

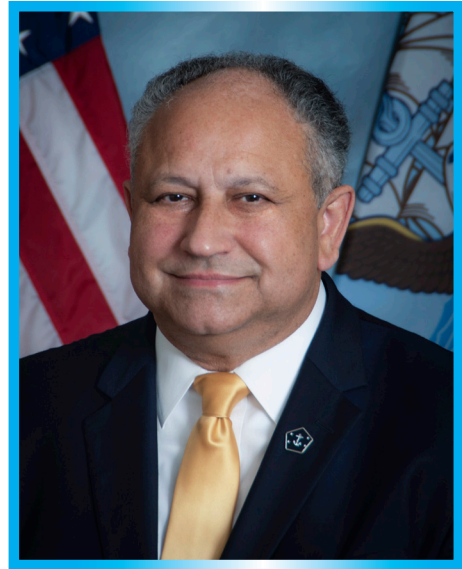


Naval Science and Technology Strategy

Sailing Directions for developing a maritime science and technology foundry to accelerate the delivery of technological innovation to the Navy and Marine Corps in an era of global competition.



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The Honorable Carlos Del Toro
Secretary of the Navy (SECNAV)

“As our Department continues to re-imagine and refocus our innovation efforts, I encourage all of you — our Nation’s scientists, engineers, researchers, inventors, entrepreneurs, and problem-solvers — to join us. — We are indeed in an innovation race — and it is one we must win.”



PURPOSE

The Naval Science and Technology (S&T) Strategy is a **global call to service** for scientists, engineers, inventors, and innovators from academia, industry, and government to work with us in solving naval problems to ensure our freedom and way of life. Guided by the North Star of delivering capabilities to American warfighters and our allies, it provides a spectrum of technological choices to the Navy and Marine Corps for future operations that create enduring advantage.

The Department of the Navy (DON) benefits from a strong organic, national and global research ecosystem at the Naval Research Laboratory (NRL) and Warfare Centers and a long history of pioneering research with academia, the private sector, and other partners that have provided the S&T foundation for naval superiority. Our long-view approach delegates to our domain leads, program officers, and researchers the autonomy to produce scientific knowledge, capability improvements, and disruptive technologies to address naval mission needs. These needs include national naval responsibilities to have a decisive understanding of the oceans and ensure we leverage any advance to deliver a warfighting edge.

This strategy builds on those strengths to respond urgently to the new era of strategic competition and a renewed focus to align with the Department of Defense (DoD) S&T strategy, to better team with our allies, Congress, partner nations, and DoD research community. We recognize the need for improvements **to the naval S&T tradecraft and process** to effectively respond to a changing national science, technology, engineering, and mathematics workforce and address the most promising research fields to support the acquisition of capability by the naval force.



*Tiffany Hennesa, U.S. NRL research biologist, transferring the liquid culture of *Exophiala lecanii-corni* into new tubes in the Microbes for Multiple Uses in Space Project (MELSP) laboratory in Washington, D.C., October 10, 2023. The NRL's MELSP will use the International Space Station (ISS) to search for production of melanin variants and other useful biomaterials that have applications both on Earth and in space. (U.S. Navy photo by Jonathan Steffen/released)*

INTRODUCTION

A critical foundation of maritime dominance for America's Navy and Marine Corps is technological superiority. Our Sailors and Marines operate in a world of new security, economic and geopolitical challenges, and the DON must move faster than our adversaries to ensure success. Industry is a vital partner, and in an age of ubiquitous and commoditized technology and knowledge, we must more rapidly adopt and adapt private sector technologies. We must continue to invest in basic research that the commercial sector and academia will not. Finally, we must focus on the unique maritime needs of the Navy and Marine Corps, which are among the **most complex and challenging science, engineering and integration endeavors**.

SECNAV has established three enduring priorities to accomplish Navy and Marine Corps missions: Strengthening Maritime Dominance, Building a Culture of Warfighting Excellence, and Enhancing Strategic Partnerships.





