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SAIL Framework within the QUAD Helix: GOVERNMENT, INDUSTRY, CITIZENS, ACADEMIA

FORGING THE FUTURE FLEET

The SAIL FRAMEWORK FOR U.S. SHIPBUILDING WORKFORCE AND INFRASTRUCTURE REVITALIZATION

A Strategic Research White Paper by the Smart Development Institute

December 11, 2025 (Updated Edition)

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1. Executive Summary

The commercial shipbuilding capacity and maritime workforce of the United States have been weakened by decades of neglect, empowering adversaries and undermining national security. **The nation now stands at a strategic inflection point: the nation must act decisively to restore its shipbuilding strength before decline becomes irreversible** in maritime readiness, growing dependence on foreign powers for critical capabilities, and reduced ability to respond to global crises. **Without decisive action**, the United States risks being unable to project maritime strength, sustain vital supply chains, or defend its economic and military interests at sea during times of conflict. Recognizing these threats, the U.S. Government must act with urgency to pass the **SHIPS for America Act** and fully implement the objectives outlined in the **April 9, 2025, Executive Order on Restoring America's Maritime Dominance**. These initiatives call for rebuilding the domestic industrial base, strengthening the maritime workforce, and ensuring the long-term resilience of the nation's shipbuilding infrastructure, all essential to safeguarding national security and economic sovereignty.

To meet these challenges, this white paper, ***Forging the Future Fleet: A Modern Framework for U.S. Shipbuilding Workforce and Infrastructure Revitalization***, presents the **SAIL Framework** for revitalization built on four interconnected pillars, **Strengthen Workforce, Augment Shipyard Capacity, Integrate Digital Modernization, and Lead National Engagement.** Each pillar addresses a core weakness: training capacity, labor shortages, outdated systems, and public awareness, while reinforcing the others to create a sustainable foundation for industrial recovery and maritime resilience. Achieving these goals requires unified and collaborative action across government, industry, academia, and the public under **the Quad Helix model**, working on a shared mission to rebuild capacity.

In the Quad Helix model, **government** sets direction and policy, **industry** drives innovation and execution, **academia** advances research and workforce development, and **citizens** contribute participation and public support. Working together, these four sectors form a **self-reinforcing ecosystem** capable of restoring America's shipbuilding leadership, ensuring security, and strengthening the nation's economic foundation. **Building on the Triple Helix model**, where government, industry, and academia collaborate to strengthen America's shipyards through workforce development, workforce augmentation, and digital transformation, the Quad Helix extends this partnership to include the public. Guided by the SHIPS for America Act and the April 9 Executive Order on Restoring America's Maritime Dominance, this partnership lays the foundation for maritime revitalization. **As these initiatives may rely on taxpayer investment, engaging the fourth helix, citizens**, through active communication and outreach is essential to foster understanding, transparency, and public trust and acceptance of this national effort to restore America's maritime strength and economic competitiveness. **Figure 1** illustrates the four interconnected pillars of America's shipbuilding revitalization strategy under a Quad Helix Framework.

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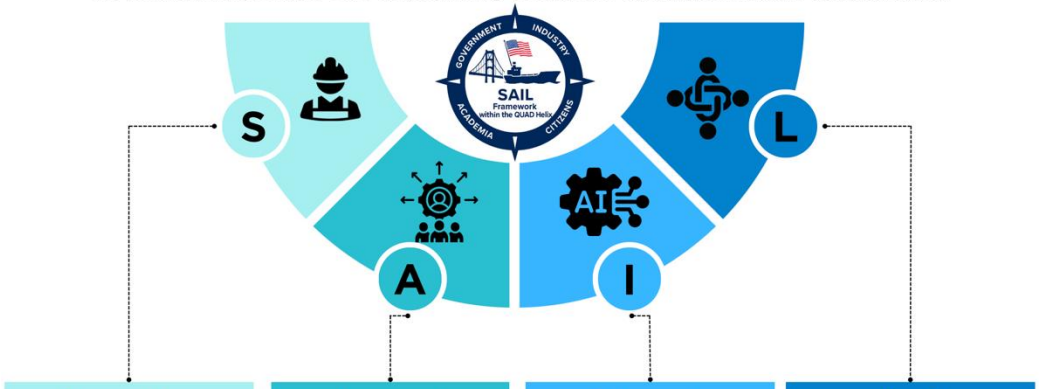
S.A.I.L. FRAMEWORK

A Modern Blueprint for U.S. Shipbuilding Workforce and Infrastructure Revitalization



Strengthen Workforce	Augment Shipyard Capacity	Integrate Digital Modernization	Lead National Engagement
GOAL Rebuild the nation's skilled trade base	**GOAL** Bridge short term workforce gaps while building long-term capacity	**GOAL** Modernize shipyards through secure, intelligent digital systems	**GOAL** Unite public, private, academic, and civic stakeholders behind the national maritime mission.
KEY ACTIONS • Modernize training curriculum and certifications • Establish regional training and mentorship hubs • Develop instructor certification and retention programs • Partner with allied nations (South Korea, Japan, and the Philippines) for expertise	**KEY ACTIONS** • Recruit vetted allied professionals under secure framework • Pair allied instructors with U.S. trainees for effective knowledge transfer • Establish industrial exchange partnerships with allied shipyards • Advocate H-1B visa National Interest Exceptions (NIEs) for shipbuilding roles	**KEY ACTIONS** • Integrate Privatized and Secure AI Ecosystem (such as Generative AI / Agentic AI) to improve Shipyard workflow and processes. • Ensure workforce training for Digital and AI literacy and proficiency • Protect data with Geofencing and defense grade cybersecurity	**KEY ACTIONS** • National awareness and education campaigns • Promote K-12 and university maritime career initiatives • Industry and community engagement events • Digital storytelling, social media podcasts and documentaries
OUTCOME A sustainable national pipeline of skilled American shipbuilders and instructors, ensuring long-term industrial capacity and workforce excellence.	**OUTCOME** Sustained production, faster training cycles, and a more resilient American workforce capable of meeting national shipbuilding demands.	**OUTCOME** Intelligent, secure shipyard operations with optimized workflows and smarter processes that amplify workforce productivity and operational precision.	**OUTCOME** A united national movement that builds public pride, inspires future generations, and strengthens support for America's shipbuilding resurgence.

