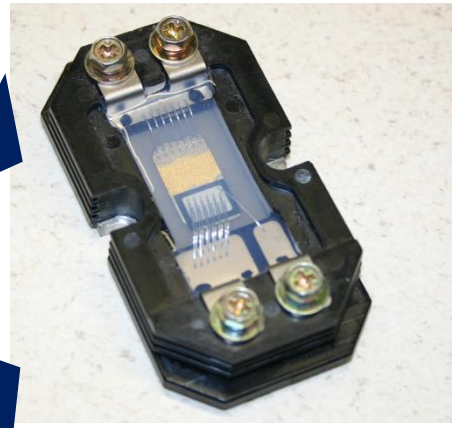
EMPF High Power Electronics Packaging

Wire bonding

- Orthodyne 3600 wire bonder
  - Larger wire applications (5 to 20 mil wire)
  - Built-in wire pull capability

Encapsulation Development and Application

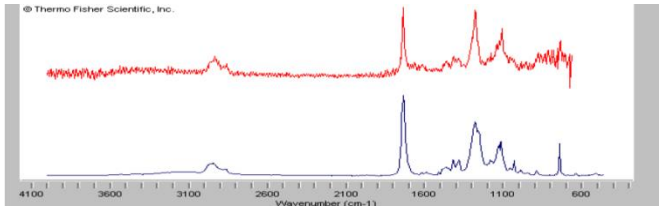
- Planetary Centrifugal mixers available for materials mixing
- De-airing dispensing materials
- Conformal Coating
- Vacuum ovens available for curing materials



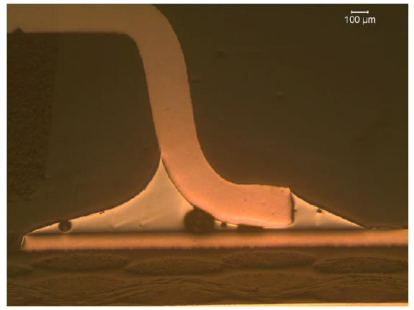
High power electronics assembly with large diameter wire bonds and high voltage encapsulant

EMPF Analytical Capabilities

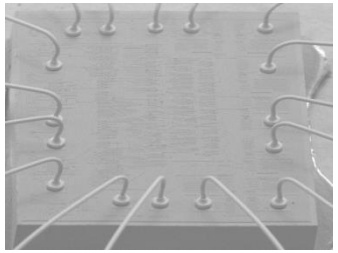
- Chemical & Elemental Detection
  - FTIR Spectroscopy
  - Ultraviolet Spectroscopy
  - Ion Chromatography
- Failure Analysis
  - Micro-sectioning
  - Laminar & CT based X-ray
- Bond and Die Attach Integrity Testing
  - Scanning Electron Microscopy (SEM)
  - Decapsulation / Delidding
  - Full range of DT / NDT



FTIR Spectral Comparison of two samples



Cross-sectional image of a lead



SEM image of an IC

EMPF ESS & Reliability Testing

Environmental Stress Screening (ESS) and Testing for Reliability

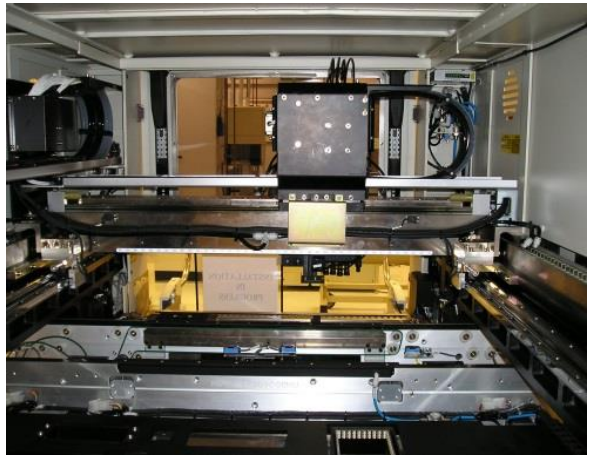
- Exposure to thermal & mechanical stresses
  - Forces latent defects to manifest themselves
  - Exposes environmental susceptibilities
  - Reveals process and workmanship related defects
  - Screening process for high reliability
- Can be part of manufacturing process or used in new product qualification testing
- Qualification and Acceptance Testing
  - Reliability (life-cycle compliance; degradation)
  - Pre-conditioning (infant mortality of parts and workmanship)

Types of ESS:

- Thermal Stressing
- Temperature/Humidity Stressing and Testing
- Accelerated Environmental Stressing
- Vibration/Mechanical Testing

EMPF Training

- Certification Training
  - IPC-A-610 Acceptability of Electronic Assemblies
  - J-STD-001 Process Control for Electronic Mfg.
  - IPC-7711 / 7721 Electronic Assembly Rework & Repair
  - WHMA-A-620 Wire Harness Manufacturing
- Engineering Level Training
  - Electronics Manufacturing Boot Camp
  - Characteristic Properties of Materials
  - Design for Manufacturability and Test
  - Failure Analysis and Reliability Testing
- Electronics Manufacturing Skills Training
  - BGA Manufacturing
  - Chip Scale Manufacturing
  - SMT Manufacturing
  - Lead Free Manufacturing
- Customized Curriculum Development
  - Boeing, Lockheed Martin, Harris, US Army, Motorola



Selected Projects

SEWIP Block 3 Thermal Management

Platform(s): *DDG-51*

- Secondary Platform(s): *other Naval Surface Combatants*
- Other Service Applicability: *Manufacturing enhancements applicable to similar platform issues*

Issue Description:

- SEWIP Block 3 leverages Block 2 functionality, and extends capabilities to include Electronic Attack (EA).
- Inadequate High Power Amplifier (HPA) thermal management limits ability to reduce SWAP cost; and impacts high capacity performance

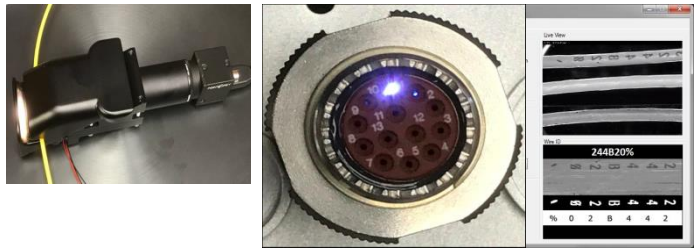
Innovation:

- Engineering trade studies to determine viable solution space
- Prototype development of HPA w/ improved thermal management solution.
- Complete advanced technical data package (TDP) to support a full rate production competition

Automated Connector Assembly System

Platform(s): *DDG-51 AEGIS Destroyer*

- Secondary Platform(s): *CVN-78; FFG(X); other Naval Surface Combatants*



Issue Description:

- Bath Iron Works (BIW) operators assemble over 10K individual cables that run throughout surface combatants under shipyard construction. The end-to-end cable connector assembly process is entirely manual, extremely complex, highly prone to operator error, and significantly contributes to labor costs for both initial work and re-work.
- BIW engineers need an improved systems-based solution that adds a significant measure of automation to certain high value operations within the assembly process, and can organically grow as other technologies are available to address remaining steps.

Innovation:

- System engineering to integrate discrete core technologies into a unique overarching solution that addresses high value operations / steps, while remaining modular & evolvable.
- Initial improvements will focus on cutting, end stripping, crimping and plugging of wires into connector housings

NiZn Energy Storage Module for Large Platforms

Platform(s): *Virginia Class Submarines*

- Secondary Platform(s): *Future Columbia Class*
- Other Service Applicability: *Modular design readily scalable to large platform energy need*

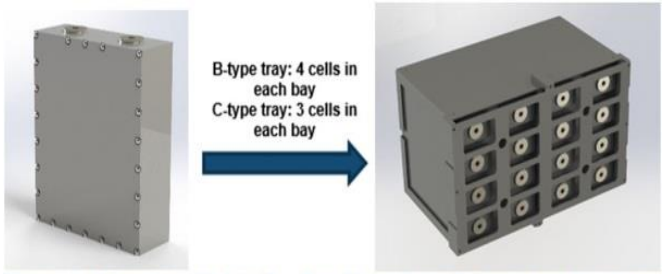


Figure 1: Schematic of 1,900Ah cell and how this will fit into type B cell tray

Issue Description:

- Lead-Acid batteries also have significant maintenance and replacement cost.
- Result is Warfighters have to operate at reduced electrical mission loads.
- Near-future missions require additional battery capacity, beyond that of current lead-acid battery technology.
- Large Lithium Ion (LI) batteries are not compatible with large manned undersea platforms