SECNAV ENDURING PRIORITIES:

- **STRENGTHENING MARITIME DOMINANCE**
- **BUILDING A CULTURE OF WARFIGHTING EXCELLENCE**
- **ENHANCING STRATEGIC PARTNERSHIPS.**

A composite photograph shows Coyote unmanned air vehicles (UAVs) being launched in rapid succession from the deck of advanced technology demonstration craft Sea Fighter (FSF 1) during an at-sea demonstration of the Office of Naval Research Low-cost UAV Swarming Technology (LOCUST) program. LOCUST can launch swarming UAVs to autonomously overwhelm an adversary. (U.S. Navy photos and composite by John Williams/released)

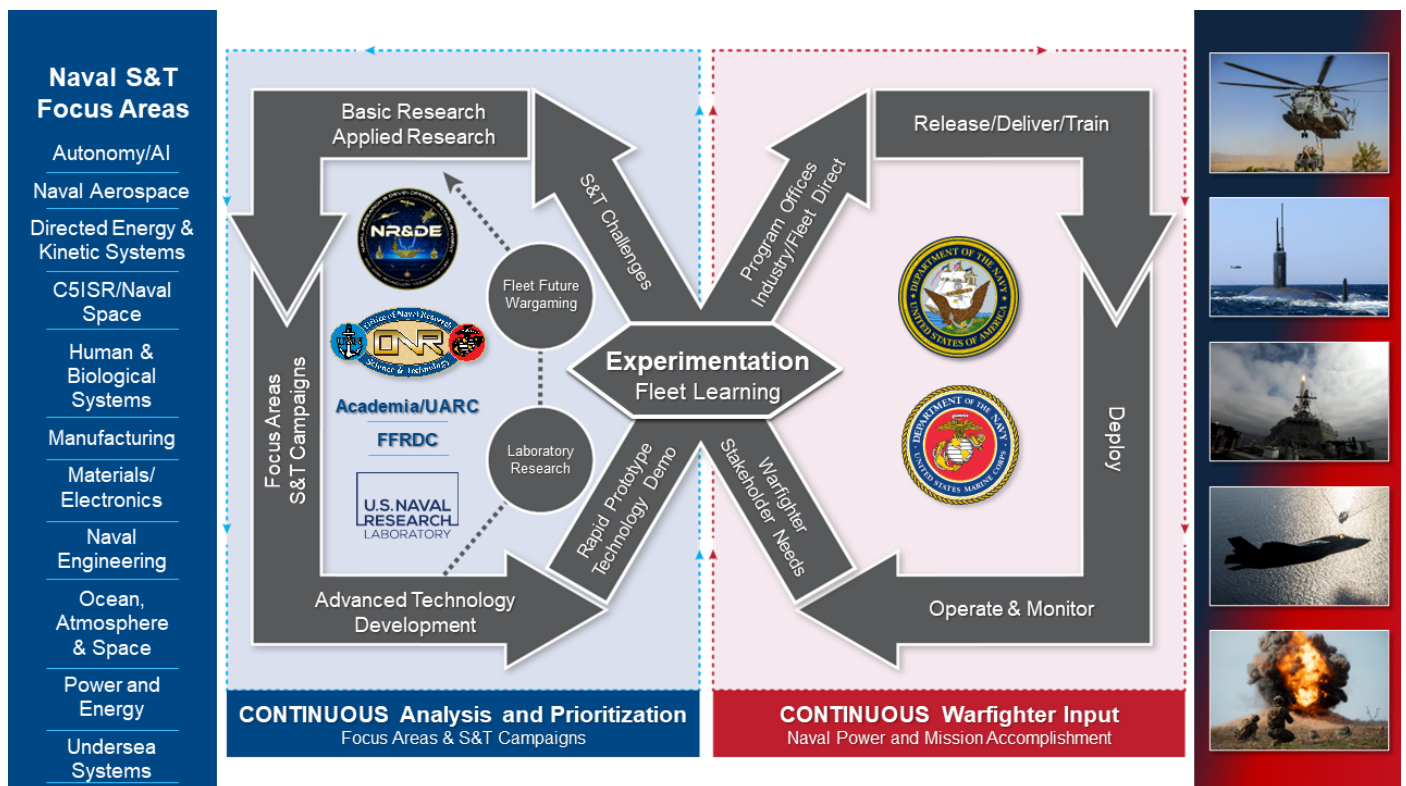
STRENGTHENING MARITIME TECHNOLOGICAL DOMINANCE

Invention, innovation and modernization will deliver technological breakthroughs that enable capabilities to increase the components of maritime dominance in future conflicts. We must constantly assess the relevance of our S&T efforts to core naval missions and operational problems. S&T is a means—maritime superiority is the end.