QUAD HELIX COLLABORATION

Government | Industry | Academia | Citizens

FIGURE 1. SAIL FRAMEWORK – THE FOUR PILLARS OF U.S. SHIPBUILDING REVITALIZATION IN QUAD HELIX FRAMEWORK

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2. Objectives

The U.S. shipbuilding industry stands at a defining crossroads. Recent federal actions, most notably the ***Ships for America Act***[1] and **President Trump's April 9, 2025 Executive Order on *"Restoring America's Maritime Dominance,"***[2] have created a renewed **national imperative** to rebuild the country's maritime strength and industrial base. These directives affirm that shipbuilding is essential not only to sustain naval superiority but also to power economic growth, innovation, and national security. **Yet the industry faces critical shortages of skilled workers, outdated training systems, and declining instructor pipelines, even as global competitors modernize at a rapid pace.** Without decisive action, the nation risks losing the industrial resilience needed for maritime readiness.

To turn this national imperative into measurable progress, this white paper outlines the practical **SAIL Framework four-pillar approach** consisting of **(1) Strengthen Workforce, (2) Augment Shipyard Capacity, (3) Integrate Digital Modernization, and (4) Lead National Engagement,** built on the **Triple Helix collaboration** of government, industry, and academia, working together to align policy, capability, and innovation. This cooperative framework ensures that every stakeholder contributes to building a skilled, adaptive, and technologically advanced shipbuilding workforce that supports both defense and commercial goals.

3. Understanding Challenges in the U.S. Shipbuilding Industry

3.1. The Workforce Challenge

The **Government Accountability Office (GAO)** recently reported that "U.S. shipbuilders remain over budget and behind schedule due to worker shortages for meeting the Navy's demands," noting that shipyards continue to struggle to recruit and retain staff with the technical skills needed for construction and repair. These workforce and capacity constraints threaten the timely execution of national shipbuilding goals and highlight the urgent need for a coordinated strategy to expand training and strengthen technical capacity across the maritime industrial base.[3]

The challenge facing America's shipbuilding industry is not just about infrastructure or capital, it is fundamentally a workforce problem. As the **U.S. Naval Institute** observed, **"while the physical plant and financial capital hold great importance, human capital determines the**

[1] *H.R.3151 - SHIPS for America Act of 2025, Congress.Gov, https://www.congress.gov/bill/119th-congress/house-bill/3151/text/ih*

[2] *Executive Order: Restoring America's Maritime Dominance, The White House, April 9, 2025, https://www.whitehouse.gov/presidential-actions/2025/04/restoring-americas-maritime-dominance/*

[3] *U.S. Navy Shipbuilding Is Consistently Over Budget and Delayed Despite Billions Invested in Industry, GAO, April 8, 2025, https://www.gao.gov/blog/u.s.-navy-shipbuilding-consistently-over-budget-and-delayed-despite-billions-invested-industry#:~:text=The%20Navy%20initially%20planned%20to,at%20blog@gao.gov.*

survival or collapse of a shipyard."[4] As shipyards invest in modernization, **physical assets can be rebuilt; a skilled workforce cannot be reconstituted overnight**. Furthermore, a recent **McKinsey & Company** analysis underscores this same point, noting that America's shipyards "face myriad challenges — from talent gaps to outdated operating models" and that increasing output will require addressing "the strained supply of skilled-trade and engineering talent."[5]

3.2. Workforce Development and Augmentation

Across the country, shipyards face a growing shortage of skilled trades. Welders, pipefitters, electricians, and machinists are in especially high demand. The American Welding Society projects a shortage of more than 360,000 welding professionals by 2027—a gap that threatens to slow or even halt ship production if left unaddressed.[6] Contributing factors include the closure of industrial education programs, waning interest in blue-collar careers, and stiff competition from other sectors like oil, gas, and construction.

The domestic pipeline alone cannot meet the near-term demand for skilled labor or instruction. **Workforce development is constrained by a shortage of qualified teachers** who can train welders, machinists, and other essential trades. **To accelerate capacity building, the United States must complement domestic training with workforce augmentation that brings in experienced trainers and technical specialists from allied nations.** These professionals can help sustain shipyard operations while transferring knowledge to new American workers, strengthening the long-term workforce base. This approach supports national security priorities, fulfills congressional intent to revitalize the maritime industry, and ensures that investments in training and modernization deliver measurable results.

3.3. Outdated Shipyard Infrastructure

Even with new investments in workforce development and augmentation, the physical and digital limits of U.S. shipyard infrastructure continue to constrain progress. Many facilities still rely on aging equipment, narrow production layouts, and limited training space that leave little room to scale. As the U.S. Government Accountability Office (GAO) has noted, insufficient investment in modernization and digital integration directly affects performance, delaying the Navy's shipbuilding goals and weakening the industrial base.[7]

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[4] *Tylet Pitrof, The Shipyard Shortage Is a People Problem, U.S. Naval Institute, September 2024, https://www.usni.org/magazines/proceedings/2024/september/shipyard-shortage-people-problem*

[5] *Charting a new course: The untapped potential of American shipyards, McKinsey & Company, June 5, 2024. https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/charting-a-new-course-the-untapped-potential-of-american-shipyards*

[6] *American Welding Society. https://weldingworkforcedata.com/*

[7] *Government Accountability Office (GAO) Report. https://www.gao.gov/assets/gao-25-106286.pdf*

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Today's shipyards need more than upgraded machinery. They require a digitally connected foundation that can support a new generation of intelligent tools. This transformation is driven by the **Privatized AI Ecosystem**, which combines secure, behind-the-firewall applications of both Generative AI and Agentic AI. **Generative AI** assists the workforce by creating and refining blueprints, producing digital work instructions, and simulating complex build scenarios that reduce trial and error. **Agentic AI**, on the other hand, acts autonomously within defined boundaries, monitoring workflows, coordinating schedules, and identifying production bottlenecks in real time, all within the shipyard's digital perimeter.

