NOT FOR PUBLICATION UNTIL RELEASED BY THE
HOUSE ARMED SERVICES COMMITTEE
INTELLIGENCE, EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

STATEMENT OF
REAR ADMIRAL MATTHEW L. KLUNDER, UNITED STATES NAVY
CHIEF OF NAVAL RESEARCH

BEFORE THE
INTELLIGENCE, EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE
OF THE
HOUSE ARMED SERVICES COMMITTEE
ON
THE FISCAL YEAR 2014 BUDGET REQUEST

APRIL 16, 2013

NOT FOR PUBLICATION UNTIL RELEASED BY THE
HOUSE ARMED SERVICES COMMITTEE
EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

Introduction

It is an honor to appear before the subcommittee to report on Department of the Navy (DoN) Science and Technology (S&T) and discuss how the President's FY 2014 Budget supports the Navy and Marine Corps (USMC). The President's FY 2014 Budget requests approximately $2 billion for Naval S&T.

For over 200 years, the Navy and Marine Corps have used S&T to provide technological superiority to enable the defense of U.S. interests. After World War II, congress established the Office of Naval Research (ONR) to "plan, foster and encourage scientific research in recognition of its paramount importance to future Naval power and national security." Our S&T objective is to support a Navy and Marine Corps that can prevail in any environment. We work directly with the Secretary of the Navy (SECNAV), Chief of Naval Operations (CNO) and Commandant of the Marine Corps (CMC) to strike a balance between near-term technology development and long-term research. As we implement CNO and CMC guidance in application of S&T resources, we constantly strive to improve system affordability, communication with the acquisition community, and constructive engagement with all of our stakeholders.

Science and Technology Strategic Plan

The Naval S&T Strategic Plan was developed to guide our investments and is regularly reviewed by Navy and USMC leadership to affirm the alignment of Naval S&T with current missions and future requirements. It ensures S&T has long-term focus, meets near-term objectives, and makes what we are doing clear to decision makers, S&T partners, customers and performers.

The Strategic Plan identifies nine focus areas where S&T investments support Navy and USMC requirements: 1) Assure Access to Maritime Battlespace, 2) Autonomy and Unmanned Systems, 3) Expeditionary and Irregular Warfare, 4) Information Dominance, 5) Platform Design and Survivability, 6) Power and Energy, 7) Power Projection and Integrated Defense, 8) Total Ownership Cost, and 9) Warfighter Performance.

Our goal is to move from existing systems and concepts of operations toward a warfighting capability to counter predicted threats in an increasingly complex and uncertain environment. The proliferation of anti-access, area-denial (A2/AD) capabilities among potential adversaries drives the need for technologies that assure access for Naval forces. One of our greatest challenges is to defeat A2/AD threats which essentially compel us to respond to $50K threats with $3M weapons. We must get on the right side of this equation – and have weapons in development that will allow us to achieve that asymmetric cost advantage currently held by some of our adversaries. Beginning with the evolution of current systems through incremental improvement and spiral development of known technology, we strive to move toward development of undiscovered, disruptive, game-changing technologies, particularly as we recognize the strategic relevance to the Pacific and Middle East.

Implementing the Strategy

We execute Basic Research (6.1) thru Advanced Technology Development (6.3) funds by dividing S&T into four primary areas – Discovery and Invention (D&I), Leap Ahead Innovations (Innovative Naval Prototypes), Acquisition Enablers (Future Naval Capabilities), and a Quick Reaction capability to respond to emerging requirements. Our portfolio balances a range of complementary but competing initiatives: while we support advances in established operational areas – we maintain a far-reaching complement of long-term research that may prove disruptive to traditional operational concepts.

Discovery and Invention

Discovery and Invention (D&I) includes basic research (6.1) and early applied research (6.2) in areas with unique requirements essential to Naval missions, as well as in areas that are undefined but hold promise for future application. D&I develops fundamental knowledge, provides a basis for future Navy/Marine Corps systems, sustains our Scientist/Engineer workforce, and has led to over 60 Nobel Prizes for ONR researchers – the most recent being Dr. David Wineland, who received the Nobel Prize in Physics in 2012. D&I is the foundation for advanced technology.