Realize Technology Gains Faster

Maritime warfare is unforgiving to those who lack agility and who do not adapt to new learning and technologies. Naval S&T must reduce warfighter risk by partnering earlier, experimenting more deliberately and ultimately scaling to put technology in their hands sooner. As a research team, we must more rapidly harvest the benefits of basic research. We will review and revise our current approaches and explore alternative transition paths to develop lanes of capability accelerators, especially those in critical maritime areas, to deliver knowledge and capability more aggressively.

We will better align our S&T approach to lower the barrier to collaborating and learn from the best of industry and academia. We will continue our S&T collaborations with allies and partners to leverage their investments. We will identify commercial technologies ready for naval use and incorporate well-established entrepreneurial practices and capital investment methods. We will explore new ways to transition critical technology and knowledge to industry so they can apply business acumen to manufacture and deliver the technology that contributes to maritime dominance at scale.



Disruptors

Technology drives maritime superiority. Today, we are at an inflection point with technologies such as Artificial Intelligence (AI), Quantum, and Biotechnology, among others, having the potential for disproportionate effects on our technical edge. We must deliberately learn, develop, experiment and field. The warfighting capabilities enabled by AI already have a wide-ranging impact on naval warfare. While war is an intrinsically human endeavor, AI strikes at the very strengths and critical aspects humans bring to warfare by assessing and deciding orders of magnitude faster than the human mind. Naval S&T must contribute to the fundamental sciences of realizing AI. However, more importantly, we need to apply AI as a tool across multiple disciplines and naval S&T challenges, from battle management aids to AI-designed materials, assured networks, and wherever our ingenuity—and AI's—takes us.

Quantum science will play a crucial role in naval warfare by enabling breakthrough technologies such as faster computation speeds, novel networks, quicker decision-making, improved accuracy in position, navigation, and timing more reliable information, robust encryption, and innovative sensors.

Similarly, Biotechnology has the potential to revolutionize naval operations by producing new technologies using living systems, such as developing new high-performance materials for maritime applications, generating and storing energy, increasing energy efficiency, biomanufacturing of critical materials, biological sensors, and adaptive systems.

Autonomy will likewise significantly affect the realm of physical effects. Autonomous systems enable us to address threats at a lower cost per unit of capability and expand our global reach. We will be able to operate in extreme environments by reducing warfighter support requirements and building highly synchronized formations leveraging man-machine teaming.

Play to Our Strengths

Long-term U.S. investment in basic and applied research underlies the technologies we use today. Cutting-edge technology like that used in our weapons, C5I, undersea, shipboard, and aviation platforms have scientific legacies from the Office of Naval Research (ONR) and others that span decades. The U.S. S&T ecosystem is a scientific culture of invention and innovation, but it does not automatically transform technology into capabilities—

Naval S&T Focus Areas

- Autonomy/AI
- Naval Aerospace
- Directed Energy & Kinetic Systems
- C5ISR/Naval Space
- Human & Biological Systems
- Manufacturing
- Materials/Electronics
- Naval Engineering
- Ocean, Atmosphere, & Space
- Power & Energy
- Undersea Systems

that takes deliberate action and connection with a warfighting need. Our understanding of the oceans has led to significant warfighting advantage, and we now operate from the sea floor to space. The ocean environment, how we operate, and how we leverage it is constantly evolving and our S&T ecosystem has never been of greater importance. While we seek accelerated learning with capabilities like AI, scientific discovery is complex, sometimes slow, and takes discipline, rigor and patience.

We will drive the connection to warfighting outcomes by employing enduring S&T Focus Areas (FAs).