Together, these capabilities function as a **force multiplier** and **productivity amplifier,** without replacing people or disrupting workforce continuity. The Privatized AI Ecosystem streamlines information flow, connects siloed data sources, and enhances decision-making across engineering, production, and logistics. **Through GeoFencing controls and defense-grade security,** every digital process remains contained within approved boundaries, ensuring full compliance with data sovereignty and cybersecurity standards.

Modernizing shipyard infrastructure to fully accommodate this ecosystem is essential to restoring efficiency, readiness, and competitiveness. **Without a secure digital backbone that supports AI-driven tools, America's shipyards risk falling behind in productivity and innovation**. The convergence of these challenges, outdated infrastructure, a depleted skilled trade pipeline, and a shortage of qualified instructors, continues to limit the nation's ability to rebuild its maritime strength.

According to the National Defense Industrial Association (NDIA), workforce constraints remain the top barrier to expanding shipbuilding capacity and supporting national security priorities. NDIA has called for urgent investment in training, mentorship, and industrial revitalization to avoid undermining the Navy's long-term fleet objectives.[8]

3.4. Projected Outlook Over the Next 3, 5, and 10 Years

The coming decade will test the capacity and coordination of America's shipbuilding workforce more than any period in recent memory. **The shortage of skilled engineers, technicians, and digital shipbuilding professionals is expected to deepen as naval and commercial demands expand, placing unprecedented strain on training systems and production schedules.**

[8] *National Defense Industrial Association (NDIA). NDIA and Navy TPP Team Up to Grow Next-Gen Shipyard Talent https://www.ndia.org/about/press/press-releases/2025/4/30/talent-pipeline-program*

3.4.1. Three-Year Outlook (2025–2028)

In the near term, shipyards will continue to face acute workforce constraints as the Navy's fleet expansion goals collide with a limited pool of qualified talent. Without a steady pipeline of certified instructors and experienced mentors, new recruits will take longer to reach proficiency, extending production timelines and driving up costs. **Many shipyards will also struggle to implement digital shipbuilding practices due to insufficient training**. Targeted investments in education, mentorship, and selective international recruitment will be essential to stabilize production and rebuild workforce momentum.[9]

3.4.2. Five-Year Outlook (2025–2030)

At the end of the decade, U.S. shipyards will be navigating a critical transition point. The global shipbuilding market, expected to approach $193 billion, will heighten competitive pressure on American yards to modernize operations and workforce systems simultaneously. Success will depend on dual investment: revitalizing physical infrastructure while scaling advanced training networks. Without coordinated public-private investment in instructor development and technical education, the U.S. risks ceding strategic ground to global competitors.[10]

3.4.3. Ten-Year Outlook (2025–2035)

Looking further ahead, the nation's goal to build and sustain a 390-ship Navy will hinge on one decisive factor: the depth and readiness of its skilled workforce. Achieving this vision will require thousands of tradespeople proficient in both traditional and digital manufacturing methods. National collaboration among shipyards, community colleges, unions, and international partners will be vital to expanding capacity, maintaining production at scale, and close the labor gap.[11] If these efforts are realized, the next decade could mark a historic turnaround, restoring the United States as both a naval power and a global leader in maritime innovation.

4. SAIL Framework - A Four-Pillar Approach to Bridge the Gaps

America's path to restoring maritime strength requires more than isolated programs or temporary fixes. It calls for a comprehensive and sustained framework that addresses the root causes of the nation's shipbuilding challenges. The SAIL Framework outlined in this section: **Strengthen Workforce, Augment Shipyard Capacity, Integrate Digital Modernization, and Lead**

[9] *National Academies of Sciences, Engineering, and Medicine. Research and Education for Maritime Progress.* https://nap.nationalacademies.org/catalog/20405/research-and-education-for-maritime-progress

[10] *Fortune Business Insights. Shipbuilding Market Size, Share & COVID-19 Impact Analysis.* https://www.fortunebusinessinsights.com/shipbuilding-market-103351

[11] *U.S. Government Accountability Office. Navy Needs a Strategic Approach for Private Sector Industrial Base.* https://www.gao.gov/products/gao-25-106286

National Engagement form an integrated strategy to rebuild capacity, accelerate learning, and modernize operations across the entire industrial base. Each pillar serves a distinct but complementary purpose: to grow the skilled labor pipeline, strengthen the teaching and technical core, digitize and secure production systems, and align the public narrative behind a revitalized national mission. Together, these pillars provide a practical roadmap for transforming today's fragmented efforts into a coordinated movement capable of closing the workforce gap and securing America's shipbuilding future.

4.1. Strengthen the Workforce through Workforce Development

Workforce Development anchors the nation's shipbuilding revitalization strategy and serves as the first pillar of sustainable industrial recovery. It focuses on rebuilding the foundation of America's skilled trade base through modern, competency-based training programs aligned with shipyard and supplier requirements. Guided by the **Triple Helix model**—a collaborative framework uniting government, industry, and academia—this initiative ensures that workforce programs are both strategically coordinated and outcome-driven.

The Workforce Development pillar establishes a national framework that expands capacity, accelerates skill acquisition, and standardizes instruction across the maritime industrial base. Key elements include:

- **Curriculum Modernization:** Align training standards with U.S. Department of Labor frameworks across critical trades such as welding, pipefitting, marine electrical systems, and mechanical work.
- **Competency-Based Certification:** Develop clear credentialing pathways to verify skill mastery and improve mobility within the industrial workforce.
- **Integrated Learning Models:** Combine simulation-based and hands-on training methods to reinforce real-world readiness and production safety.
- **Regional Training and Mentorship Hubs:** Create geographically distributed centers of excellence to provide accredited instruction, mentorship, and instructor development supported by the Triple Helix collaboration.
- **Instructor Development and Retention:** Build a structured national effort to train, certify, and retain qualified instructors capable of scaling skill development nationwide.