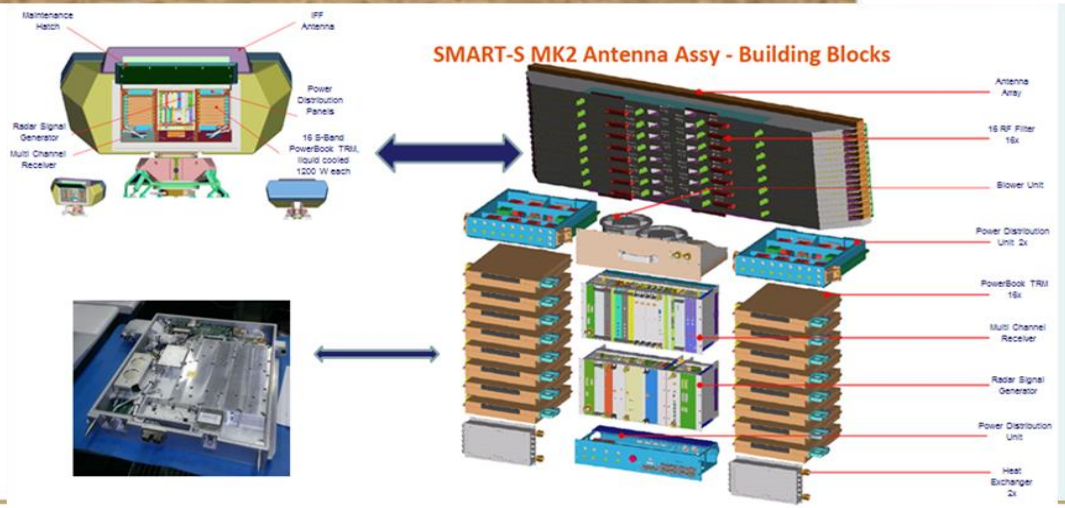
Innovation:

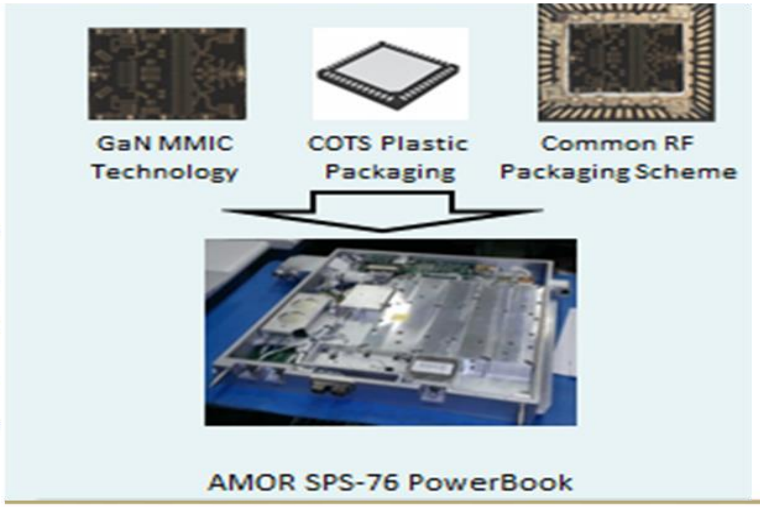
- 10X submarine battery cell scale-up capacity from Deep Cycle Marine Battery (G31) size of 200 Ahr to 1900Ahr

ONR SuperSwarm

- **SuperSwarm Program:** A broad S&T Initiative managed by ONR Code 30, Expeditionary Warfare. The program addresses strategic needs for large numbers of small, inexpensive autonomous drones to engage in various mission threads within multiple operational environments, including aerial, surface, subsurface, and land, among others.
- **EMPF Currently Supporting 3 MRRs**
  - Software Defined Radio
  - Carrier Board (Sensors Interface & Processors)
  - Electronic Speed Controls
- **EMPF Scope**
  - ManTech Manufacturing Enhancements & Prototypes
  - Materials & Technologies Research

Radar Affordability





Radar Affordability

Problem

- The DoD has minimal R&D investment reuse among Radar & EW systems. Each system has a unique design, supply chain, training, and obsolescence issues.
- Each DoD Radar & EW system requires specialized warfighter expertise not leverage-able across platforms.
- Today, each system is uniquely acquired and maintained. Training and sustainment is specialized for each system.

Objective

- The Radar Affordability Initiative offers the DoD common, modular building blocks performing like functions across Radar & EW systems.
- The RAI approach enables acquisitions to compete subcomponents within a design. The DoD also receives GPR for each investment, enabling competition breaking sole source dependencies.
- At the completion of RAI projects, the DoD will have full GPR for **T/R Modules**, **solid state amplifiers**, and **limiters**. Additionally, the DoD will have evidence showing the common, modular approach **shortens hardware upgrade periods**.

Radar Affordability Projects

- Reduce the cost of the G/ATOR T/R Module through the consolidation of functionality utilizing SiGe MMIC technology as well as migrating to a non-hermetic organic package
- At a minimum maintain G/ATOR T/R Module form factor, reliability and performance
- Achieve at least a 20% cost reduction per system when compared to G/ATOR LTCC GaAs T/R Module

- Solid State replacement of TWTs incorporating high power GaN MMICs in spatially combined amplifiers with integral power supplies
- Additive production of Spatial combiner and modules
  - Direct Laser Metal Sintering (DLMS) for RF Components
  - Direct Laser Structuring (DLS) for RF Components
- GaN SSPAs enable 10 yr. MTBF lowering TOC

- GaAs & GaN High Power VPIN Family of Solid State limiters for RADAR, EW & Communication systems
- Common narrow & wideband high performance limiters that address multiple current & Next Gen system needs
- Wafer level Hermetic coatings for low cost module manufacturing approaches
- Low Cost Standardized Plastic packages

- Baseline TRM performance in a simulation model using generic threat characteristics
- Adjust radar model parameters enabling detection
- Manufacture TRM with enhanced capabilities
- Test predicted performance versus SDTS testing

Radar Affordability
Potential Radar / EW Platforms

- Radar Systems w/tube technology candidates for replacement (SSA/advanced HPA; AM)
- Electronic Warfare (EW) w/focus on Electronic Attack leading to electronic HP weaponry

Radar	NAVY/USMC	ARMY	AIR FORCE
Air →	AN/ZPY-4(V)1	APS-143B(V)3/C(V)3	AN/APG-63(V), 65, 66, 68(v)
	AN/APG-73	AN/MPS-39	AN/APN-242
	AN/APY-10, 11(USCG)		AN/APQ-122(V)
	AN/APS-130, 137B(V)5		
Sea →	AN/SPS-49A(V)1, 55, 64(V)9, 65, 67(V)5, 73(V)12/17		
	AN/SPG-62		
Land →	AN/SPQ-9B		
	RIR-778		AN/FPQ-17 MIR
EW → (w/power)			
	AN/ALQ-99(V), 162(V), 214(V), 217(V) AN/USQ-113(V) AN/SLQ-32(V)7	AN/AAR-57(V), AN/APR-48A/B, AN/ALQ-212(V)	AN/ALQ-144A/B/C, 161A

Common Focal Point: Thermal Management/Packaging, New Standards / New Approach

Questions

David Ditto

Electro-Optics Center

PennState
Applied Research Laboratory

NAVY MANTECH
manufacturing technology program

Electro-Optics Center ManTech Update

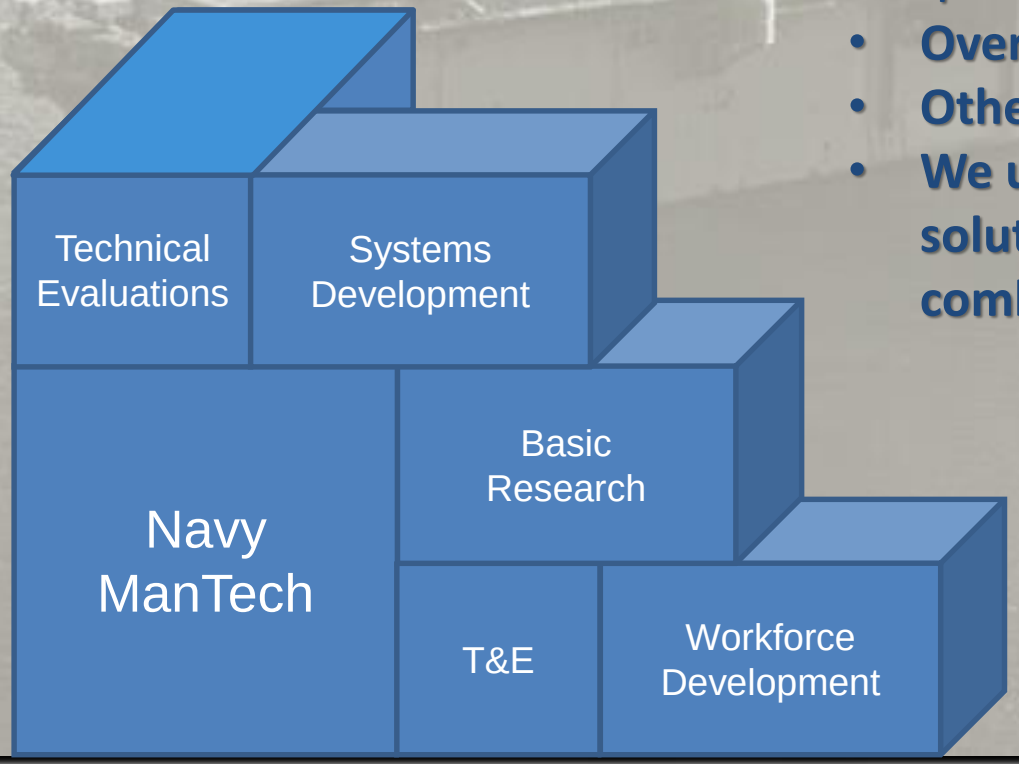
Presented by: David H. Ditto, EO ManTech Director, Penn State Electro-Optics Center