Approximately 45 percent of ONR investments are in D&I. We invest resources in the best research areas and projects to develop a broad base of scientific knowledge from which INP, FNC, and quick reaction efforts are generated. Approximately 60 percent of basic research is executed with academic and non-profit performers, with programs peer reviewed by outside scientific and technical experts who provide an independent assessment of the scientific merit of the research being conducted. Results are reviewed by ONR program officers, division directors, department heads and senior leadership. Risk, impact, significance, originality, scientific merit, principal investigator, and budget resources are evaluated.

The best recent example of direct links between D&I and advanced technology was reported in early March of this year, when a pioneering atomic theory involving quantum mechanics barely imagined early in the last century was verified through current ONR research investments. A team of scientists from Massachusetts Institute of Technology and the University of California at Berkley demonstrated that while the positive charge of an atomic nucleus and negative charge of the surrounding electrons balance each other out to provide atomic stability, under certain conditions the electrons collapse into the nucleus. That phenomenon has been simulated and observed, with profound implications for our understanding of basic physics and chemistry. It has the potential to contribute to the improved design of nanotechnology devices, development of ultrafast transistors, and development of graphene-based electronic devices used in detection of trace chemicals and biomarkers. In addition to ONR, this research was sponsored by the Department of Energy, National Science Foundation, and the Engineering and Physical Sciences Research Council in the United Kingdom. It is not going too far out on a limb to suggest that this may result in yet another Nobel Prize awarded to ONR researchers.

ONR's University Research Initiative (URI) includes the Multidisciplinary University Research Initiative (MURI), the Defense University Research Implementation Program (DURIP), and the Presidential Early Career Award for Scientist and Engineers (PECASE). MURI supports teams of researchers investigating topics that intersect multiple technical disciplines in order to speed transition of basic research to practical applications. ONR awarded 14 MURI grants in FY2009,

12 in FY 2010, 11 in FY 2011, 9 in FY 2012, with 8 awards expected in FY 2013. DURIP supports research essential to the Navy through grants for the purchase of instrumentation necessary to perform cutting-edge research. PECASE identifies and honors the achievements of young scientists and engineers at the outset of their careers and encourages them to explore S&T professions in academia and Naval laboratories.

Other D&I initiatives include the Basic Research Challenge, which funds promising research not addressed by the current core program. ONR also sponsors the Young Investigator Program, which supports academic scientists and engineers who, early in their careers, show exceptional promise for doing Naval research. Education and research opportunities for undergraduate and graduate students, fellows, and future faculty members are provided through the Naval Research Enterprise Internship Program (NREIP), in which participants work at Naval laboratories and warfare centers. The In-House Laboratory Independent Research (ILIR) and Independent Applied Research (IAR) programs sponsor critical research, while furthering the education of scientists and engineers at Warfare Centers. Finally, ONR intends to strengthen our partnership with Historically Black Colleges and Universities and Minority Institutions (HBCU/MI), which brings together Naval Laboratories and warfare centers with dozens of HBCU/MIs, giving hundreds of students an opportunity for hands-on experience in the Naval research environment.

Science, Technology, Engineering and Mathematics (STEM)

Our ability to support the warfighter depends on our ability to sustain a Science, Technology, Engineering and Mathematics (STEM) workforce – with D&I investments supporting STEM outreach from kindergarten through post-doctoral education. One of our greatest challenges involves our concern that the number of U.S. citizen STEM graduates will not keep up with future U.S. demand or with international competition for the same talent.

Navy's STEM program is intended to ensure a strong STEM workforce. As I testified last year, our S&T workforce is aging, with about 2/3 of Navy science and engineering professionals over age 40, and approximately 50% retirement eligible by 2020. Because Navy's S&E workforce is comprised mostly of engineers, we face a potentially staggering shortfall – particularly in Naval engineering, computer science and ocean engineering. Our production of engineers has been flat for two decades, and far less in these specialty fields. Complicating our challenge is the fact that DoN must rely on U.S. citizens for classified work.

Our investments seek to increase diversity and numbers of students pursuing STEM degrees. Areas of emphasis include: 1) freshman and sophomore STEM retention in college, 2) hands-on STEM programs in urban and rural middle schools, 3) teacher training in Naval-relevant fields of study, and 4) mission-critical graduate student and post-doctoral support. Programs incorporate Naval content, metrics to measure impact, and coordinate with other Federal STEM programs. Further, programs are selected based on potential for growth and geographic expansion, as well as ability to serve underrepresented student populations.