This strategy, however, faces strong headwinds due to a persistent shortage of instructors and technical trainers. The current domestic pipeline cannot meet the near-term demand for teaching personnel needed to sustain training momentum. **To close this gap, the United States will require strategic international partnerships**, particularly with **allied countries, South Korea, Japan, and the Philippines,** which offer strong maritime education systems, experienced personnel, and certification frameworks that align with U.S. industry

standards. Recruiting qualified instructors and technical specialists from these allied nations is a prudent and necessary interim measure when managed under a secure and structured framework. **Japan, South Korea, and the Philippines share long-standing defense and industrial ties with the United States, reinforcing common security and maritime objectives.** Their participation can bridge immediate instructional gaps without displacing American workers or compromising sovereignty. This approach strengthens knowledge transfer, maintains production within U.S. facilities, and **reflects proven collaboration models already used across the defense and aerospace sectors within the NATO alliance**.

South Korea

As one of the leading nations in commercial shipbuilding, South Korea is known for its advanced modular construction techniques and extensive use of automation in shipyards such as Hyundai Heavy Industries and Samsung Heavy Industries. South Korea's maritime training institutions, including Korea Maritime and Ocean University, produce highly skilled engineers, technicians, and quality control professionals. These individuals possess deep expertise in digital shipyard operations and can contribute significantly to U.S. shipbuilding modernization efforts and training initiatives.

While South Korea is a global leader in shipbuilding, it is also currently grappling with significant labor shortages exacerbated by an aging population and declining birth rates. The shipbuilding industry faces an estimated shortage of around 14,000 workers, with projections indicating a need for an additional 45,000 to meet current demands.[12] Efforts to mitigate this include expanding skilled worker visa quotas and establishing training partnerships with neighboring countries.

Japan

Japan has a long-standing tradition of precision shipbuilding and is a global leader in robotics and smart manufacturing. Educational institutions such as the National Institute of Technology (KOSEN) and the Japan Maritime College focus on hands-on engineering, automation, and safety practices. Japanese professionals are known for their discipline, attention to detail, and expertise in integrating advanced technologies into production workflows. These capabilities make Japan a valuable source of instructors, mentors, and innovation leaders in digital shipbuilding environments.

Japan's shipbuilding sector is similarly affected by demographic shifts, with a rapidly aging population and a shrinking workforce. A recent Reuters survey revealed that two-thirds of Japanese companies are significantly impacted by labor shortages due to the country's declining and aging

[12] *Stimson Center. (2023). Waypoints and Course Adjustments: Toward Naval Shipbuilding Cooperation with South Korea. Retrieved from: https://www.stimson.org/2025/waypoints-and-course-adjustments-towards-naval-shipbuilding-cooperation-with-south-korea*

population.[13] The government has implemented measures such as raising the retirement age and encouraging older individuals to remain in the workforce. Despite these efforts, the labor shortage remains a pressing issue, particularly in industries like shipbuilding that require specialized skills.

Philippines

In contrast to the aging workforces in South Korea and Japan, the Philippines boasts a young, dynamic, and highly skilled maritime labor pool. The country is the world's largest supplier of maritime labor, with over 30% of global seafarers originating from the Philippines.[14] Filipino professionals are renowned for their strong English proficiency, adaptability, and hands-on shipyard experience. The Philippines' robust network of maritime training institutions, certified by the International Maritime Organization (IMO) and overseen by agencies like the Technical Education and Skills Development Authority (TESDA), ensures a steady supply of competent maritime workers.

Moreover, the Philippines has a history of providing skilled labor to both South Korea and Japan to support their shipbuilding industries. This established track record positions the Philippines as a reliable partner for workforce development initiatives aimed at revitalizing the U.S. shipbuilding sector.

4.2. Augment Shipyard Capacity through Workforce Augmentation

The shortage of qualified instructors and technical trainers remains the most immediate challenge to rebuilding America's shipbuilding workforce. **The Workforce Development pillar establishes the foundation for long-term capacity building, but it cannot expand quickly enough to meet current production demands. Workforce Augmentation functions as a hybrid extension of that effort, bridging short-term labor shortages while strengthening long-term talent pipelines.** Through targeted recruitment, surge staffing, and apprenticeship initiatives, this pillar delivers near-term workforce support and opens transition pathways for workers from related trades and industries into shipbuilding and repair roles.

This strategy is built on collaboration, not outsourcing. Allied professionals work within American facilities, under American standards, and alongside American mentors and apprentices. Their purpose is to strengthen instruction, share advanced methods, and help stabilize production timelines across shipyards that face the steepest shortages of skilled labor. Each engagement is

[13] *Reuters. (2025). Japan Firms Face Serious Labour Crunch as Aging Population Bites. Retrieved from: https://www.reuters.com/sustainability/sustainable-finance-reporting/japan-firms-face-serious-labour-crunch-aging-population-survey-shows-2025-01-15*

[14] *Institute of Developing Economies – JETRO. (2020). Maritime Education in the Philippines: Nurturing the World's Seafarers. Retrieved from: https://www.ide.go.jp/library/English/Publish/Reports/Brc/pdf/re32_03.pdf*

temporary, targeted, and focused on transferring knowledge directly to U.S. workers so that these skills remain part of the national industrial base.

The Workforce Augmentation pillar focuses on several coordinated actions:

- **Allied Instructional Support:** Bring in qualified instructors and technical mentors from partner nations such as Japan, South Korea, and the Philippines to fill short-term gaps in teaching and training.
- **Knowledge Transfer Agreements:** Pair allied specialists with American trainees and instructors to ensure that practical skills and advanced techniques are passed on to the domestic workforce.
- **Security and Vetting Framework:** Operate under strict U.S. Department of Defense security protocols, including background screening and facility access controls, to maintain the highest standards of safety and confidentiality.
- **Industrial Exchange Partnerships:** Create opportunities for American personnel to observe and learn within allied shipyards, building familiarity with modern production systems and shared operational standards.
- **Capacity Bridging:** Maintain production stability and training continuity while new domestic instructors complete certification and readiness programs.