We will establish FAs to complement the DoD Critical Technologies and provide investment to create and advance foundational scientific knowledge. FAs sustain the academic and industry ecosystems that build the S&T workforce, infrastructure, and institutional expertise required to solve naval problems and develop the intellectual capacity and flexibility necessary for the uncertain S&T needs of future naval forces. FAs can change, but they are rooted in fundamental, enduring naval problems. Over long time frames, FAs comprise hypotheses that must be measured and assessed for long-term operational relevance. We must rigorously assess technical progress in the FAs, provide a clear and consistent demand signal to our partners on priorities and adjust the investment balance as needed.

Experimentation and War Gaming

We will integrate experimentation and war gaming with this strategy's research efforts. Using FA guidance, we will conduct and participate in experiments that solve complex Fleet and Force technical problems tied to the Naval Implementation

Framework, Navy Force Design, USMC Force Design, and the Commandant's Planning Guidance. The experiments will use hypotheses derived from FA research to solve

specific problems and test FA assumptions and objectives. While there is value in participating in large fleet exercises, we will also shift to experimentation aimed at the closure of critical technology shortfalls and, when the experiments fail or disprove hypotheses, adjust the approach of our focus areas armed with data and new knowledge.

Experiments should have varying levels of risk to ensure we stay focused on solving naval problems while balancing evolutionary advances with revolutionary game changers.

The DON will increase its integration of long-range war gaming with S&T, incorporating projected technologies in operational contexts. We will explore the digital twinning of future technologies before they are ready to bring to physical experiments. We will use "red teaming" to attack and thwart our own technology development as early as possible to determine if we need to adjust our research or terminate projects to shift to entirely different approaches with agility. The S&T portfolio is where the DON can accept risk because learning that approaches are untenable in basic and applied research or advanced technology development is orders of magnitude cheaper than learning during acquisition. As in experiments, war gaming must test Focus Area assumptions and their validity. The efforts must be part of how the DON more quickly assesses S&T approaches, learns from science, adjusts, and drives toward winning future conflicts.

“Whether you’re talking about artificial intelligence, cyber, unmanned platforms, directed energy or hypersonic missiles, we are on the cusp of technological breakthroughs that are going to define future conflict.”

-Admiral Lisa Franchetti
Chief of Naval Operations

BUILDING A CULTURE OF S&T EXCELLENCE



U.S. Marine Corps Cpl. Maxwell A. Fritz, a field radio operator with Bravo Company, Special Purpose Marine Air-Ground Task Force Crisis Response-Africa, prepares to advance for the assault on Military Operations on Urban Terrain Town during Platinum Lion 16-3 at the Novo Selo Training Area, Bulgaria, May 10, 2016. Hundreds of troops from five NATO countries came together to train with mechanized assets and demonstrate the ability to work seamlessly as one force. (U.S. Marine Corps photo by Cpl. Immanuel Johnson/released)

The Honor, Courage, and Commitment of America's Sailors and Marines have historically driven and will continue to drive America's naval success in the future—they fight the fight. On the other side of the coin, technology is their toolbox. The mastery of technologies and systems used by those women and men enables their success in battle. From sailing ships to nuclear-powered submarines, warriors' familiarity and skill in using their weapons and tools is part of their warfighting excellence, and learning from their experience in warfighting leads to better weapons. Naval S&T does not solve research problems in isolation; it is part of a campaign of learning and constant improvement, and it contributes to our warfighting culture writ large. To ensure the best outcomes for the Navy, we will team with Program Offices, System Commands, the Naval Research and Development Enterprise, ONR, Navy Disruptive Capabilities Office, USMC Rapid Capabilities Office, Marine Corps Warfighting Laboratory, the Defense Advanced

“Refinements to Force Design, or any plan, are constant. We make those refinements from our campaign of learning where we develop concepts, evaluate them through wargames, experiment with the concept to improve it or reject it, and then provide feedback to the chain of command.”

-General Eric Smith
Commandant of the Marine Corps

Research Projects Agency, Strategic Capabilities Office, NavalX, Defense Innovation Unit, Chief Digital and Artificial Intelligence Office and others to leverage each other's strengths.