Presented to: National Shipbuilding Research Program All Panel Meeting
March 13, 2019

Office of Naval Research
USN ONR Science & Technology

Navy ManTech at EOC

- The Penn State Electro-Optics Center has been the Navy's ManTech Center of Excellence in Electro-Optics since 1999
- Located in Freeport Pennsylvania
- Other Services leveraged (SOCOM, MDA, Army, AF, USMC, etc.)



- **EOC completed 58 Navy ManTech projects**
- **$93.5M in expenditures**
- **Over $1B in cost savings /avoidance**
- **Other Services continue to leverage EOC**
- **We utilize the best available to arrive at solution—internal, subcontracted, or a combination of both**

NAVY MANTECH manufacturing technology program

CREATING 21ST CENTURY SOLUTIONS FOR NAVAL MAINTENANCE

Office of Naval Research ONR Science & Technology

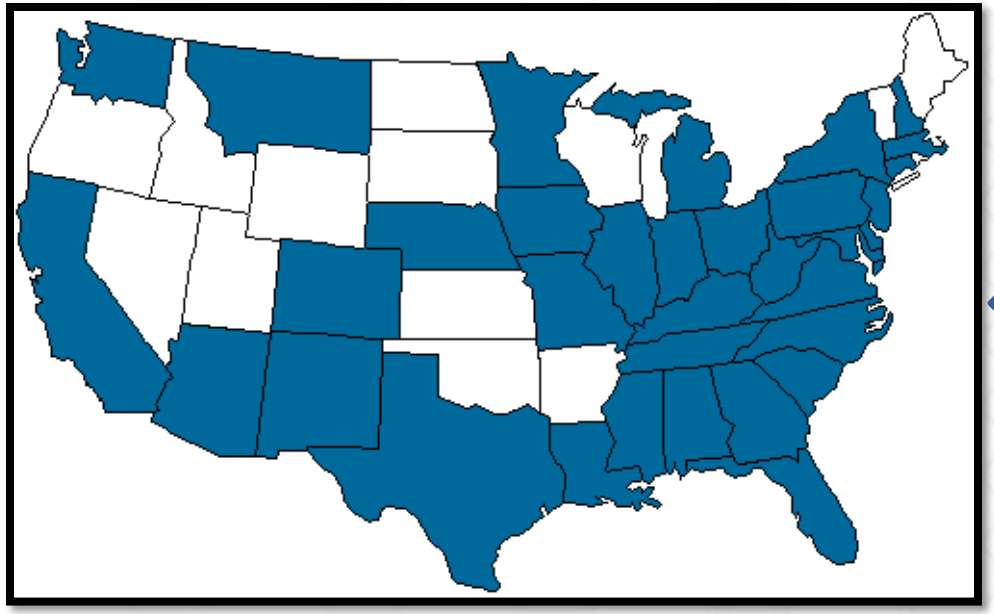
PennState
Applied Research Laboratory

Electro-Optics Alliance

"An Alliance of 400+ Companies,
Academic, Government, and Non-Profit Institutions
Committed to Providing the Best Capabilities
to Our Warfighters"

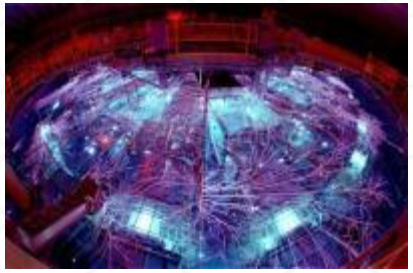
Defense Contractors

Academic Researchers



Manufacturing

Government Labs



ManTech Shipbuilding Related Projects at EOC

Current Projects:

- SiC High Efficiency Power Switches Wafer Process Improvement
- Augmented Visualization for Manual Welding
- Test Adapter Efficiency Improvement
- Automated Preheat Temperature Measurement

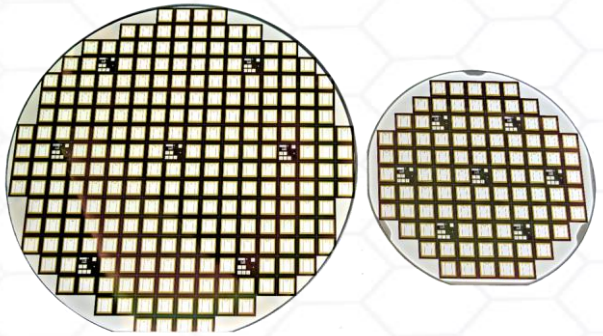
PennState Applied Research Laboratory

SiC High Efficiency Power Switches Wafer Process Improvement

Increased Yield for High Power Switching Devices

Issue Description: The Cost of High Power, 6.5kV and 10kV MOSFET Silicon Carbide (SiC) Switching Devices for Shipboard Use is Excessive.

Project Objective: Improve device manufacturing technology to increase yield In the production of high power switching devices



Expected Outcome & Benefits:

- Reduced cost through improved yield at wafer, epi and device fabrication level
- Increased power density resulting in a decreased footprint (size and weight) for ship power switches

Status: Ongoing, nearly complete

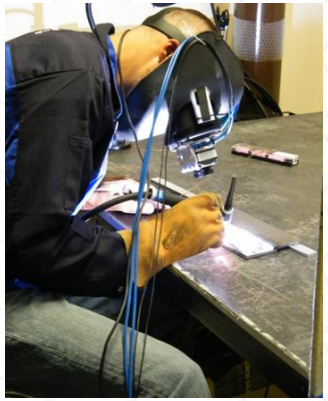
Subcontractor: Wolfspeed, a Division of Cree, Inc.

PennState
Applied Research Laboratory

Augmented Visualization for Manual Welding

Increased Welder Productivity

Issue Description: Providing adequate visibility of the welding process has been a difficult problem for decades. The high levels of UV radiation and extremely bright light prevent direct viewing.



Project Objective: Develop indirect viewing system for use in welding, beta test system, and commercialize for use in the shipbuilding industry

Expected Outcome & Benefits:

Provides affordable 3D viewing in a variety of environments

- Improves welder arc-time productivity
- Faster transition from novice welder to expert
- Develop and retain trained welders

Status: Ongoing

Subcontractor: Ingalls Shipbuilding

PennState
Applied Research Laboratory

Test Adapter Efficiency Improvement

Improved Electrical, RF, Fiber Optic Cable Testing

Issue Description: Cable testing and troubleshooting is difficult in shipboard environments. This project will improve and automate the processes

Project Objective: Further develop and improve the Integrated Link Test System and significantly reduce the number of Adapter Cables required.

Expected Outcome & Benefits:

- Improve productivity and first-time quality
- Introduce Optical Time Domain Reflectometry (OTDR) for fiber optic cable testing & diagnostics
- Reduce transcription errors with direct interface to test database

Status: Ongoing

Subcontractor: Ingalls Shipbuilding

PennState Applied Research Laboratory

Automated Preheat Temperature Measurement

Improved Temperature Measurement and Control for Selected Operations

Issue Description: Weld preheat and other critical temperature measurements are difficult to do, manpower intensive, and do not lend themselves to automation.

Project Objective: Utilize current state of the art temperature sensors, data acquisition systems and interfaces to automate temperature measurement.

Expected Outcome & Benefits:

- Significant reduction in manual labor.
- Improved control, data retention, and traceability of temperature.

Status: Ongoing

Subcontractor: General Dynamics Electric Boat

ManTech Shipbuilding Related Projects at EOC

New Starts

- Tank Inspection Using Drones
  - Using drone and sensor technology to inspect inside large tanks with Newport News Shipbuilding
- Automated Metrology for Structural Fabrication
  - Automate precision measurement technology for large structural components with Bath Iron Works
- Wireless-Assisted Measurement and Data Reporting
  - wireless equipment for data transmission and augmented reality glasses as an aid for operator tasking and verification of data.