To implement this approach at scale, the United States must make practical use of the **H-1B visa program** to bring qualified allied instructors and technical experts into the country as temporary guest workers. **The H-1B program offers a lawful and controlled mechanism to address urgent skill shortages** while ensuring that all participants operate under U.S. labor and security regulations. **However, significant barriers limit its effectiveness for the shipbuilding sector.** The hefty **$100,000 H-1B application fee would make participation cost-prohibitive for most employers**, and the absence of a **National Interest Exemption (NIE)** for shipbuilding prevents the program from being used to meet national defense priorities.

To make workforce augmentation viable and aligned with national security objectives, the U.S. government should designate shipbuilding and maritime industrial training as a **National Interest Exemption (NIE)** category within the H-1B visa program. This action would allow the temporary entry of qualified instructors and technical specialists from allied nations under a secure and fully vetted framework. In addition, the hefty **$100,000 H-1B application fee should be removed** for defense-critical industries such as shipbuilding, where such costs would severely limit participation and undermine the nation's ability to rebuild its industrial base. Removing this financial barrier and granting an NIE designation would create a controlled and transparent pathway for allied workforce participation that directly supports fleet readiness, industrial revitalization, and U.S. economic security. **This policy adjustment would align the H-1B framework with the broader goals of industrial revitalization and defense readiness.** It would allow the Department of Labor, the Department of Defense, and the Department of Homeland Security to coordinate visa prioritization for allied trades and technical instructors working within secure shipbuilding environments.

Workforce Augmentation therefore serves as a practical bridge between present need and future self-sufficiency. It enables shipyards to keep pace with naval production goals, protects the quality of instruction, and supports the steady expansion of the domestic talent pool. When integrated with the Workforce Development framework, this approach strengthens the entire maritime industrial base and ensures that America's shipbuilding revival continues without interruption.

4.3. Integrate Digital Modernization through a Privatized AI Ecosystem

As the workforce foundation strengthens through development and augmentation, the next step in rebuilding America's shipbuilding capacity is to give that workforce the modern tools it needs to perform at its best. The shipyard of the future depends not only on skilled people but also on intelligent digital systems that extend their capability, simplify complex tasks, and ensure that every process operates with precision and coordination. Digital Modernization delivers this capability through the **Privatized AI Ecosystem**, a secure, behind-the-firewall network of A**rtificial Intelligence** systems designed specifically for the defense industrial base and governed entirely within the shipyard's digital perimeter.

This proposed Privatized AI Ecosystem has already been implemented and validated in two of the largest county governments in Virginia where scale, security, and coordination are critical to daily operations. These deployments have shown how secure AI systems can transform complex workflows into faster, more transparent, and more efficient processes while keeping all data within a protected digital perimeter. The results demonstrate that when artificial intelligence is implemented responsibly, within a controlled infrastructure and guided by clear governance, it can streamline communication, accelerate decision-making, and reduce administrative burden across departments. **The same proven model can be applied to shipyards to enhance coordination, strengthen safety oversight, simplify documentation, and improve production efficiency from planning to delivery.**

Within this ecosystem, two complementary forms of AI work together to enhance human capability: **Generative AI** and **Agentic AI**.

Generative AI strengthens the informational and creative backbone of the shipyard. It assists engineers, planners, and managers by supporting **Ship Design, generating blueprints, creating work instructions, drafting reports, and summarizing complex technical documents.** Examples adapted from county deployments include:

- **AI Chat Assistants** that help staff compose emails, maintenance reports, meeting notes, and shift summaries securely within the shipyard network.
- **Knowledgebase Assistants** integrated into collaboration tools such as Microsoft Teams, allowing workers to ask operational or safety-related questions and receive instant, validated answers from approved internal manuals, training materials, or defense documentation.
- **AI-Driven Procurement Tools** that analyze usage patterns and supplier data to help logistics teams plan material purchases, optimize inventory, and reduce waste.
- **Policy and Compliance Assistants** that provide real-time guidance on OSHA standards, Navy technical manuals, and evolving defense production policies, saving hours of manual research and improving regulatory compliance.

Agentic AI operates as the digital workforce inside the shipyard, performing context-aware actions that mirror many of the support functions handled manually today. These systems automate recurring administrative and operational workflows under strict rules and permissions. Applications include:

- **Maintenance and Inspection Agents** that guide technicians through inspection checklists, log results, and automatically update digital maintenance records.
- **Work Order Agents** that walk supervisors through repair request forms, route them for approval, and notify the appropriate trade teams—all within secure systems like Dataverse or SharePoint.
- **Production Coordination Agents** that monitor work progress, flag delays, and suggest schedule adjustments based on material availability or workforce readiness.
- **Customer and Workforce Support Agents** that respond to routine inquiries about safety training, facility access, or project status, freeing up human staff for higher-level work.

Looking ahead, this same ecosystem can also incorporate **robotics and autonomous drones** as physical extensions of Agentic AI. These systems can perform repetitive or high-risk tasks such as inspecting hull integrity, monitoring safety zones, and transporting materials across the yard. Operating entirely within the shipyard's secure boundary, these autonomous systems act as sensor-equipped agents—collecting data, making micro-decisions, and executing actions under the same governance and cybersecurity framework that governs all digital operations. The Digital Modernization pillar focuses on several key actions:

- **Secure AI Integration:** Embed the Privatized AI Ecosystem into shipyard networks to maintain data sovereignty and comply with defense security standards.
- **Workforce Enablement:** Train shipyard personnel and instructors to use AI confidently so that technology becomes an everyday tool for safety, productivity, and efficiency.
- **Data Interoperability:** Connect engineering, logistics, and training systems through unified data platforms that enable seamless information sharing and faster decision-making.
- **Production Optimization:** Apply AI insights to scheduling, materials management, and quality assurance to improve consistency and performance across projects.