Sailor, Marine, Scientist and Engineer Teaming

To prepare warfighters to use future technologies and ground those technologies in warfighter needs, ONR, which leads basic and advanced research and drives areas of rapid capability development and experimentation, will use the DevOps "mindset" with scientists and engineers informing Sailors and Marines and vice versa. This environment will give Warfighters familiarity and early training on future systems and better inform scientists and engineers in developing robust and optimized systems. To speed up technology development and capability delivery, we will focus on accelerating the system development life cycle by teaming between researchers, industry, and Sailors and Marines using experimentation and technology demonstrations. Today's Sailors and Marines grew up with technology, are savvy with it, adapt to it and, when we put it in their hands, they often innovate, find new uses, and offer insightful perspectives that benefit both sides of the equation. Our scientific and engineering community must **leave the comfort of controlled events** and expose their ideas and concepts to warfighters to realize earlier benefits.

Partnering and Building Capacity

Naval S&T will expand special partnerships with naval educational institutions at home and abroad: the Naval Postgraduate School (NPS), the US Naval Academy (USNA), the Naval War College (NWC), Federally Funded Research and Development Centers and University Affiliated Research Centers (UARCs). By teaming with the NPS Innovation Center and the school's faculty, staff and students, we can innovate faster. NPS S&T students' theses focus on

relevant naval problems with faculty immersed in naval culture—we will reinforce both. Midshipmen at USNA are learning to become Navy and Marine officers, but they offer fresh perspectives as technology natives, many pursuing degrees in science and engineering. Working with the USNA on Science, Technology, Engineering and Mathematics (STEM) outreach, giving midshipmen S&T awareness, and sponsoring student and faculty projects is a win-win for research and developing officers more ready to employ technology and innovation adeptly. We will team with NWC, which offers opportunities for senior officers to incorporate S&T into advanced warfighting studies, premier war gaming facilities expertise, and faculty engagement, providing expert assessment of S&T's relevance in advanced warfighting problems. Lastly, the Navy will continue to partner with UARCs to maintain essential engineering and technology capabilities of particular importance to our warfighters.



Experiments, exhibits, presentations and interactive booths informed and entertained the crowds of students and their families that filled the Gaylord National Resort and Convention Center in National Harbor, Maryland on Sunday, April 3, 2023 at the Sea-Air-Space STEM Expo. (U.S. Navy photo by Michael Walls/released)

Our Nation's most promising engineers and scientists continue **to be hungry to serve** the Nation. Naval Research provides them with meaningful and challenging research areas and encourages the autonomy needed to foster creativity and intellectual freedom to explore S&T challenges passionately. We cannot manage our scientists and engineers to revolutionary results; instead, we must help them better understand naval problems, provide them with needed resources, give them early responsibility for projects, clear their obstacles, and let them work.

Just as the Navy and Marine Corps rely on Professional Military Education, we must mentor and foster our civilian scientists' and engineers' mastery of STEM disciplines at the graduate, postgraduate and postdoctoral levels. We must encourage their technical progression and interest in naval problems as an investment in the workforce that can solve future technological problems. We must invest in the facilities and infrastructure they need to deliver leading-edge research. The purpose of their work is higher than themselves: to solve naval problems and enable advanced capabilities for our naval warfighters. We do this by encouraging active participation in professional communities while protecting the hard-earned capabilities and knowledge we do not want our potential adversaries to have. This discernment is nuanced, but one that must strike with a clear-eyed view of how our potential adversaries have weaponized against us the very open and sharing culture we enjoy.

STEM

As stated in our Naval STEM Strategic Plan, the DON has a rich history of providing STEM education and outreach opportunities across

the Nation, to include educational institutions that cultivate a diverse and well-trained talent pool for the Navy and Marine Corps. Our warfighters' superiority depends on technological innovations and scientific breakthroughs today and in the future. To promote an environment where these breakthroughs continue, the DON must foster initiatives and collaborations to promote the development of the future and current Naval STEM workforce and **expand those efforts to two year and certificate programs** that support mission essential skills for shipyard team members, in areas such as uncrewed system maintenance, along with others. Deliberate investments in STEM education and outreach initiatives are a critical duty of the DON and are essential to America's continued technological dominance.