Continuing Thrust—Using Electro-Optic Technology to Reduce Costs and Improve Quality in Shipbuilding

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PennState
Institute for Manufacturing
and Sustainment Technologies

Thanks!

NAVY MANTECH
manufacturing technology program

Dale Orren

Center for Naval Metalworking

Center for Naval Metalworking

Dale Orren

Deputy Director

12 March 2019

www.navalmetalworking.org

Overview

- **Mission: Identify, develop, and deploy metalworking and related manufacturing technologies to reduce the cost and time to build and repair key naval platforms and other relevant industries. Focus is shipbuilding and shipyard improvements to support Navy ManTech Investment Strategy**

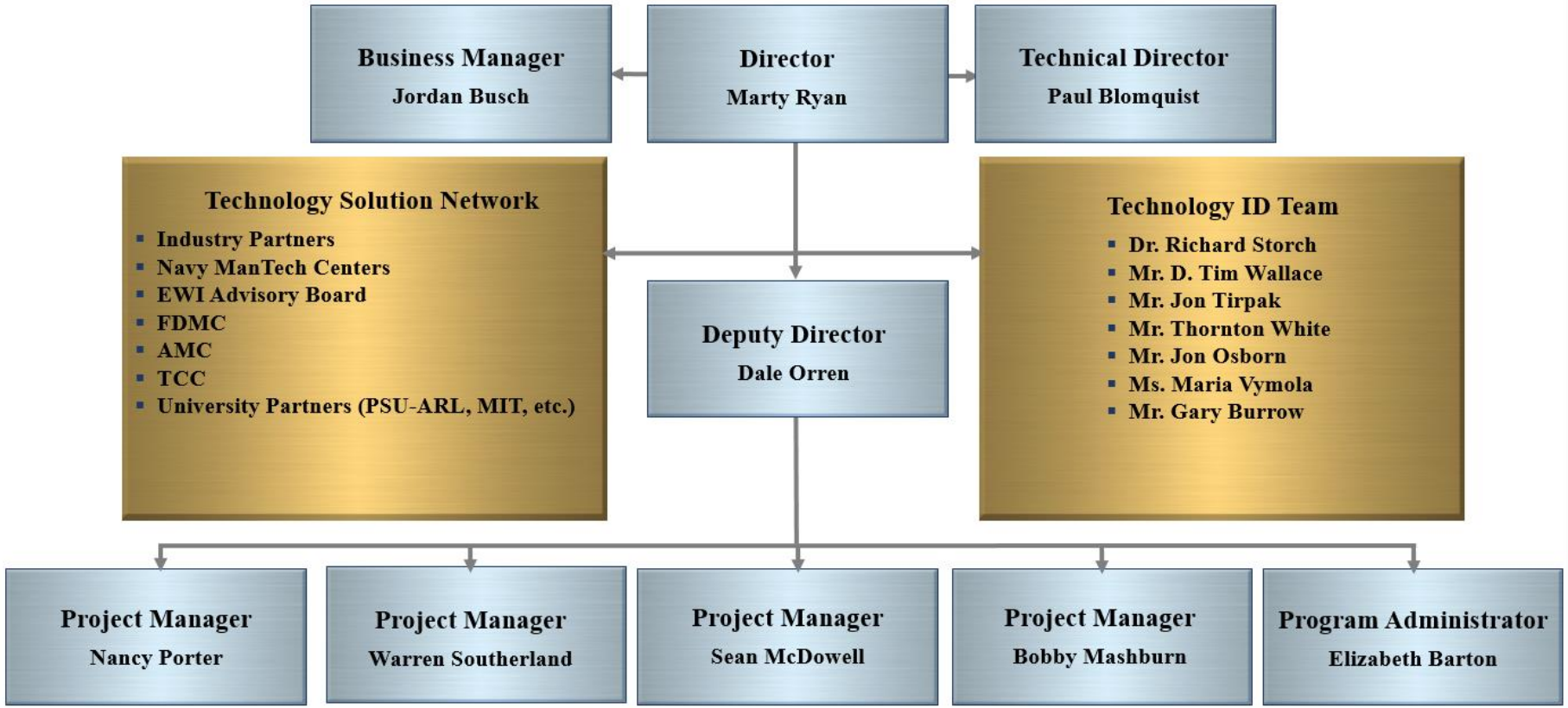
- **Hybrid COE Model: Deliver the best value to the Navy by:**
  - **employing proven successful virtual center model, augmented by available technical resources**
  - **teaming with industry experts and the best technology providers, generating the best technology teams**
  - **implementing results to address the requirements of Navy weapon systems.**

Focus Areas

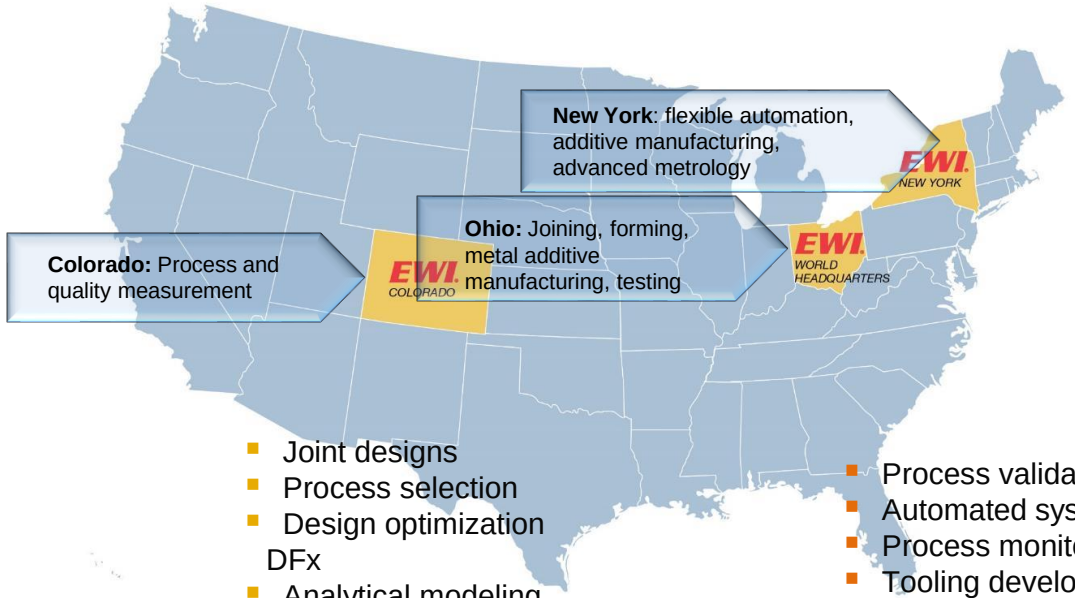
*metals and advance metallic materials
*metal-based composites & ceramics
*metallic materials-based systems
*metal/non-metals interfaces issues
*primary metal materials manufacturing processes (e.g. additive manufacturing)
*joining techniques
*surface and heat treatments
*metalworking systems engineering activities
*material characterizations and testing
*process design control
*product design and structural performance
*environmental issues and recycling
*information and data handling and transfer
*manufacturing technology/industrial base infrastructure
*inspection technologies

CENTER FOR NAVAL METALWORKING

Organizational Structure



Partnership



- Materials selection
- Manufacturability
- Formability
- Joining constraints

- Joint designs
- Process selection
- Design optimization
- DFx
- Analytical modeling
- Inspectability / NDE

- Process validation
- Automated systems development
- Process monitoring and controls
- Tooling development
- Onsite training and support

CONCEPT | FEASIBILITY | CONCEPT DESIGN | DEVELOP PROCESS | MANUFACTURING TRANSITION | VOLUME PRODUCTION

- Weldability analysis
- Process feasibility
- Joining trials
- Technology demonstration
- Property characterization

- Process optimization
- Rapid prototyping
- Testing and analysis
- Equipment specification

- Onsite troubleshooting
- Continuous improvement
- Failure analysis
- Service life inspection

Projects

CENTER FOR NAVAL METALWORKING

Alternate Leak Detection Methods

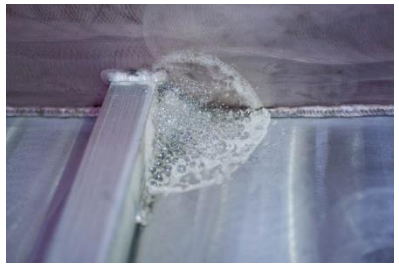
PEO	Project Lead	Project Status	Cost Savings
Ships (DDG-51)	Huntington Ingalls Industries-Ingalls Shipbuilding	Completed May 2018	Five-year savings of $603,520

Objective

Implement a new inspection technology that removes the manual application of soap and water to weld joints for leak detection.

