Technology Investment Plan FY23

NATIONAL SHIPBUILDING RESEARCH PROGRAM™
Taking Shipbuilding and Repair to the Next Level

MISSION

- Employ a unique collaborative framework to research, develop, mature, and implement industry-relevant shipbuilding and sustainment technologies and processes, improving efficiency across the U.S. shipyard industrial base and meeting future demand.

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1. INTRODUCTION

The National Shipbuilding Research Program's mission is to employ a unique collaborative framework to research, develop, mature, and implement industry-relevant shipbuilding and sustainment technologies and processes, improving efficiency across the U.S. shipyard industrial base and meeting future demand. The NSRP's Government impact is primarily on Navy ships, but the program is also intended to benefit other Government organizations such as the U.S. Coast Guard (USCG), National Oceanic and Atmospheric Administration (NOAA), Maritime Administration (MARAD), Military Sealift Command (MSC), and Army Corps of Engineers (ACoE). The NSRP considers unmanned and optionally-manned vessels to be types of ships fully within the mission scope. The NSRP's mission equally includes reducing the total ownership costs of U. S.-flag commercial ships.

The NSRP team typically considers a wide range of national, Navy, and Naval Sea Systems Command strategies and plans (see Strategic Investment Plan Section 10, Bibliography) to determine the NSRP's role within the higher level strategies. The NSRP's role is to support the Nation's plan to increase its maritime capability by increasing the overall number of vessels, improving the combat capability of military vessels, increasing the operational availability of all vessels, and improving the ability to rapidly upgrade mission systems, all while reducing the total ownership costs of these vessels. The NSRP mission statement was updated in February 2022 to reflect the Program's commitment to achieving these goals, and to strategically align the program to the three major phases of the ship/mission system lifecycle (design, build, sustain).

NSRP conducted a Technology Investment Plan (TIP) workshop on 24-26 January 2023 to identify high priority issues and current industry challenges where research proposals would be of particular interest to the program. The workshop attendees included a cross-section of highly-experienced shipbuilders and repairers from the member shipyards, along with senior government representatives from the Navy's Program Executive Offices, the Naval Sea Systems Command (NAVSEA) NSRP Program Office, and NAVSEA headquarters and field unit staffs.

2. RESEARCH AND DEVELOPMENT AREAS OF PARTICULAR INTEREST

Readers are encouraged to review the NSRP Strategic Investment Plan (SIP) for discussion of the program and the three Major Initiatives. Proposals addressing these topics will receive strongest consideration by the Executive Control Board (ECB). However, the ECB wishes to clearly emphasize that this list should not be viewed as excluding any other ideas. The ECB will continue to consider those proposals which best further the mission of the collaboration.

3. MAJOR INITIATIVES

The Definitions and sub-Initiatives of each Major Initiative in this TIP are taken directly from the SIP. In fact, the numbering from the SIP is carried forward into the TIP. The TIP provides specific project interest areas, which are directly aligned to a particular sub-Initiative of a particular Major Initiative. The program seeks proposals that provide **research, development, and implementation** for these interest areas**.**

Information, Design, & Integration (ID&I) (SIP 7.1)

Definition (SIP 7.1.1)

The Information, Design, & Integration (ID&I) Major Initiative focuses on the research of emerging technology, and the management of information to design and develop advanced solutions that support the full product lifecycle.

The ID&I Major Initiative consist of three Panels as follows:

- Business Technologies (BT)
    - The Business Technologies Panel focuses on emerging digital capabilities, blending process and information to develop advanced solutions that support product lifecycles from concept to disposal.
- Ship Design and Material Technologies (SDMT)
    - The SDMT Panel focuses on providing increased capabilities and cost reduction initiatives across the complete spectrum of design processes and the identification of materials to support rapid and efficient development, construction, sustainment, and disposal.
- Ship Warfare Systems Integration (SWSI)
    - The SWSI Panel focuses on the cost of integration and test for warfare and communication systems in ship construction and maintenance/modernization. The Panel improves coordination across programs, warfare and communication integrators, ship designers, and shipbuilders.