August 2, 2023. Then-Vice Chief of Naval Operations Adm. Lisa Franchetti speaks to the Texas A&M all female robotics team at RoboSub 2023. The ONR-sponsored Naval STEM competition for high school and college students from around the world was held in San Diego, California. (U.S. Navy photo by Michael Walls/released)

ENHANCING NAVAL SCIENTIFIC DIPLOMACY

Like science itself, partnerships cannot be surged. Partners must nurture their relationship over time with committed collaboration from both sides to build trust and confidence. The Navy has domestic and international partnerships through ONR, not only with stakeholders and warfighters but with the performers it uses to research S&T. With the support of Congress, ONR employs long-term investment in government labs, academia, and industry around the globe to develop strategic partnerships. We will further develop and strengthen our partnerships through S&T collaboration to ensure our competitive edge. Just as Marines and Sailors fight as web-connected teams, we will conduct our research as an integrated global team of scientists and engineers to defend our shared values.

Partnerships at Home

Naval S&T has a long history of highly successful relationships with sister services and other U.S. government S&T and research organizations. As part of the DoD S&T Enterprise, we maximize collaboration in DoD Communities of Interest to use each other's best practices and competencies and eliminate costly duplication. Additionally in areas of climate science and understanding our oceans we will work with other agencies to increase our knowledge. In 2023, the DoD S&T Strategy designated Critical Technology Areas (CTAs) to address the key national security challenges. This strategy is fully nested with the CTAs, with the DON strongly contributing to and leveraging other CTA work to solve naval problems and provide the Navy and Marine Corps with critical technologies.

We will continue to make investments and support robust relationships with industry and academia to develop institutions' technical ability and interest in naval problems. We will support new ways for businesses to work with the Navy and USMC and vice versa. Industry brings extensive research capability, and naval forces rely on industry to scale the technology to relevant quantities. Industry and small businesses often lead the way in bringing the most innovative technology to consumers, and we will work with them to get Sailors and Marines technology at the same pace. We must collaborate better to use their leading-edge research and transfer knowledge to transition technology more quickly to solve naval problems into production and jump-start small businesses with world-class research.

Coupled with NRL, American universities and academic institutions remain **a worldwide powerhouse** in S&T research. As performers, they conduct much of the ingenious work needed to take fundamental science to usable technology. We fund an innovation and invention **engine** using scientists and engineers from and affiliated with academia. To have a strategic reserve of scientists and engineers

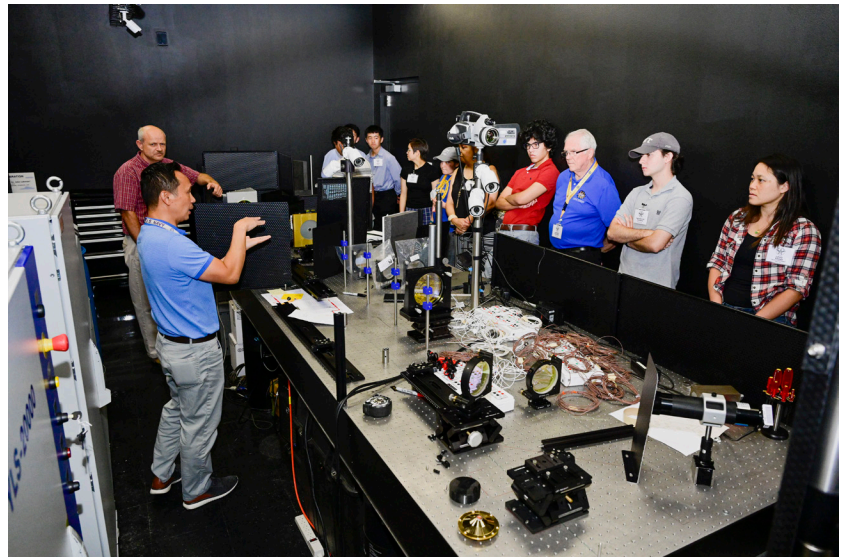
“Research, development, science, and technology enable us to innovate at the speed of relevancy – ensuring our competitive edge over our adversaries.”

-The Honorable Carlos Del Toro
SECNAV

capable of solving naval problems, we will invest in academia to build STEM undergraduates, graduate students, doctoral candidates, and post-docs interested in naval problems and foster career-long partnerships with naval S&T.