- **Continuous Learning:** Create digital feedback systems that capture lessons from each ship or module built and feed them back into planning, training, and process improvement.

Digital modernization does not replace people; it enhances them. The Privatized AI Ecosystem allows every worker, from apprentice to supervisor, to perform at a higher level of precision and efficiency while maintaining the craftsmanship and judgment that define American shipbuilding. **When combined with strong workforce development and targeted augmentation, digital modernization transforms shipyards into intelligent, coordinated enterprises that are secure, adaptive, and ready to meet the needs of a modern fleet.**

While the three pillars strengthen the technical foundation of the shipyard, true transformation also depends on communication, understanding, and collaboration. **The success of this new industrial ecosystem will rely on the ability to share its vision, build public awareness, and align educators, policymakers, and communities around a common purpose.** This final pillar completes the evolution from the **Triple Helix** model, linking government, industry, and academia, to a **Quad Helix** framework that includes citizens as active participants in revitalizing America's shipbuilding base. The next pillar, **Communication and Outreach**, focuses on uniting these four forces to sustain national momentum and shared commitment behind America's maritime revival.

4.4. Lead National Engagement through Communication and Outreach

The national effort to revitalize America's shipbuilding industry, set in motion through the **Ships for America Act** and the **April 9 Executive Order on Restoring America's Maritime Dominance,** requires more than workforce revitalization and digital modernization. It also depends on the nation's collective understanding of why this mission matters. **Communication and Outreach** ensures that the progress achieved through Strengthening the Workforce, Augmenting Shipyard Capacity, and Integration of Digital Modernization becomes a **shared public commitment supported by every sector of society**. A key strategic objective for the *Congressional Guidance for a National Maritime Strategy – Reversing the Decline of America's Maritime Power* is **calls for public outreach to demonstrate how American shipbuilding and U.S.-flag shipping are critical to national security, and that maritime workers are essential.**[15] This final pillar expands the traditional Triple Helix model of government, industry, and academia into a **Quad Helix**, which includes citizens as active participants in rebuilding America's maritime strength.

[15] *CONGRESSIONAL GUIDANCE FOR A NATIONAL MARITIME STRATEGY - Reversing the Decline of America's Maritime Power, Page 5, April 30, 2024, https://www.kelly.senate.gov/wp-content/uploads/2024/05/Congressional-Guidance-for-a-National-Maritime-Strategy.pdf*

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The U.S. Merchant Marine, U.S. shipbuilding and repair facilities, the Nation's port system, and supporting industries, collectively known as the U.S. maritime industry, integrates our economy with a vast global system that moves more than 90 percent of the world's trade by tonnage, including energy, consumer goods, agricultural products, and raw materials.[16] **Yet many citizens do not realize** that shipbuilding and maritime logistics directly influence the price of consumer goods, the reliability of supply chains, energy security, and even emergency response capabilities during national crises. **This lack of awareness weakens public support for industrial investment** and obscures the role of maritime workers as essential contributors to national security and economic resilience. **The Communication and Outreach pillar addresses this gap by bringing the maritime story to the forefront of national understanding**. It aims to show how every community, from coastal shipyards to inland manufacturing hubs, depends on a strong and self-sufficient shipbuilding base. Through consistent messaging and education, this pillar connects the industry's strategic objectives to the everyday lives of American citizens, transforming the shipbuilding mission into a shared source of pride and purpose.

The **Communication and Outreach** pillar translates national maritime policy into public understanding and civic participation. Its goal is to turn legislation and industrial strategy into visible, relatable progress that citizens, educators, and community leaders can recognize and support. Achieving this requires a coordinated effort to highlight the economic, technological, and cultural importance of shipbuilding across all forms of media, education, and community engagement. Through promoting awareness at every level, from Congress to classrooms, this pillar ensures that America's maritime resurgence is sustained by informed citizens and future generations who see themselves as part of the nation's industrial story.

The Communication and Outreach pillar focuses on several key actions:

- **National Awareness Campaigns:** Launch collaborative initiatives with federal, state, and local partners to communicate how shipbuilding strengthens economic growth, national defense, and community resilience.
- **Educational and Workforce Partnerships:** Integrate maritime and manufacturing topics into K–12, vocational, and university programs, inspiring students to pursue careers in the trades, engineering, and maritime management.
- **Public-Private Collaboration:** Coordinate with industry associations, unions, and academic institutions to ensure consistent messaging about the value of domestic shipbuilding and allied cooperation.
- **Community Engagement:** Develop shipyard open houses, public exhibits, and media features that showcase modern shipbuilding technologies, workforce opportunities, and success stories.
- **Digital and Media Outreach:** Leverage traditional and digital platforms—television, social media, podcasts, and documentaries—to share innovation milestones, workforce achievements, and the everyday relevance of the maritime industry.

[16] *U.S. Maritime and Shipbuilding Industries: Strategies to Improve Regulation, Economic Opportunities and Competitiveness, March 6, 2019, https://www.transportation.gov/testimony/us-maritime-and-shipbuilding-industries-strategies-improve-regulation-economic*

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Effective communication builds trust, strengthens resolve, and turns national policy into shared purpose. Through coordinated outreach and education, every American can see the connection between shipbuilding and the nation's prosperity, security, and technological progress. Together, the four pillars of the SAIL Framework: **Workforce Development**, **Workforce Augmentation**, **Digital Modernization**, and **Communication and Outreach** form a complete framework for restoring America's maritime power. Each pillar reinforces the others: developing skilled people, expanding instructional capacity, integrating advanced digital tools, and uniting the public behind a clear national mission. When guided by the principles of the **Quad Helix**, this framework transforms shipbuilding from an industrial challenge into a collective enterprise—one that advances economic opportunity, strengthens national defense, and reaffirms America's leadership on the world's oceans.