ID&I Sub initiatives (SIP 7.1.2)

1. Reduce time for qualification and application of systems, materials, components and manufacturing technologies
2. Advance and leverage digital shipbuilding
3. Identify and implement flexibility, modularity, and scalability across platforms
4. Investigate and apply solutions and best practices to support enterprise business processes and information management
5. Develop design guidance to support, maintain, and sustain unmanned platforms

6. Advance design, materials and processes that reduce sustainment/modernization costs and schedule
7. Incorporate autonomy in design processes and decision support tools
8. Define, integrate and implement innovative approaches to cybersecurity compliance, solutions, education & awareness

7.1.2.1 Reduce time for qualification and application of systems, materials, components and manufacturing technologies:

1. Additive manufacturing (AM)
2. Non-metallic materials for shipboard application
3. Low/no welding pre-heat materials
4. Advanced structural materials
5. Application and impact of battery chemistries
6. Sources and application of Alternative Energies
7. Approval of new/updated specifications and standards

7.1.2.2 Advance and leverage digital shipbuilding:

1. Integrate Enterprise Processes and Tools to support digital shipbuilding including:
   a. Internal and External Product Lifecycle Management (PLM)
   b. Manufacturing Execution Systems (MES)
   c. Enterprise Resource Planning (ERP)
   d. Modeling and Simulation
   e. Data management, exchange, and reuse
   f. Digital Twin
   g. Augmented Reality/Virtual Reality/Mixed Reality
   h. Knowledge management and retention
2. Enable the Digital Thread by integrating Computer-Aided tools, analysis, manufacturing, and sustainment technologies (CAx) into the enterprise environment
3. Develop a fully integrated and collaborative Model-Based Enterprise (MBE)
4. Evaluate application of secure Cloud, Mobile, Industrial Internet of Things (IIoT) and Data Capture Technologies in the shipbuilding arena

7.1.2.3 Identify and implement flexibility, modularity, and scalability across platforms:

1. Access and removal routes
2. Align just-in-time equipment with design and production
3. Common space design

4. Standard physical interfaces
5. Standard system interfaces
6. Hull, Mechanical & Electrical (HM&E) equipment packages
7. Advanced shipboard networking technology
8. Electronic equipment and racks
9. Power Control and Management Systems

7.1.2.4 Investigate and apply solutions and best practices to support enterprise business processes and information management for:

1. Data configuration management and governance
2. Data exchange and delivery
3. Data inter-operability and intra-operability between internal/external systems
4. Shipbuilding informatics (data analytics, business intelligence, and reporting)

7.1.2.5 Develop design guidance to support, maintain, and sustain unmanned platforms:

1. Physical integration
2. Platform interoperability
3. Physical and data security
4. Power architecture
5. Mission Systems
6. Standards and interfaces for UxV (Unmanned Air, Surface, Subsurface Vehicles) such as Unmanned Maritime Autonomy Architecture (UMAA)
7. Evolving battery chemistry and storage

7.1.2.6 Advance design, materials and processes that reduce sustainment/modernization costs and schedule:

1. Impact of environmentally resistant materials and surface treatment techniques
2. In-situ monitoring technologies and methods
3. Customizable techniques for assessing localized material properties
4. Apply digital data acquisition tools
5. Expand re-use of product model data
6. Damage-tolerant design methods

7.1.2.7 Incorporate autonomy in design processes and decision support tools:

1. Improved application of robotic manufacturing
2. Modular construction
3. Design for Production (DfP) rules and optimization
4. Design for Sustainment (DfS) rules and optimization

5. Large scale additive manufacturing
6. Inspections & Repair (e.g., tank, weld quality)
7. Application of Artificial Intelligence and Machine Learning (AI/ML)

7.1.2.8 Define, integrate and implement innovative approaches to cybersecurity compliance, solutions, education & awareness:

1. Increase awareness of cybersecurity best practices for enterprise processes and tools
2. Introduce compliance solutions for enterprise processes and tools
3. Investigate solutions for protecting data systems

Ship Production Technologies (SPT) (SIP 7.2)

Definition (SIP 7.2.1)

The Ship Production Technologies (SPT) Major Initiative addresses the fabrication, assembly, and testing phases of ship production, and the disassembly, repair/conversion, reassembly and testing phases of maintenance and modernization activities.