Partnerships Abroad

America does not have a monopoly on scientists and engineers or innovation. Working with allied and friendly foreign institutions and collaborating with global partners opens the aperture to S&T talent and ideas and builds trust with partners globally. With our partners, we will collaborate in scientific research and technology development to jump-start interoperability when the technology is newly fielded. Mutual support by enabling S&T partner advances will greatly enhance all warfighting capabilities. Collaborating with allies on technology early enables faster integration of capabilities. These close partnerships will allow us to move beyond interoperability to interchangeability. To increase our strategic influence, we will increase our international partnerships by leveraging scientific diplomacy, increasing the number of foreign academic partners, and promoting the open exchange of ideas



Tam Vo, an electrical engineer in the High Energy Laser and Metrology Lab at Naval Surface Warfare Center, Corona Division, addresses local high school students as part of Science and Technology Education Partnership's, "STEM in Defense," pilot program hosted by the warfare center in Norco, California. (U.S. Navy photo by Neil Mabini/released)

and collaboration implicit in basic research. Scientific research is often an inexpensive yet meaningful way to collaborate with foreign countries and enhance **Naval Scientific Diplomacy**.



The International Cooperative Engagement Program for Polar Research (ICE-PPR) International Workshop for Sea Ice and Icebergs was held recently at the U.S. Naval Academy in Annapolis, Maryland. (Photo courtesy Office of Naval Research/released)

ONR and the Navy International Program Office provide access to worldwide S&T solutions for current and future naval challenges. We will reach out to a broad global technical community and the operational Fleet and Force commands to foster cooperation in areas of mutual interest and to bring the full range of possibilities to the Navy and Marine Corps. With a Global Engagement plan, we will implement this strategy with our foreign partners. Focusing on and delivering technology to Sailors and Marines, we will expand our global engagement and work with our partners to advance and provide scientific knowledge and technology.

We must constantly assess the relevance of our S&T work to naval power and operational problems and opportunities. S&T is a means—Maritime Dominance is the end. Our Focus Areas are our ways, and we must align them with both near and long-term naval warfare requirements and anticipated naval needs. The naval research community must constantly dialogue with Navy and Marine Corps leadership and warfighters. We will look to the CNO's NAVPLAN, the Marine Corps Force Design, and the Navy's Force Design to set the course for the key Focus Areas, measure our progress, analyze its relevance and impact, learn and adjust. When the technical path becomes clearer to solve specific S&T gaps, and science presents opportunities to achieve game-changing operational effects, the Navy will design S&T Campaigns as another way to deliver. S&T Campaigns are deliberate plans to design and invest in integrated S&T programs to create major technological sea changes that solve major challenges and exploit opportunities to enable operational advantages for the future fleet and force.

Force Design Alignment

The CNO NAVPLAN Force Design Imperatives provide a clear direction to guide naval S&T investments. ONR will use the imperatives to research S&T that will expand distance, leverage deception, harden defense, increase distribution, ensure delivery and generate decision advantage.

Marine Corps Force Design is well underway in deploying smaller purpose-built stand-in forces with greater lethality, minimal signature, and enhanced littoral maneuver and sustainment that win the maritime reconnaissance and counter-reconnaissance fight. ONR will continue to support Force Design and look beyond for future capabilities.