Approach

- **Assessed Soap Bubble Inspection Procedure**
- **Determined inspection trends**
- **Developed guide to remediate commonly occurring weld defects**
- **Identified welds (with physical characteristics)**
- **Identified typical weld failure weld areas**
- **Developed mitigation strategies to prevent weld defects**
- **Developed inspection procedures.**
- **Conducted performance comparison of alternate NDT procedures vs. the baseline soap bubble leak testing**
- **Identified and developed implementation**



Projects

CENTER FOR NAVAL METALWORKING

High Speed Rotating Welding Arc Process

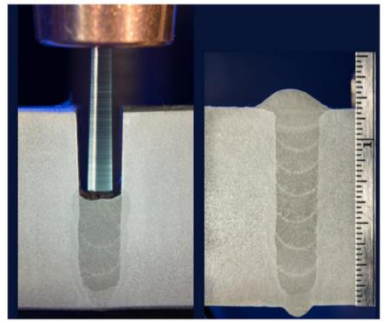
PEO	Project Lead	Project Status	Cost Savings
Submarines/ Ships (DDG-51)	General Dynamics Electric Boat/ General Dynamics Bath Iron Works	Completing April 2020	• Projected DDG51 5-year saving (6 Hulls) = $1,684,800 • Projected VCS 5-year savings (2 Hulls) = $473,400 • Projected VCS/VPM 5-year savings (8 Hulls) = $2,518,488 • Projected CLB 5-year savings (2 Hulls) = $994,140

Objective

Determine the advantages of and develop the process parameters and conditions for use of High Speed Rotating Welding Arc Process for Navy surface ship and submarine applications.

Approach

- **Determine candidate surface ship and submarine applications**
- **Develop candidate welding parameters**
- **Develop functional requirements**
- **Conduct lab & shipyard testing**



Projects

CENTER FOR NAVAL METALWORKING

Robotic Process for Installing Hull Inserts

PEO	Project Lead	Project Status	Cost Savings
Submarines	General Dynamics Electric Boat	Completing November 2020	• Projected CLB savings = $1.23M/hull • Projected VCS savings = $2.16M/hull

Objective

Improve the hull insert installation processes by investigating and developing a robotic solution that increases weld quality and reduces labor requirements.

Approach

- **Develop Process Baseline**
- **Define Functional Specifications**
- **Perform Hardware & Software Modification**
- **Conduct System Simulation Testing**
- **Conduct Cutting, Grinding, Beveling, Welding Evaluation**
- **Verify System Scalability**
- **Execute Implementation Plan**

Projects

CENTER FOR NAVAL METALWORKING

Shaped Plate Automation and Verification

PEO	Project Lead	Project Status	Cost Savings
Ships (DDG-51)	Huntington Ingalls Industries-Ingalls Shipbuilding	Completing November 2020	DDG-51 - $700K/hull Combined 5-year savings DDG, LHA, LPD and NSC - $7.1M

Objective

Reduce the manual labor in shaping shell plates through enabling rapid positioning and alignment of shell plates on fixtures developing in-process verification processes

Approach

- **Baseline Fabrication Shop and Shell Shop Processes**
- **Complete Concept Development**
- **Develop Fabrication Shop Prototype**
- **Develop Shell Shop Prototype**
- **Conduct Automated Line Heating/Plate Shaping Pilot**
- **Conduct Shell Shop Fixture Pilot**

Current state:
Plate shaping with flame heating

Projects

Electron Beam Welding and Cladding

PEO	Project Lead	Project Status	Cost Savings
Submarines (CLB)	Northrop Grumman Mission Systems	Completing February 2021	CLB - $1.02M Per CLB hull

Objective

Investigate the potential for Electron Beam Welding to replace conventional arc welding processes commonly used during submarine eject system component fabrication.

Approach

- **Develop Process Requirements**
- **Conduct Coupon Testing**
- **Conduct Pre-Production Component Testing**
- **Validate Qualification Support Testing**
- **Perform System Demonstration**

NGMS Electron Beam Welding Equipment

Currents Projects & Future Candidates

CENTER FOR NAVAL METALWORKING

- Hydrogen Diffusion Study" w/NSWCCD and NNS
- TIP TIG Welding (GTAW) Process" w/EB
- NNS Foundry Casting Improvements" w/NNS
- Automated Hull Frame Welding" w/EB
- Weld-Through Preconstruction Primer for HSLA-65" w/NNS
- Robotic Beveling and Tapering Cell" w/EB
- Develop Fitting Aid Tools" w/EB
- Automated Pipe Fitting Scriber" w/BIW
- Improved Clamp-on Orbital Welding Equipment" w/NNS
- Welding Applications" w/Ingalls
- Deep Hole Drilling-Tight Tolerance Equipment" w/NNS and BIW
- Remote Control of Mechanization Operations" w/NNS
- Seam Welder Optimization" w/NNS
- Robotic Fitting for Interim/Modular Parts Assemblies" w/EB
- Hybrid Additive Manufacturing Process" (S&T) w/Ingalls
- Automated In-Process Weld Inspection" w/Ingalls
- Rifled Hole Assessment" w/LM
- NDT Robotic Inspection" w/EB
- Additive Manufacture of T-408 Diffuser" w/GE
- Aero Aft Transition Doubler (ATD) in support of CH-53K" w/GKN

Contact

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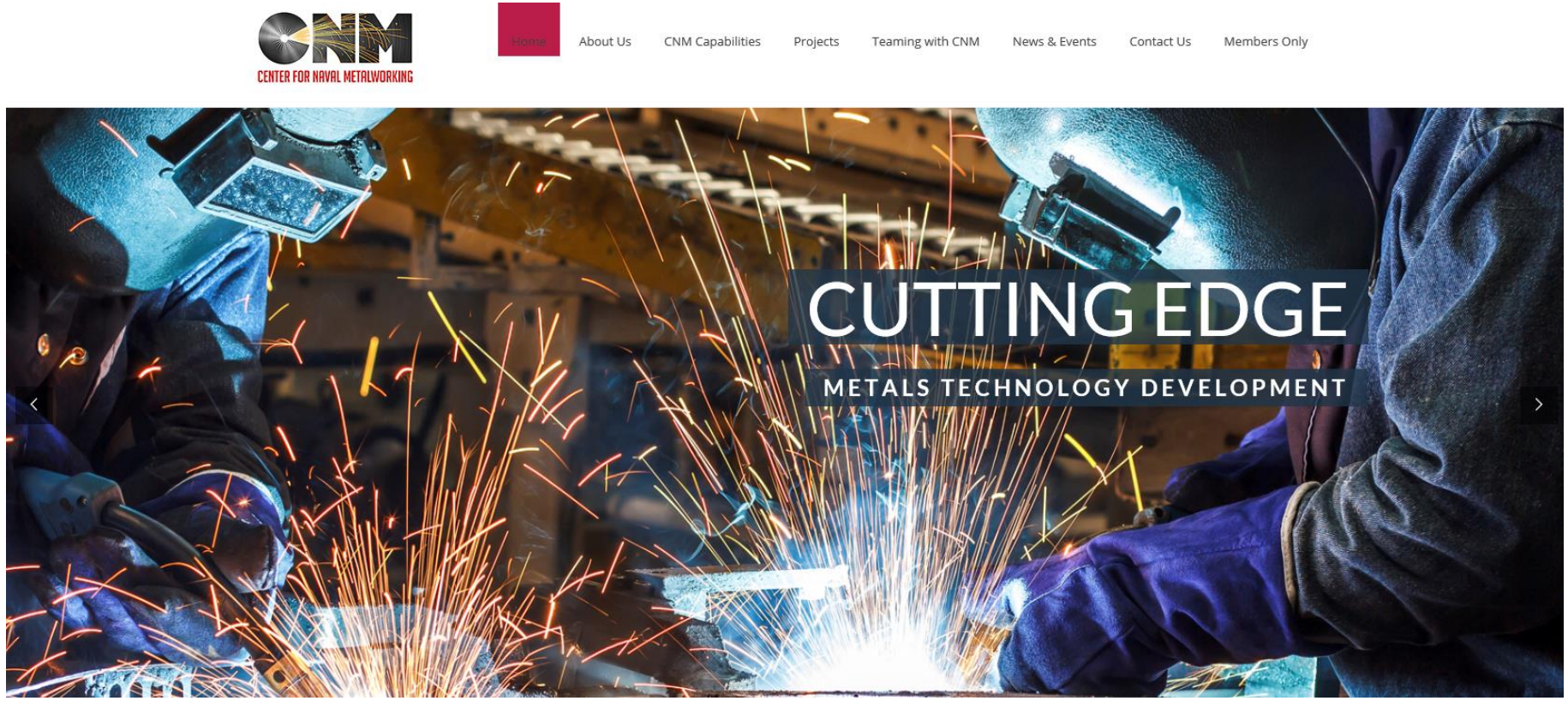


www.navalmetalworking.org

Kevin Carpentier

Naval Shipbuilding and Advanced Manufacturing

Naval Shipbuilding & Advanced Manufacturing Center

Kevin Carpentier, Technical Director

NSRP All Panel Meeting

12 March 2019

Background

- **Mission:** Identify, develop and deploy advanced manufacturing technologies that will reduce the cost and time to build and repair Navy platforms.
- **NSAM's Virtual COE Model:** Deliver the best value to the Navy by:
  - *Teaming with industry experts and the best technology providers*
  - *Creating project development, review and execution teams as needed*