The SPT Major Initiative consist of the following four panels:

- Electrical Technologies (ET)
    - Research, develop and implement technologies and processes focused on improvements to installation, testing and operation of shipboard electrical systems.
- Planning, Production Processes, and Facilities (PPPF)
    - Discover and disseminate best practices focused on the principal manufacturing processes, equipment, planning, and facilities required to support the fabrication, assembly, and testing phases of ship production, repair and maintenance.
- Surface Preparation and Coatings (SPC)
    - Research, evaluate, develop and sustain current and emerging technologies focused on coatings and corrosion control that will reduce cost and maintain or enhance quality of new construction shipbuilding and repair of U. S. Navy and commercial ships.
- Welding Technology (WT)
    - Research, develop and implement the technologies and efficiencies focused on welding and allied processes, including weld joint preparation, forming, post weld heat treatment and inspection methods.

SPT Sub initiatives (SIP 7.2.2)

1. Improve Manufacturing Processes for construction, fabrication and assembly
2. Improve Manufacturing Processes for outfitting, installation and testing
3. Improve shipyards sub-tier supplier performance with respect to quality, cost and schedule
4. Increase use of Automation, Robotics and Mechanization in product fabrication, processes and testing including enablers such as standardization of design
5. Increase knowledge and proficiency of overall workforce
6. Develop and qualify of emerging technologies
7. Develop and implement the digitalization of shipbuilding to facilitate development or introduction of tools for improved construction and sustainment activities
8. Investigate consolidation of standards, and improvements to Standardization, Commonalities and Modularity
9. Improve quality, level of detail, and automation of job planning and work instructions
10. Develop a framework for qualification and incorporation of additive manufacturing (AM) into shipbuilding and repair
11. Develop solutions to improve installation, maintenance and efficiency of shipboard networks
12. Develop warehousing scheduling and logistics improvements to facilitate equipment delivery

7.2.2.1 Improve Manufacturing Processes for construction, fabrication and assembly:

1. Develop and implement technologies that improve the quality, efficiency and user friendliness of existing manufacturing processes
2. Develop and implement technologies that improve current inspection processes
3. Develop and implement technologies and processes that move work off hull to more efficient work environments
4. Optimize construction strategy to support coating processes
5. Develop and implement tools to automate testing processes
6. Increase utilization of accuracy control technologies

7.2.2.2 Improve Manufacturing Processes for outfitting, installation and testing:

1. Develop and implement technologies and processes that move work “off hull” and upstream in the manufacturing process to more efficient work environments
2. Identify and evaluate methods to improve cableway designs, protect cable media, and facilitate rapid cable identification following a casualty event
3. Facilitate implementation of “hatchable” equipment
4. Develop and implement technologies or tools to facilitate improvements to the termination process of electrical cables, including medium voltage cables

5. Design, develop, and gain approval for more efficient outfitting processes, i.e. common foundations
6. Increase utilization of accuracy control technologies
7. Develop and implement tools to automate testing processes
8. Develop and implement processes for expanded use of plug and play components
9. Develop and implement methods to promote increased modularity

7.2.2.3 Improve shipyards sub-tier supplier performance with respect to quality, cost, and schedule:

1. Increase supply base technical knowledge of and time to proficiency in specification requirements
2. Increase supply base knowledge, awareness and proficiency to ensure satisfactory execution of work
3. Improve inspection, quality and remediation at sub-tier suppliers

7.2.2.4 Increase use of Automation, Robotics and Mechanization in product fabrication, processes and testing including enablers such as standardization of design:

1. Develop a streamlined Navy (NAVSEA) qualification and shipyard acceptance process to facilitate implementation of automation and robotics tools
2. Develop and implement common, holistic strategies for accelerated insertion of automation, robotics and mechanization including considerations for design, infrastructure, capital procurement, applications, robust/flexible system designs, control of upstream production process, and workforce training
3. Develop and implement equipment, strategies and requirements to facilitate the implementation of COBOTs
4. Develop and implement simple, general purpose mechanical aides for fixturing prior to robotic processing
5. Develop and implement novel sensor technologies and control algorithms that enable adaptive automation
6. Identify and demonstrate applications that utilize drones during the inspection process
7. Research and advance the automation of ancillary processes
8. Integrate predictive analyses into off-line robotic programming or ship design software programs
9. Identify and demonstrate applications for human augmentation technology

