Technology Investment Plan FY22

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 reviewed 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 22-23 January 2020 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.

Ship Design and Material Technologies (SDMT) (SIP 7.1)

Definition (SIP 7.1.1)

The Ship Design and Material Technologies (SDMT) Major Initiative covers the full spectrum of ships, systems and equipment for design, construction, and sustainment. The initiative investigates new materials, processes, technologies, commonality and standardization principles with the goal of adding value for future programs, reducing the cost of new designs, minimizing the cost of maintenance and repair and controlling the total ownership cost to the U.S. Government and the commercial sector. This MI also focuses on emerging technology research and the blending of process and technology to manage information and develop advanced solutions that support the full product lifecycle.

This Major Initiative consists of three panels: the Ship Design and Material Technologies (SDMT) Panel, the Ship Warfare Systems Integration (SWSI) Panel, and the Business Technologies (BT) Panel.

- The SDMT Panel is focused on projects that provide increased capabilities and cost reduction initiatives across the complete spectrum of design processes (concept to detail) and the use of advanced materials to support the rapid and efficient development, construction, sustainment, and disposal of the next generation vessels.
- The SWSI Panel reduces the costs of integration and test for warfare and communication systems in ship construction and maintenance/modernization. The Panel facilitates communications among Government programs, warfare systems integrators, communication system integrators, ship designers, shipbuilders and other NSRP panels.
- The Business Technologies Panel focuses on emerging technology research and education and the blending of process and technology to manage information and develop advanced solutions that support the product lifecycle from concept to disposal.

SDMT Sub initiatives (SIP 7.1.2)

1. Reduce time for development and qualification of emerging materials and manufacturing technologies
2. Develop and implement autonomous processes in design for construction
3. Develop materials, design and logistics processes that reduces sustainment/modernization costs and schedule
4. Develop advanced learning (AI/machine learning) and decision support tools focused on sustainment, ship availability, and design

5. Develop design guidance regarding unmanned or manned platforms for production, integration, sustainment, and operation
6. Identify and implement designs that create flexibility, modularity, and scalability across new or existing platforms
7. Research and leverage foreign, domestic and adjacent industries for design, materials and manufacturing technologies
8. Promote technologies that lead to affordable solutions for digital shipbuilding
9. Develop processes and technologies that create innovative approaches to cybersecurity compliance, solutions, education & awareness
10. Identify areas within information management that benefit the shipbuilder and our Navy customer
11. Emerging Technologies & Business Processes

7.1.2.1 Reduce time for development and qualification of emerging materials and manufacturing technologies for:

1. Additive manufacturing
2. Approval of specifications and standards
3. Repair processes for legacy systems
4. Non-metallic materials for shipboard application
5. High throughput materials manufacture
6. Low/no welding pre-heat materials
7. Advanced structural materials
8. The application of advanced insertion of materials (AIM) based qualification techniques

7.1.2.2 Develop and implement autonomous processes in design for construction for:

1. Improved application of robotic manufacturing
2. Modular construction
3. Design for Production (DfP) rules
4. Large scale additive manufacturing

7.1.2.3 Develop materials, design and logistics processes that reduce sustainment/modernization costs and schedule for:

1. Environmental resistant materials and surface treatment techniques
2. In-situ monitoring technologies and methods
3. Customizable techniques for achieving localized material properties
4. Identifying design tools and method for efficient upgrades
5. Incorporation of 3D products

7.1.2.4 Develop advanced learning (AI/machine learning) and decision support tools focused on sustainment, ship availability, and design for:

1. Capturing effects of materials and manufacturing processes
2. Optimizing design and manufacturing process decisions

3. Early prediction of failures for lifecycle

7.1.2.5 Develop design guidance regarding unmanned or manned platforms for production, integration, sustainment, and operation for:

1. Physical integration
2. Security
3. Power architecture
4. C5ISR
5. Weapons
6. Standards and interfaces for UxV (Unmanned Air, Surface, Subsurface Vehicles)

7.1.2.6 Identify and implement designs that create flexibility, modularity and scalability across new or existing platforms for:

1. Access and removal routes
2. Mission spaces
3. Standard interfaces for maintenance
4. Investigating best practices across foreign and domestic industries

7.1.2.7 Research and leverage foreign, domestic and adjacent industries for design, materials and manufacturing technologies for:

1. Marine structural materials
2. Continuous production technologies
3. Design for just-in-time equipment
4. Artificial Intelligence (AI) and machine learning
5. Automation
6. Damage tolerant design methods
7. Non-metallic materials for shipboard application