Stakeholders, Partners & Results

NSAM/CNST Results

- Transition Rate of 96%, *Implementation Rate 89%* (*13+ years*)
- Return on Investment > 8.7
- Over $688M in Navy Cost Savings
  ($2.41B potential when all fully implemented)
- 15 Active Projects (36 *more in development*)

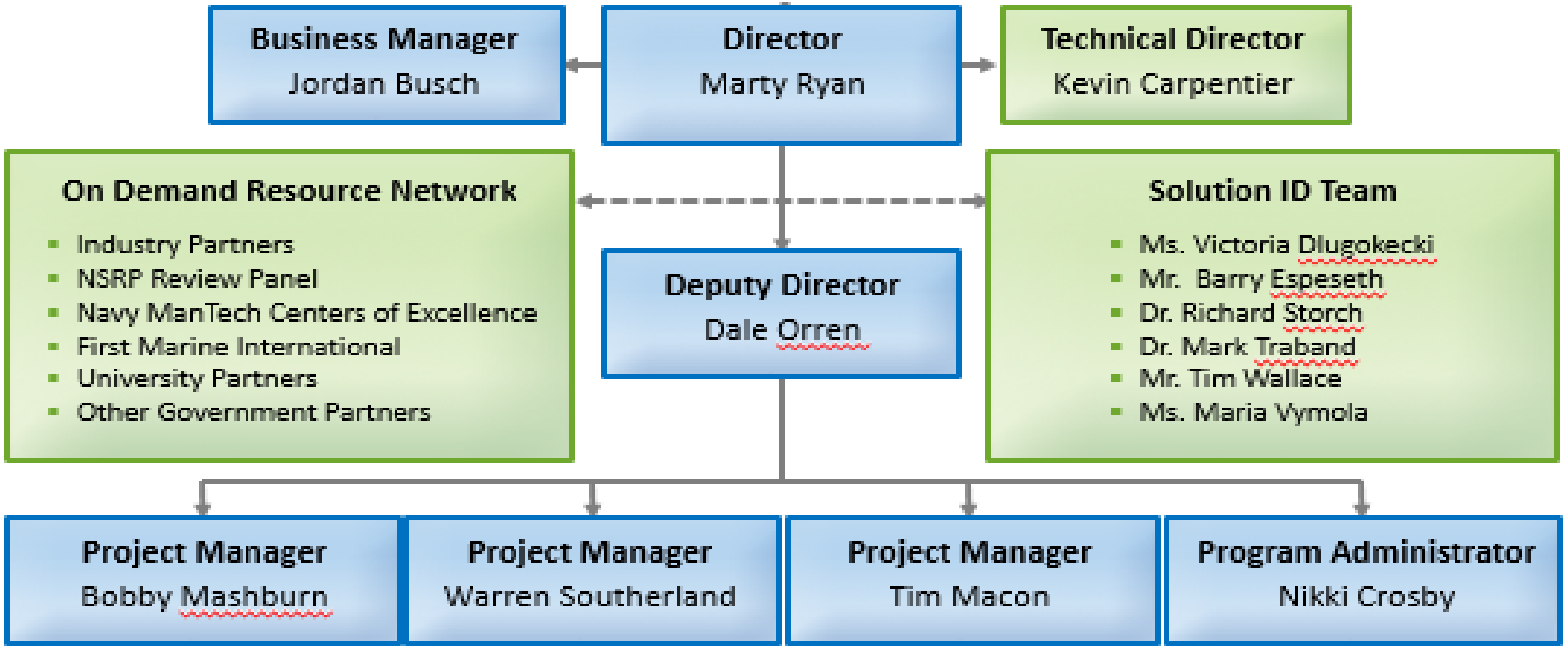
Stakeholders

PEO SHIPS
Program Executive Office Aircraft Carriers
F-35 LIGHTNING II
TEAM SUBMARINE
NAVSEA NAVAL SEA SYSTEMS COMMAND

Industry Partners

GENERAL DYNAMICS
Electric Boat
Bath Iron Works
A GENERAL DYNAMICS COMPANY
Ingalls Shipbuilding
Newport News Shipbuilding
LOCKHEED MARTIN
NORTHROP GRUMMAN

Organization



3D Data Exchange

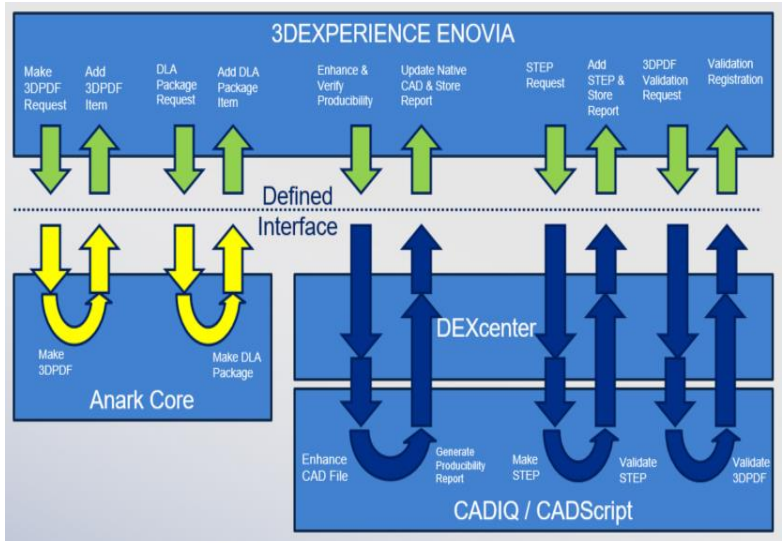
PEO	Project Lead	Project Status	Cost Savings
NAVAIR	PMA-261	Completed May 2018	$10.8M/Year

Objective

Develop a process to convert 3D Models to 3D PDF to provide production-quality model-based documents and Technical Data Packages for down-stream users

Approach

- Data Analysis
- Requirements Definition and Analysis
- Develop Architecture and Build 3D Data Exchange System
- Pilot 3D Data Validation and 3D Data Exchange



Geospatial Component Location, Identification and Condition

PEO	Project Lead	Project Status	Cost Savings
Carriers	HII-Newport News	Completed Mar 2018	$2.6M per CVN hull over 5 years and $342k per VCS hull

Objective

Develop an electronic work notification and recording system to provide real-time location of preventive maintenance components.

Approach

- Determine format and user interface of GeoCLIC tool
- Develop functional requirements
- Use Agile Software Development process to develop a portable, user-friendly tablet app.
- Pilot the system with a Modular Air Cooler
- Investigate feasibility of using a drone to carry the tablet/RFID reader

Virtual Reality Inspection of Piping Systems

PEO	Project Lead	Project Status	Estimated Cost Savings
Submarines	GD-Electric Boat	Completing Jun 2019	$161K/annually VCS $836.9K/annually VCS (Block V) $322.1K/annually CLB

Objective

Employ Virtual Reality (VR) to allow piping inspection planners to be immersed in a full scale mock-up of a piping environment and automatically determine and indicate the test boundaries of a work item.

Approach

A one-phase project consisting of three major development releases.

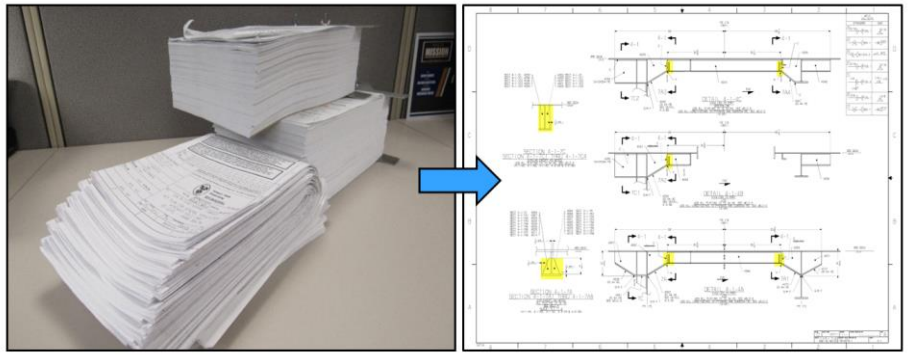
- Manage VR Session per Piping Inspection Task
- Display Inspection and Installation Status
- Create Inspection Work Assignment

Digital Thread – Shipbuilder/Supplier Interface

PEO	Project Lead	Project Status	Cost Savings
Carriers	HII-Newport News	Completing Mar 2020	$10.6M/Hull

Objective

To improve the material procurement process by extending the digital thread to the shipbuilding supply base and improve first-time quality, cycle times, schedule performance and supplier readiness.