7.2.2.5 Increase knowledge and proficiency of overall workforce:

1. Improve deployment method of industry standards and training, i.e. Electrical (fiber optic, medium voltage), Welding, and SPC (blasting and coating)
2. Develop and implement tools/processes to build shipbuilding skills that lead to documented proficiency
3. Develop and implement modern tools and methods to reduce training timeline

7.2.2.6 Develop and qualify emerging technologies:

1. New electrical technologies to address:
   a. Energy efficiency and storage
   b. Distribution and protection for medium voltage (i.e., bus pipe, MVDC)
   c. New solutions for topside and bulkhead electrical penetrations
2. Automatable and high speed weld inspection processes
3. Advanced welding processes to improve deposition rates and quality
4. Enhanced Surface Preparation & Coatings (SPC) techniques
5. More efficient paint removal methods
6. Enhanced universal corrosion control system across programs
7. Enhanced fire control and protection methods for hot work
8. Improve methods for outfitting trades (i.e. HVAC, sheet metal, machining, piping)

7.2.2.7 Develop and implement the digitalization of shipbuilding to facilitate development or introduction of tools for improved construction and sustainment activities:

1. Develop a streamlined Navy (NAVSEA) qualification and shipyard acceptance process to facilitate implementation of sensors, Internet of Things (IoT), and Industry 4.0 for shipyard facilities use
2. Technologies to address:
   a. A network of sensors, Internet of Things (IoT), and Industry 4.0 for shipyard facilities use
   b. Digital twin concepts for facilities and project management
   c. Effective means of information transfer to trade workforce (such as visual work instruction)
   d. More efficient communication between engineering, planning, production and procurement
3. Increase acceptance and use of mobile and wearable computers for shipyard applications
4. Expand data capture and records management systems to identify and eliminate bottlenecks and inefficiencies in production
5. Augmented reality tools to improve production and maintenance/sustainment efficiency
6. Increase utilization of material/equipment tracking and health monitoring systems

7.2.2.8 Investigate consolidation of standards, and improvements to Standardization, Commonality and Modularity:

1. Reduce or eliminate unique part numbers for same items
    a. Raw materials
    b. Discrete parts
    c. Number of paints
2. Develop and implement standardized tools and processes for fitting and assembly
3. Standardize and implement methods for intermediate lifts (such as bulkheads/webs/frames)
4. Align distributed systems with construction zones to facilitate modular construction techniques

7.2.2.9 Improve quality, level of detail, and automation of job planning and work instructions:

1. Implement technologies and processes that move work upstream to more efficient work environments
2. Utilize modularity during ship construction to optimize installation sequences and reduce equipment care and protection efforts
3. Utilize tools to better estimate work content, duration and cost
4. Utilize tools to simulate the build and validate the plan before production
5. Develop and implement digital twin and simulation modeling concepts for:
    a. Shop floor planning and tactical re-planning
    b. Production training

7.2.2.10 Develop a framework for qualification and incorporation of Additive Manufacturing (AM) into shipbuilding and repair:

1. Develop a streamlined Navy (NAVSEA) qualification and shipyard acceptance process to facilitate implementation of Additive Manufacturing (AM) for shipyard use
2. Develop and implement common, holistic strategies for accelerated insertion of additive manufacturing that includes considerations for design, infrastructure, capital procurement, applications, robust/flexible system designs, control of upstream production process, and workforce training
3. Develop and implement a strategy and requirements for conventional weld installation and repair procedures of AM parts.