7.1.2.8 Digital Shipbuilding

1. Integrate Enterprise Processes and Tools to support digital shipbuilding including Internal and External PLM, Manufacturing Execution Systems (MES), Data Exchange, ERP, Modeling and Simulation
2. Enable the Digital Thread by integrating Digital Design tools, analysis, manufacturing (CAx) and sustainment technologies into the enterprise environment
3. Develop a fully integrated and collaborative Model-Based Enterprise (MBE)
4. Enable the Digital Twin across the External and Internal Enterprise
5. Leverage Cloud, Mobile, IIOT and Data Capture Technologies in the shipbuilding arena

7.1.2.9 Cybersecurity Compliance, Solutions, Education & Awareness

1. Increase awareness of Cybersecurity best practices for Enterprise Processes and Tools, Model-Based Enterprise (MBE), Internal/External PLM, data access, and data exchange

2. Introduce compliance solutions for Enterprise Processes and Tools, Model-Based Enterprise (MBE), Internal/External PLM, data access, and data exchange
3. Investigate solutions for protecting data systems including IIOT, Scanning Technologies, Mobile Technologies, Cloud Technologies and Autonomous Systems

7.1.2.10 Information Management

1. Identify solutions and best practices for data configuration management and governance
2. Identify and propose standards for data exchange, delivery, interoperability, intra-operability between internal/external systems such as CAD, PLMs, MES, IIOT, Scanning and Cloud Technologies
3. Implement innovative solutions for shipbuilding informatics (data analytics, business intelligence, and reporting)

7.1.2.11 Emerging Technologies & Business Processes

1. Explore the evolution and feasibility of these emerging technologies to improve shipyard efficiency, listed in order of priority:
    1. Additive Manufacturing
    2. Cloud Technologies
    3. Autonomous Systems
    4. Industrial Internet of Things (IIOT)
    5. Mobile Technologies
    6. Knowledgeware
    7. Artificial Intelligence and machine learning
    8. AR/VR/MR
    9. Scanning Technologies
    10. Robotics

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.

This Major Initiative consists of the following four panels: Electrical Technologies; Planning, Production Processes, and Facilities; Surface Preparation and Coatings; and Welding. The SPT Major Initiative focuses on the following:

- Fabrication, assembly, and erection of all ship structures
- Outfitting processes (electrical, piping, sheet metal, etc.)
- Equipment installation and test

- Surface preparation and coatings
- Welding/Joining/Non-Destructive Testing
- Support Services (planning, production control, accuracy control, etc.)
- Manufacturing Services (transportation and rigging, tool rooms, temporary ventilation/lighting, etc.)

SPT Sub initiatives (SIP 7.2.2)

7.2.2.1 Improving Manufacturing Processes

1. Implement technologies and processes that move work off hull to more efficient work environments
2. Identify improvements in fiber optic cable, connector and testing methodologies
3. Identify and demonstrate applications that utilize drones during the inspection process
4. Increase utilization of accuracy control technologies
5. Implement technologies that improve current inspection processes
6. Standardize strategies to optimize shipyard coating processes
7. Develop technologies or tools to facilitate termination of electrical cables (medium voltage cables)

7.2.2.2 Increase use of Automation and Robotics

1. Identify use cases and business opportunities for automation and robotics in shipyards
2. Develop common, holistic strategies for accelerated insertion of automation that include considerations for design, infrastructure, capital procurement, applications, robust/flexible system designs, control of upstream production process, and workforce training
3. Develop simple, general purpose mechanical aides
4. Develop technology to allow for utilization for human augmentation in automation control
5. Develop novel sensor technologies and control algorithms that enable adaptive automation
6. Research and advance the automation of ancillary processes
7. Integrate predictive analyses into off-line robotic programming or ship design software programs
8. Develop requirements associated with automation

7.2.2.3 Increasing 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 basic shipbuilding skills that lead to certification
3. Increase vendor base knowledge and awareness of Navy shipbuilding and repair requirements

7.2.2.4 Development and Qualification of Emerging Technologies

1. Investigate full shipyard impact of additive manufacturing on production processes
2. Develop new energy storage and energy efficiency technologies
3. Develop a qualification process and qualified system for bus pipe
4. Develop automatable and high speed weld inspection processes
5. Develop medium voltage DC power distribution and protection technologies
6. Develop additional Surface Preparation & Coatings (SPC) techniques
7. Enhance corrosion control system
8. Improve cable tagging and cableway management technologies (e.g. RFI cable tags)
9. Develop new solutions for topside and bulkhead electrical penetrations
10. Develop advanced welding processes to improve deposition rates and quality

7.2.2.5 Digitalization of Shipbuilding

1. Expand data capture and records management systems
2. Increase use of mobile and wearable computers for shipyard applications
3. Increase utilization of material/equipment tracking systems
4. Develop effective means of information transfer to trade workforce
5. Develop a network of sensors and Internet of Things (IoT) for shipyard facilities use