Approach

Focus on three improvements:

- Simplified Technical Data Packages – Provide suppliers with clear, concise requirements that are specific to the material being purchased.
- 3D Design Disclosures – Provide suppliers 3D packages that clearly convey design intent and support CNC machining.
- Secure Exchange Medium – Establish a secure method of two-way data transfer between the shipyard and suppliers.

Hybrid Laser Arc Welding

PEO	Project Lead	Project Status	Estimated Cost Savings
Ships	HII-Ingalls	Completing Jun 2019	$3.06M per DDG-51, $2.75M per NSC, and $15.4M per LPD

Objective

Develop process parameters and conditions for single-sided, hybrid laser arc welding (HLAW) butt welds for various types and thicknesses of steel. HLAW reduces the welding heat input used to join metals, minimizing distortion and reducing rework costs.

Approach

- Phase 1: Develop and evaluate process parameters for single-sided HLAW butt welds for thickness and material combinations defined in the NAVSEA-approved process qualification plan.
- Phase 2: Focus on the fatigue and explosive dynamic testing that the Navy requires for characterizing performance in sea-state operational loading conditions and mission capabilities.

Save Employment of Augmented Reality in a Production Environment

Objectives

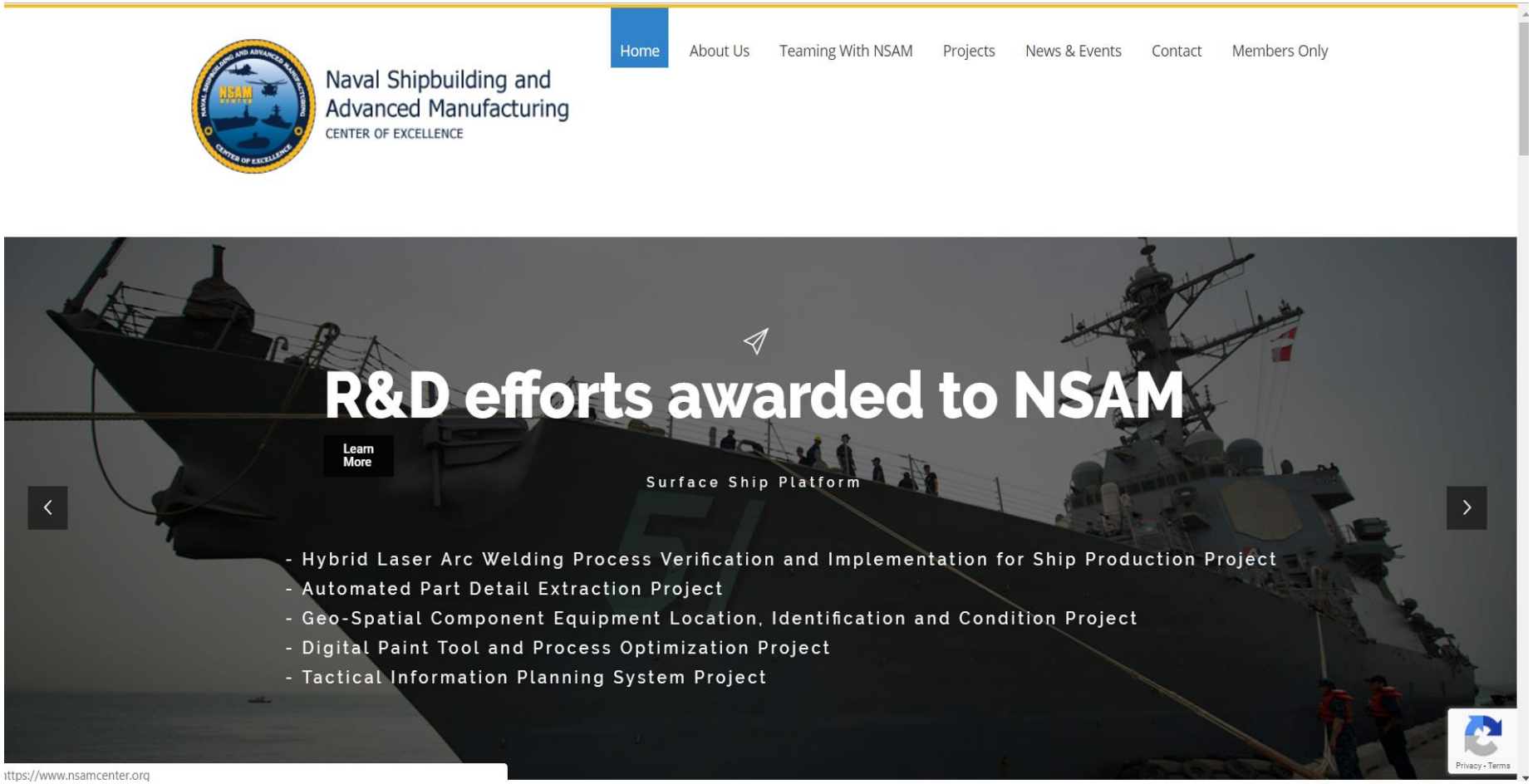
- Investigate the following technology areas:
  - Wearables & Mobile Devices for Augmented Reality*
  - Wearables & Mobile Devices for Mixed Reality*
  - Safety Requirements
  - Security Considerations
  - User Interfaces

Approach

- Conduct market research to determine the state of the market capabilities
- Determine technology requirements for the industry (Desired State)
- Conduct an infrastructure assessment (Current State)
- Perform a Gap Analysis
- Develop Implementation Roadmap and Pilot Plans
- Provided final Conclusions and Recommendations

Currents Projects and Future Candidates

- Increased Automation of NDT Tracking (DDG)
- Induction Straightening (CVN)
- Digital Paint Tool and Process Improvement (DDG)
- Sheet Metal Modernization (VCS/CLB)
- RFID for Part Delivery and Tracking (DDG)
- CNC Forming of Steel Plates (VCS/CLB)
- Robotics for Shape Cutting, Valve Cladding, Appendage Welding, Lead Installation and Stud Welding (Various)



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Composite Manufacturing Technology Center