4.5. Key Takeaways – SAIL Framework for U.S. Shipbuilding Revitalization

Four Pillars of the SAIL Framework	Core Takeaway
Workforce Development	Strengthen the workforce by establishes a sustainable national pipeline of skilled shipbuilders and instructors to rebuild America's industrial capacity.
Workforce Augmentation	Augment Shipyard Capacity by bridging immediate labor gaps through secure, allied workforce collaboration that strengthens U.S. production and training continuity.
Digital Modernization (Privatized AI Ecosystem)	Integrate Digital Modernization by equipping shipyards with secure, intelligent systems that amplify workforce productivity and operational precision.
Communication and Outreach	Lead the Nation by uniting the public, industry, and government behind a shared maritime mission that restores national pride and long-term support.

Beyond the four pillars, the SAIL Framework gains its full strength when viewed through the Quad Helix model, which positions government, industry, academia, and citizens as equal partners in revitalizing America's shipbuilding base. Each pillar reflects the contribution of one sector, but it is their combined momentum that creates a durable national strategy. **Government** sets policy direction and investment priorities; **Industry** drives innovation and execution; **Academia** produces the workforce and advances research; and **Citizens** provide the public understanding and support needed to sustain long-term maritime revitalization. Together, these four sectors create a self-reinforcing ecosystem where training, augmentation, modernization, and outreach move in

alignment, ensuring that the SAIL Framework does not operate as separate initiatives but as a unified national effort to rebuild shipbuilding capacity and restore America's maritime strength.

5. Stakeholders and Call to Action

While the **SAIL Framework for U.S. Shipbuilding Revitalization**, operating under the **Quad Helix model**, offer an excellent framework for shipyard modernization, **success ultimately depends on the coordinated effort of key stakeholders**. No single entity, public or private, can restore maritime strength on its own. The success of this blueprint depends on how effectively government, industry, education, technology, and international partners align their priorities, share resources, and act with urgency. Each stakeholder has a clear role to play in rebuilding the workforce, modernizing infrastructure, and sustaining the long-term resilience of the U.S. maritime industrial base.

The following table identifies the primary stakeholder groups, their roles within this framework, and the specific actions or outcomes expected from them. Together, these coordinated actions form the operational foundation for implementing the objectives of the SHIPS for America Act and the April 9, 2025, Executive Order on Restoring America's Maritime Dominance.

5.1. Stakeholder Mapping and Call to Action Matrix

Stakeholder Group	Role / Influence	Expected Actions or Outcomes
Smart Development Institute	SMART Enabler	• Implement the **Shipbuild Talent Hub** initiative to bring in the necessary specialty skills from allied countries utilizing its H-1B visa cap-exempt status to support workforce development and augmentation. • Leverage its proven experience in digital transformation and business process improvement with emphasis of integrating Privatized AI Ecosystems for improving Shipyard workflows and processes for maximizing efficiencies. • Facilitate upskilling to build as digitally literate Shipbuilding workforce to do more with less. • Lead the National Engagement by facilitating the Quad Helix model to ensure national understanding and acceptance of the mission and objectives of revitalizing the Shipbuilding Industry of the U.S.
Federal Policymakers and Legislative Stakeholders (U.S. Congress, MARAD,	Authorize funding and oversee policies and program alignment.	• Enact and fund the *SHIPS for America Act*. • Establish multi-year appropriations for workforce and shipyard modernization.

Stakeholder Group	Role / Influence	Expected Actions or Outcomes
DOT, DoD, White House OSTP)		• Integrate maritime revitalization goals into broader national industrial strategy. • **Grant a National Interest Exemption (NIE) for the shipbuilding industry** to expedite recruitment of qualified allied specialists for critical skills gaps. • **Remove or substantially reduce the current H-1B visa application fee** for shipbuilding and maritime technical occupations to encourage strategic international workforce participation under U.S. security frameworks.
U.S. Navy, DoD, and Defense Industrial Base (NAVSEA, PEO Ships, PEO Submarines, OUSD Industrial Policy)	Implement modernization programs and sustainment initiatives.	• Prioritize domestic shipyard utilization and modernization. • Incorporate Privatized AI Ecosystems for digital shipbuilding and performance management. • Strengthen supplier engagement and transparency across the value chain.
Shipbuilding Industry and Private Sector Partners (Major shipyards, suppliers, and trade associations)	Operate, innovate, and expand industrial capacity.	• Invest in workforce upskilling and digital infrastructure. • Adopt standardized data and AI-driven production tools. • Establish apprenticeships and mentorship programs in collaboration with local institutions.
Workforce Development and Education Ecosystem (Community colleges, maritime academies, trade schools, DOL)	Build the skilled labor pipeline and sustain training capacity.	• Expand maritime and technical training programs. • Modernize curricula to reflect new digital tools and techniques. • Create instructor exchange programs and credentialing partnerships with allied nations.
AI and Technology Ecosystem (Systems integrators, AI developers, cybersecurity firms)	Provide digital transformation capabilities and ensure data security.	• Deploy secure, behind-the-firewall Privatized AI systems for shipyards. • Develop interoperable tools for workforce planning, predictive maintenance, and knowledge management. • Support shipyards in achieving compliance with defense-grade cybersecurity standards.
International Allied Partners (South Korea, Japan, Philippines – maritime education and training institutions)	Support workforce development through training exchange and cooperation.	• Establish certified instructor exchange programs. • Share best practices in modular construction, safety, and digital shipbuilding. • Develop joint training and accreditation frameworks aligned with U.S. standards.