MOVING OUT

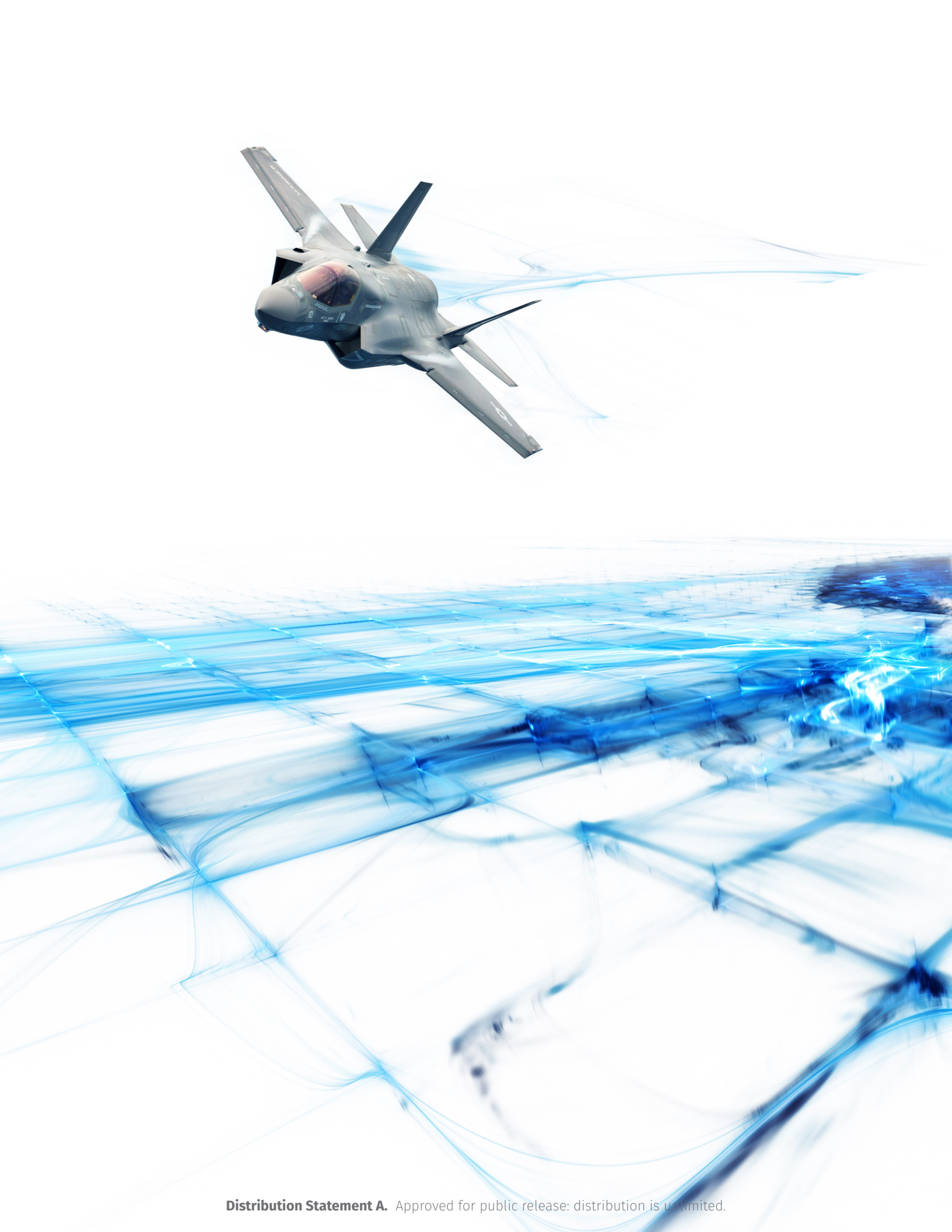
Facing profound change, the Naval Research Enterprise must adapt to accelerate learning, deliver technology options to acquisition and industry, and ultimately serve the warfighter better. In support of these efforts, I'm directing the Chief of Naval Research to develop a series of S&T Execution Plans. These plans will align with the CNO's NAVPLAN Implementation Framework and the Commandants Force Design. They will ensure we adapt to new modalities and S&T tradecraft in our Basic and Applied Research portfolios. We will also drive our rapid capability and experimentation advanced research to the most



Harry S. Truman Carrier Strike Group in the Atlantic Ocean, April 2019. (U.S. Navy photo by Mass Communication Specialist 3rd Class Maxwell Higgins/released)

pressing fleet challenges—with an eye towards not only supporting capability delivery—but maintenance, supportability, affordability, and rapid scale. Additionally, these S&T campaign plans will leverage war gaming, learning from fleet exercises, and avoid duplicative investment from other partners to get the most value from every dollar. Furthermore, the plans will enhance our naval scientific diplomacy to learn and team with nations around the globe that share our values of academic freedom.

Carlos Del Toro
Secretary of the Navy



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