CMTC Update

Jon Osborn, Deputy Director

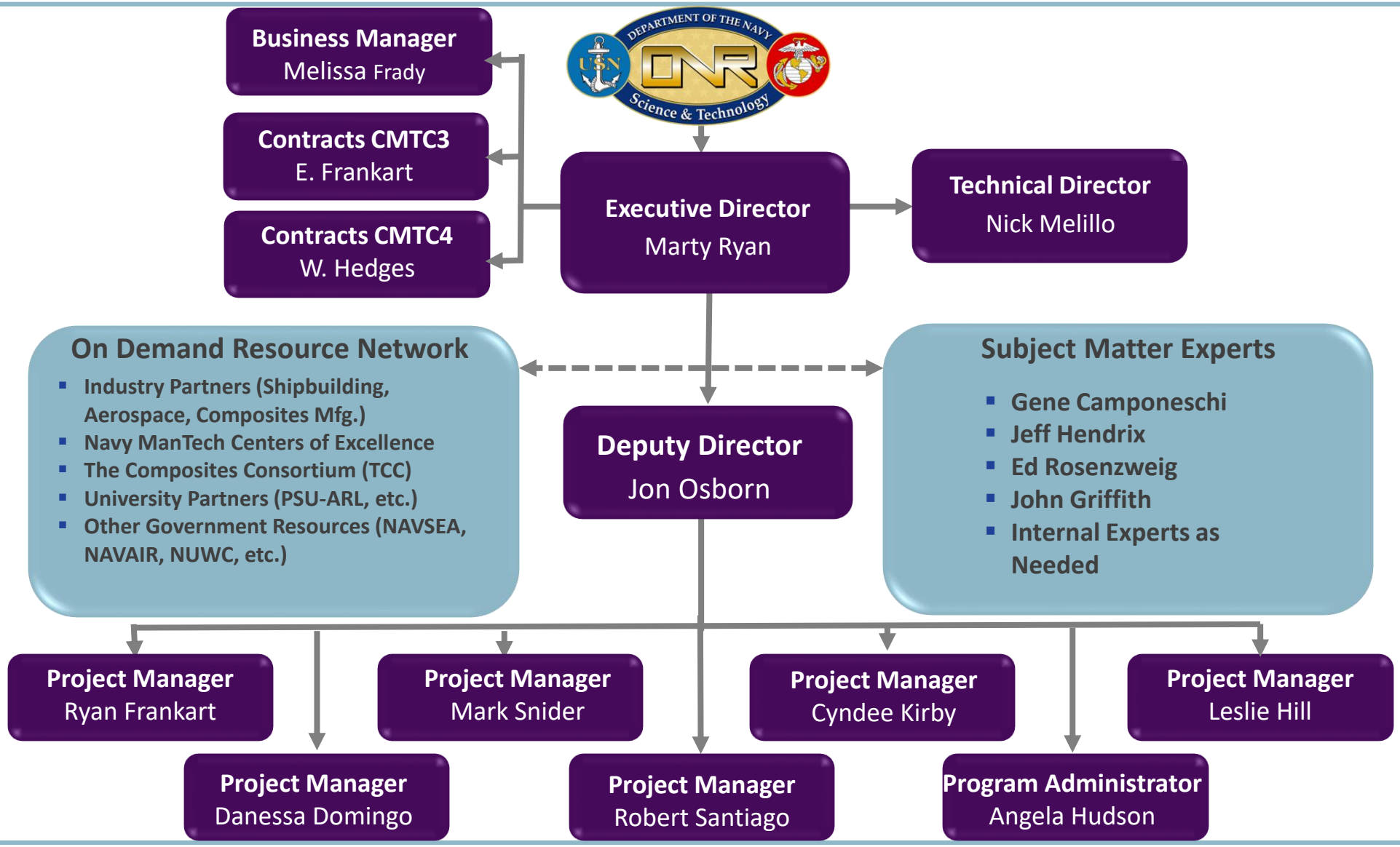
NSRP All Panel Meeting

Prepared under ONR contract number N00014-D-17-4003 as part of the Navy ManTech Program. Apportioned from DCN 43-2489-17.

Background

- **Mission: Identify, develop and deploy advanced composite manufacturing technologies that will reduce the cost, time to build and repair of Navy platforms.**
- **CMTC's Virtual COE Model: Deliver the best value to the Navy by:**
  - ***Teaming with industry experts and the best technology providers***
  - ***Driving state of the art material solutions from the best available sources to implementation on target platforms***

Organization Chart



Stakeholders, Partners & Results

CMTC Results

- Transition Rate of >*75%* (*over 18+ years*)
- >$940M in Cost Savings Returned to the Navy
- Reduced Maintenance for Naval Platforms
- 12 Active Projects (*30+ more in development*)

Stakeholders	Platform OEMs
PEO Subs (VIRGINIA and COLUMBIA)	General Dynamics Electric Boat
PEO Ships (DDG-51)	HII – Ingalls
PEO Carriers (CVN 78 Class)	HII – Newport News Shipbuilding
PEO JSF (F-35)	Bath Iron Works
PEO (A) CH-53K	Lockheed Martin
NAVAIR	Northrop Grumman
NAVSEA	

CMTC Research Focus Areas

- **Composites and Advanced Materials**
  - Fiber-reinforced polymeric (organic) resin composites
  - Ceramic-matrix, metal-matrix, and carbon-carbon composites
  - Graphite, glass, and polymeric fibers as well as alternate reinforcements
  - Coating materials and treatments
  - Engineering plastics and similar materials
- **Complex Structures and Design**
  - Composite “sandwich” stiffening core materials such as foam, ceramic, balsa wood, polymeric or metallic honeycomb
  - Composite “external” stiffening concepts such as hat and blade stiffeners and methodologies to manufacture them
  - Materials for radomes and other electrical applications
  - Pourable filling, shaping, and fairing materials
  - Adhesives, adhesive bonding, fastening, and related composite joining technologies
- **Testing and Inspection**
  - Mechanical, physical, chemical, thermal, and/or electrical testing
  - Quality assurance/advanced non-destructive evaluation
  - Modeling and simulation, (i.e., cure modeling, finite element analysis, etc.)
- **Processing and Automation**
  - Process analytics
  - Robotic or automated processing of the above materials (i.e., drilling, machining, etc.)
  - Polymeric and ceramic additive manufacturing technologies
  - Repair technologies (factory and sustainment)
  - Sealant, coating, and filling materials technologies, including mixing, application, and removal
  - Engineering plastics and similar materials related processes (thermoforming, sanding/polishing, etc.)
  - Chemical technology and environmentally-safe practices for composite materials and manufacturing processes

Extended Life Propulsion Shaft Surface Treatment

PEO	Shipyard Lead	Project Status	Cost Savings
Carriers	HII– Newport News	Complete & Implemented	$140M/14years

Objective

Identify failure mechanism of current covering and defeat that failure mechanism to allow for a 15 year corrosion prevention system.

Approach

- Worked with Penn State ARL and NSWCCD to determine the failure mechanism of the current covering
- Developed additional processing step
- Implemented on CVN as a demonstration
- Process and approach has been included in MIL-STD-2199A for coverings for main propulsion shafting for ships and submarines

Submarine Sail Support Program

PEO	Shipyard Lead	Project Status	Cost Savings
Sub	GD Electric Boat	Complete & Implemented	>$150M

Objective

The submarine environment offers a unique challenge where doubly curved steel sections are difficult and expensive to fabricate and all steel components require frequent maintenance due to corrosion in the harsh underwater environment. Composite materials offer the perfect combination of corrosion resistance, strength of materials, and acquisition cost savings over doubly curved or hard to maintain steel components.

Approach

- Team with NAVSEA Sail Cost Reduction Program
- Flood Ports, Slack Racks, Cableways, Covers, Doors, Access Panels, Sail Cusps, Trailing Edge

Fire Safe Resins – MS&T

PEO	Shipyard Lead	Project Status
Ships/ Subs	GD Electric Boat	Complete - 2 Follow-On Initiatives

Objective

Develop robust Fire, Smoke, & Toxicity (FST) safe materials for internal applications. Targeting the most restrictive FS&T requirements.

Approach

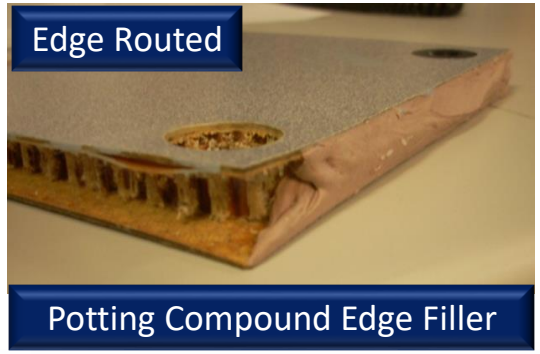
- Improve the processing of phenolic resins
  - Able to process 1-2% void content FST phenolic panels
- Survey cutting edge materials and additives to improve performance
- Deliver manufacturing process to industrial base

False Deck Panel Improvement

PEO	Shipyard Lead	Project Status	Cost Savings
Ships	HII – NNS, HII – Ingals, Bath Iron Works	Active	$6.4M

Objective

The current honeycomb resin core Nomex® false deck panels necessitates a complex, labor intensive edge treatment and manual measurement process for false decking fabrication and installation. This project seeks to reduce the cost and time associated with these processes.



Approach

- Carry forward NSRP and ManTech project work to a solution that will work for all surface ships
- Must be cross platform applicable
- Must reduce cost
- Reduce installation time/eliminate rework
- Should reduce maintenance requirements

Composites Projects Focus for Ship Platforms

- High On the Ship/Too Heavy for Personnel Lift
- Below Waterline
- Curved or Doubly Curved
- High Amounts of Touch Labor (automation)
- Failing Due to Vibration or Corrosion
- Integrated Weapons Systems/Multi Platform Support
- Use of exotic metals

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CMTC Composites Manufacturing Technology Center (https://cmtc.ati.org)

THE PROGRAM

CMTC is an Office of Naval Research (ONR) Center of Excellence. The program develops improved manufacturing processes for composite-based components and facilitates technology transfer to resolve manufacturing and repair issues identified and prioritized by the Navy's Program Executive Offices, other DoD services and industry.

THE ENTERPRISE

CMTC is a virtual enterprise connecting ONR, prime suppliers, university researchers, and small businesses. Industry and academia compete for projects individually or in partnerships. Project teams are assembled and dissolved as needed. This virtual center approach keeps costs low and ensures that ONR gets the best technology from the best sources.

HOW IT WORKS

CMTC issues calls for new project concepts on behalf of ONR. Any company or team of companies can submit project concepts. CMTC works with proposers to refine concepts and ensure alignment with DoD challenges. This process leads to formal technical and cost proposals. ONR evaluates proposals and selects sources. CMTC awards projects and work begins.