5.2. Unified Call to Action

The path to revitalizing America's shipbuilding strength begins with shared responsibility. Congress must act swiftly to fund shipyard modernization, workforce development, and targeted immigration reforms that strengthen the labor pipeline. **The Navy and defense agencies** must synchronize procurement and training initiatives with industrial capacity. **Shipyards and suppliers** must embrace digital transformation and invest in people as their most valuable asset. **Educators and training institutions** must accelerate the production of maritime professionals ready for modern shipyard operations. **Technology partners** must secure the digital perimeter through responsible and sovereign AI integration. **Allied nations** must serve as trusted collaborators, contributing expertise and instructional capacity. If each stakeholder fulfills these roles with discipline and urgency, the United States can rebuild a maritime ecosystem that sustains national security, technological leadership, and economic strength for decades to come.

6. Conclusion

The revitalization of America's shipbuilding industry depends on more than new technology or expanded training. It requires a **united national effort anchored in collaboration among all key stakeholders:** government, industry, education, technology, and international partners. The **four pillars of the SAIL Framework** presented in this white paper: **Workforce Development, Workforce Augmentation, Digital Modernization, and Communication and Outreach**, form a single framework for rebuilding capacity, strengthening instruction, modernizing production, and inspiring public commitment. Together, they promote and sustain a **Quad Helix model** that unites government, industry, academia, and the public in a common mission to restore maritime strength and national pride. **Success will depend on disciplined execution, measurable outcomes, and transparent coordination among every participant in the shipbuilding ecosystem**.

These strategies directly advance the goals set forth in the **Ships for America Act** and the **April 9 Executive Order on Restoring America's Maritime Dominance**. Both initiatives call for a revitalized industrial base, a stronger maritime workforce, and modernized shipyard capacity that can meet the growing needs of the Navy and the nation. **The four pillars outlined in this paper provide the structure to achieve those mandates** by building a skilled labor pipeline, accelerating the adoption of secure digital technologies, and uniting public and private stakeholders around a shared vision of maritime revitalization.

Through this integrated approach, the United States can overcome the challenges that have long constrained its shipbuilding capacity and reclaim its position as a global leader in maritime innovation. *What begins as a plan to rebuild shipyards ultimately becomes a movement to strengthen the economy, restore industrial confidence, and secure the nation's future at sea.* **Revitalizing America's shipbuilding industry is not only an economic imperative—it is a reaffirmation of national resolve, technological leadership, and maritime pride.**

Appendix A: Reference Validation Summary Sheet

Document Title: *Forging the Future Fleet: The SAIL Framework for U.S. Shipbuilding Workforce and Infrastructure Revitalization*
Date Verified: November 2025

#	Reference Title / Source	Organization / Publisher	URL	Status	Source Type
1	*H.R.3151 – SHIPS for America Act of 2025*	U.S. Congress	congress.gov/bill/119th-congress/house-bill/3151/text/ih	✅ Active	Legislative Document
2	*Executive Order: Restoring America's Maritime Dominance*	The White House	whitehouse.gov/presidential-actions/2025/04/restoring-americas-maritime-dominance	✅ Active	Executive Order
3	*U.S. Navy Shipbuilding Is Consistently Over Budget and Delayed...*	U.S. Government Accountability Office (GAO)	gao.gov/blog/u.s.-navy-shipbuilding-consistently-over-budget-and-delayed	✅ Active	Federal Report Summary
4	*The Shipyard Shortage Is a People Problem*	U.S. Naval Institute	usni.org/magazines/proceedings/2024/september/shipyard-shortage-people-problem	✅ Active	Industry Journal
5	*Charting a New Course: The Untapped Potential of American Shipyards*	McKinsey & Company	mckinsey.com/industries/aerospace-and-defense/our-insights/charting-a-new-course	✅ Active	Industry Analysis
6	*Welding Workforce Data Portal*	American Welding Society	weldingworkforcedata.com	✅ Active	Workforce Database
7	*GAO Report GAO-25-106286: Navy Needs a Strategic Approach for Private Sector Industrial Base Investments*	U.S. GAO	gao.gov/assets/gao-25-106286.pdf	✅ Active	Federal Report (PDF)
8	*NDIA and Navy TPP Team Up to Grow Next-Gen Shipyard Talent*	National Defense Industrial Association (NDIA)	ndia.org/about/press/press-releases/2025/4/30/talent-pipeline-program	✅ Active	Industry Press Release
9	*Research and Education for Maritime Progress*	National Academies of Sciences,	nap.nationalacademies.org/catalog/20405	✅ Active	Research Report

#	Reference Title / Source	Organization / Publisher	URL	Status	Source Type
		Engineering, and Medicine			
10	*Shipbuilding Market Size, Share & COVID-19 Impact Analysis*	Fortune Business Insights	fortunebusinessinsights.com/shipbuilding-market-103351	✅ Active	Market Analysis
11	*GAO-25-106286 Product Page*	U.S. GAO	gao.gov/products/gao-25-106286	✅ Active	Federal Product Record
12	*Waypoints and Course Adjustments: Naval Shipbuilding Cooperation with South Korea*	Stimson Center	stimson.org/2025/waypoints-and-course-adjustments	✅ Active	Policy Research Report
13	*Japan Firms Face Serious Labour Crunch as Aging Population Bites*	Reuters	reuters.com/sustainability/sustainable-finance-reporting/japan-firms-face-serious-labour-crunch	✅ Active	News Article
14	*Maritime Education in the Philippines: Nurturing the World's Seafarers*	Institute of Developing Economies – JETRO	ide.go.jp/library/English/Publish/Reports/Brc/pdf/re32_03.pdf	✅ Active	Research Report (PDF)
15	*Congressional Guidance for a National Maritime Strategy – Reversing the Decline of America's Maritime Power*	U.S. Senate (Sen. Kelly's Office)	kelly.senate.gov/wp-content/uploads/2024/05/Congressional-Guidance-for-a-National-Maritime-Strategy.pdf	✅ Active	Legislative Guidance Document
16	*U.S. Maritime and Shipbuilding Industries: Strategies to Improve Regulation, Economic Opportunities, and Competitiveness*	U.S. Department of Transportation	transportation.gov/testimony/us-maritime-and-shipbuilding-industries-strategies-improve-regulation-economic	✅ Active	Federal Testimony