7.2.2.11 Develop solutions to improve installation, maintenance and efficiency of shipboard networks:

1. Reduce distributed system congestion and weight
2. Improve installation efficiency and facilitate efficient maintenance/overhaul activities:

a. Signal testing techniques (compartmentalize sub-system level techniques)
b. Connector installation processes

3. Improve throughput capacity (e.g. blown optical fiber, signal density)
4. Improve temporary data connectivity during construction phase in shop and in ship
5. Develop and implement methods for protecting sensitive cable media

7.2.2.12 Develop warehousing scheduling and logistics improvements to facilitate equipment delivery:

1. Weather protection for sensitive components at pre-installation stage
2. Develop digital twin concepts for material movement and storage within the shipyard
3. Streamline methods to determine that delivered product is as expected
4. Improve methods for material kitting and delivery
5. Improve methods for WIP storage and tracking
6. Develop and implement methods for JIT delivery from suppliers
7. Standardize KANBAN and AGILE methods across all work centers

Infrastructure, Logistics and Sustainment (IL&S) (SIP 7.3)

Definition (SIP 7.3.1)

The Infrastructure, Logistics and Sustainment (IL&S) Major Initiative focuses on improving shipbuilding and sustainment processes for manned and unmanned vessels. This includes attracting and developing a skilled workforce, while maintaining and advancing shipbuilding, modernization and repair capabilities. A focus remains on compliance with environmental, occupational safety and health requirements. It also includes logistics and sustainment processes associated with post-delivery, life cycle support of Navy, other Federal government agency, and commercial vessels.

The IL&S Major Initiative consists of the following two Panels:

- Workforce & Compliance
    - The Workforce & Compliance Panel reflects a recent merger of the Workforce Development and the Environmental, Health and Safety Panels. Projects will focus on improving the industry's workforce development ecosystem, recruiting, maximizing training efficiency and effectiveness, and developing technologies to solve workforce challenges. It also includes researching and addressing current and emerging environmental, health and safety issues to ensure stewardship of industry and communities.
- Sustainment
    - The Sustainment Panel has the mission of reducing the cost of ship logistics and sustainment activities to include repair, maintenance and modernization while increasing operational availability for manned and unmanned vessels. Panel focus will be placed on advancing technologies, materials, processes and procedures that realize greater

efficiencies in lifecycle sustainment. The Panel also includes researching and evaluating opportunities for implementation of digital tools, new technology, and processes to increase operational availability.

IL&S Sub Initiatives (SIP 7.3.2)

1. Recruit, retain and continually develop a skilled and motivated workforce (pathway for critical skills development)
2. Improve the effectiveness of training content and delivery to reduce the training time for knowledge capture, training transfer and quality outcomes
3. Develop new and leverage existing technologies to enhance occupational health, safety, and environmental factors and/or reduce injury rates, property damage and costs associated with compliance
4. Incorporate sustainment considerations in the design phase of manned and unmanned vessels and components to support ship maintenance and modernization of hull, mechanical, and electrical as well as mission system infrastructure
5. Develop new inspection and maintenance processes and procedures to support minimal time in availabilities
6. Develop and implement processes to address supply chain issues
7. Develop processes to improve material/early condition assessments and prognostic monitoring tools to support condition based maintenance and structural health
8. Develop and implement life cycle cost modeling for flexible adaptable manned and unmanned systems as compared to traditional ship building practices

7.3.2.1 Recruit, retain and continually develop a skilled and motivated workforce (pathway for critical skills development):

1. Develop an innovative approach for career pathways (K+) specific to manned and unmanned shipbuilding and repair via skill/ability matrices
2. Develop innovative outreach programs and talent management solutions to identify and recruit critical/specialty skill sets
3. Develop or enhance pathways for skills development through standardized curricula and nationally recognized portable credentials, qualifications and certifications
4. Develop knowledge retention and succession/workforce planning solutions for the shipbuilding and repair industry
5. Implement standardization of Navy specification training for supplier technical personnel

7.3.2.2 Improve the effectiveness of training content and delivery to reduce the training time for knowledge capture, training transfer and quality outcomes:

1. Review and select best practices for knowledge capture to ensure continuity of knowledge transfer

2. Identify and develop innovative skill based lab training
3. Research and select best practices for simulated training environments for the "next generation" workforce – examples: gaming app, AR/VR, training videos, streaming, computer based training and high velocity learning

7.3.2.3 Develop new and leverage existing technologies to enhance occupational health, safety, and environmental factors and/or reduce injury rates, property damage and costs associated with compliance:

1. Develop data analytics to review historical data during different stages of ship construction and repair to eliminate reoccurrence and costs associated with safety mishaps to include fire prevention
2. Develop technologies to identify, process and reduce pollutants (hazardous materials/hazardous waste) from shipbuilding and sustainment processes
3. Implement training tools to educate and identify workplace hazards to reduce injuries and improve safety
4. Identify and implement robotics and automated/assisted processes to replace inherently high risk/dangerous jobs
5. Evaluate materials and methods that are fire resistant for replacement of current materials in use during new construction and repair availabilities
6. Investigate and develop technologies for the identification, mitigation, and suppression of hazards such as, fire and welding during ship building overhaul and maintenance

7.3.2.4 Incorporate sustainment considerations in the design phase of manned and unmanned vessels and components to support ship maintenance and modernization of hull, mechanical, and electrical as well as mission system infrastructure:

1. Develop improved design tools to standardize shipbuilding design practices across shipyards that facilitate sustainment
2. Develop innovative methods to leverage the use of existing equipment and components in modernization design efforts to minimize cost and in-service availability time
3. Identify and pursue advanced materials (composites) that reduces the burdens associated with cost and longevity
4. Improve accuracy of engineering and design products supporting ship modernization and upgrades
5. Identify/provision existing commercial advanced technologies for shipbuilding, modernization and repair applications
6. Leverage advanced technology to assist remote personnel to accurately determine locations of potential interferences when designing for modernization and ship upgrades.

7.3.2.5 Develop and implement new inspection and maintenance processes and procedures to support minimal time in availabilities:

1. Incorporate emerging technologies to advance inspection, sustainment and improved reliability
2. Evaluate digital support tools and processes to reduce time in availability
3. Develop capability to automate detection, non-destructive inspection, and assessment of corrosion and delamination on vessels
4. Mature capabilities for problem identification and rapid repair of critical systems such as propulsion and steering system components
5. Adapt comprehensive production planning systems to develop an integrated plan tailored to short duration availabilities
6. Perform qualification efforts for advanced technologies that will be more reliable and/or require less maintenance than legacy technologies
7. Develop Virtual Reality/Augmented Reality capabilities that can enhance ship check and planning processes.

7.3.2.6 Develop and implement processes to address supply chain issues:

1. Investigate alternative additive manufacturing technology and materials to mitigate issues with parts obsolescence and/or long lead times
2. Develop data analytic and predictive modeling methods that support early identification of potential supply chain issues
3. Codify guidelines to assist suppliers in addressing supplier gaps with the execution of Quality Management Systems such as welding, Non-Destructive Testing, shock and vibration

7.3.2.7 Develop processes to improve material/early condition assessments and prognostic monitoring tools to support condition based maintenance and structural health:

1. Develop data analytic methods that support early identification of potential system failures
2. Explore robotics or other AI/ML methods to improve condition inspections of hulls, tanks and other systems
3. Explore condition based maintenance and structural health monitoring capabilities from other industries

7.3.2.8 Develop and implement life cycle cost modeling for flexible adaptable manned and unmanned systems as compared to traditional ship building practices:

1. Research and implement efforts to identify life cycle cost models that help with reducing shipbuilding costs
2. Research, develop, and implement a cost model that identifies the differences between flexible, adaptable, manned and unmanned systems from traditionally designed ships
3. Examine how the different phases of new construction and modernization can be more accurately estimated and propose reflective cost model(s) for future acquisitions

4. CONCLUSION

NSRP is committed to supporting the national Defense and maritime strategy by providing a collaborative framework and performing research and development on shipbuilding and ship repair processes and technologies that will reduce the total ownership cost of United States Government and U. S.-flag commercial ships, and enhance the capacity of the US maritime industrial base to meet future demand. The NSRP will collaborate with other organizations to execute the strategy described in this TIP to support the nation's plan to increase its maritime capability by increasing the overall number of vessels, increasing the combat capability of military vessels, increasing the operational availability of all vessels, and improving the ability to rapidly upgrade mission systems.

The strategic objectives that promote the NSRP mission consist of funding R&D projects that affect total ownership cost as follows:

- Insertion of relevant technologies that reduce design, acquisition, testing or delivered ship operations and sustainment (maintenance/repair/conversion) costs
- Development of improved processes that reduce design, acquisition, testing or delivered ship operations and sustainment (maintenance/repair/conversion costs