7.2.2.6 Standards, Commonality and Modularity

1. Utilize modularity during ship construction to optimize installation sequences and reduce equipment care and protection efforts
2. Develop processes for expanded use of plug and play components
3. Standardize access to high change spaces to aid in upgrade and repair activities
4. Facilitate implementation of “hatchable” equipment
5. Align electrical design with construction zones to facilitate modular construction techniques
6. Design, develop, and gain approval for more efficient outfitting processes i.e. common foundations

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

Definition (SIP 7.3.1)

The Infrastructure, Logistics and Sustainment Major Initiative is focused on supporting all direct shipbuilding and sustainment processes. This includes developing a skilled workforce, and maintaining the well-being of shipbuilding and ship repair communities through compliance with environmental, health and safety requirements. It also includes logistics and sustainment processes associated with life cycle support of Navy, other Federal government agency, and commercial ships. The Major Initiative consists of a Panel and a Working Group as follows:

- Workforce

The Workforce Panel reflects a recent merger of the Workforce Development Panel and the Environmental, Health and Safety Panel. As such, its mission includes the scope of each of the prior panels. It includes reducing the cost of shipbuilding and ship repair and adopting best practices through projects centered on improving the industry's workforce development ecosystem, maximizing training efficiency and effectiveness, and developing technologies to solve workforce challenges. It also includes researching, developing, and sustaining current and emerging environmental, health and safety issues to promote and improve health and safety, wellness, and environmental stewardship of industry communities.

- Sustainment Working Group

  The Sustainment Working Group has the mission of reducing the cost of ship logistics and sustainment activities, and increasing operational availability, with a focus on improved technologies, processes and procedures that realize greater efficiencies in lifecycle sustainment of Navy, other Federal government agency, and commercial ships. The Working Group should also research and evaluate opportunities for how the use of digital tools, new technology, and processes could decrease the time spent in a maintenance availability.

IL&S Sub Initiatives (SIP 7.3.2)

(NOTE: the IL&S Sub Initiatives and project interest areas are still under development)

7.3.2.1 Attract, retain and continually develop a competent and motivated workforce (pathway for craft skills development; workforce development pipeline)

1. Improve branding and awareness campaigns
2. Develop innovative partnerships with external trade schools/training facilities
3. Promote/advertise and prepare workers for technology advancements
4. Develop or enhance pathways for skills development through standardized curricula and nationally recognized portable credentials
5. Research and select best practices for communicating with next gen workforce – examples: gaming app, YouTube, streaming
6. Define and build talent management solutions for all hard-to-fill/high demand jobs in the industry
7. Identify, design, and implement talent pipelines critical to shipbuilding and repair industry
8. Develop career pathways specific to shipbuilding and repair via skill/ability matrix
9. Develop portable credentials for training and link to shipyard jobs
10. Develop knowledge retention and succession/workforce planning solutions for the shipbuilding and repair industry
11. Improve employee work experience and effectiveness through innovative technologies
12. Develop innovative ways to better train people
13. Develop/select innovative and effective ways to mitigate the need for retraining and re-certification
14. Develop specialty skills within current workforce

15. Improve processes to reduce reliance on specialty skills
16. Improve retention through high velocity learning – see, swarm/solve, share, and sustain

7.3.2.2 Improve the effectiveness and reduce the training time for knowledge capture and training transfer

1. Implement best practices of computer based training
2. Review and select best practices for knowledge capture
3. Identify and develop innovative skill based training i.e.: gamification

7.3.2.3 Eliminate workplace injuries and improve shipbuilder well-being

1. Identify and select best practice training and wellness programs to increase productivity and reduce liabilities to the shipbuilding and repair industry
2. Develop organizational change management solutions to reduce injuries in shipbuilding and repair industry through habit based learning
3. Investigate injury reduction benefits from wearable technology and human augmentation, including other industries, for implementation in shipbuilding and repair industry
4. Optimize training in order to eliminate workplace injuries
5. Conduct data analysis of wellness programs to show effectiveness
6. Optimize and implement back-to-work programs to reduce loss of work time
7. Identify and select best ergonomic and human factor practices to prevent injuries
8. Investigate new product insertion for improved employee efficiency and safety

7.3.2.4 Develop new and leverage existing technologies to enhance health, safety, and environmental factors and/or reduce costs associated with compliance

1. Identify technologies/processes to reduce pollutants (hazmat/hazwaste) from shipbuilding and sustainment processes
2. Investigate real time environmental monitoring equipment for regulatory compliance and emissions reduction
3. Investigate alternative environmentally friendly technologies for cadmium and chromium processes to minimize exposures to employees and to reduce hazardous waste disposal costs

7.3.2.5 Incorporate sustainment in design

7.3.2.6 Develop new maintenance processes and procedures to support minimal time in availabilities

7.3.2.7 Incorporate advanced technologies to benefit sustainment or improve reliability

7.3.2.8 Supply chain issues

7.3.2.9 Information/data management

4. CONCLUSION

NSRP is committed to supporting the national 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. 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