By the end of middle school, many students – particularly from underserved populations (minorities, females, those from urban and rural settings) decide to opt out of STEM education. It is critical to engage these students no later than middle school by offering a variety of hands-

on learning opportunities and mentoring experiences to build STEM confidence and encourage them to pursue the math and science classes needed to be STEM eligible in college.

This investment can only be justified if we are improving our workforce. For many investments we may not be able to see a return for years. However, we assess each investment to determine how it contributes to achieving Naval goals. We are in the process of developing a comprehensive metrics and evaluation plan for all STEM programs, which measures not only numbers of students and teachers, but assesses our ability to fulfill Naval requirements.

Leap Ahead Innovations (Innovative Naval Prototypes)

Innovative Naval Prototypes (INP) involve approximately 12 percent of the S&T budget. They focus on high-risk/high-payoff opportunities from the D&I portfolio that can significantly impact Naval capabilities if we can mature the technology. INPs are discontinuous, disruptive, radical departures from established requirements and operational concepts. Approved and overseen by the Naval Research, Development, Testing and Evaluation (RTD&E) Corporate Board (Undersecretary of the Navy; Assistant Secretary of the Navy for Research, Development and Acquisition; Vice Chief of Naval Operations; Assistant Commandant of the Marine Corps), the goal is to prove concepts and mature technology in four to eight years, allowing informed decisions about risk reduction and transition into acquisition programs. In order to facilitate transition to acquisition programs, Program Managers and Deputy Program Managers are primarily selected from ONR and the Acquisition community.

INPs include:

Electromagnetic Railgun is a revolutionary long range gun with multi-mission potential including ballistic and cruise missile defense, long range land attack, and anti-surface warfare against small boats and ships. Fired by an electric pulse, Railgun eliminates explosive gun propellant from ships' magazines resulting in greater resilience to battle damage. ONR has established a firm foundation for ongoing system development. Since 2005 the state of the art for launch energy has advanced by a factor of 5 (to 32 mega joules) providing the potential to launch lethal projectiles to ranges up to 110 nautical miles. Projectile design is underway including successful open range lethality testing, component development and extensive modeling and simulations. Barrel life has increased from tens of shots to over 400 with a path to 1000 shots. Contractor built advanced composite launchers have been strength tested to operational levels. Meanwhile, the physical size of the pulsed power system has been reduced by a factor of 2.5 through increased energy density so that the system will fit into current and future surface combatants. Current ONR research is focused on rep-rate capability of multiple rounds per minute which entails development of a tactical prototype gun barrel and pulsed power systems that incorporate advanced cooling techniques. These components are being designed to transition directly into prototype weapons systems currently being conceptualized. ONR is working closely with Naval Sea Systems Command (NAVSEA) and the Office of the Secretary of Defense (OSD) Strategic Capabilities Office to ensure maximum commonality and to reduce the need for expensive and time consuming redesign. Developmental testing is ongoing at Naval Surface Warfare Center, Dahlgren, Virginia as well as the Naval Research Laboratory (NRL). I invite you to visit either of these world class facilities.

Integrated Topside (InTop) will enable Navy to dominate the electromagnetic spectrum through development of multi-beam, multi-function ultra-wideband apertures and Radio Frequency (RF) equipment for all ship classes. We are developing advanced Electronic Warfare, Information Operations, Radar, Satellite and Line of Sight Communications using: 1) open architecture for RF equipment, plus computer hardware and software that will enable industry to contribute to development of affordable new systems and upgrades, and 2) modular systems that enable the same technology to be scalable across all Naval platforms and significantly reduce logistics, training, and maintenance costs. We continue prototype tests and demonstrations at facilities in Maryland, New Jersey, New York, Rhode Island, Texas, and the Naval Research Laboratory (NRL), with subsequent initial deliveries for commencement of testing by the Naval Undersea Warfare Center (NUWC) for submarine Satellite Communications (SATCOM) and by NRL for the Surface Electronic Warfare Improvement Program (SEWIP) Block 3 prototype.

The Large Displacement Unmanned Undersea Vehicle (LDUUV) is developing a reliable, long endurance UUV capable of extended operation in cluttered littoral environments. The program is developing the needed energy, autonomy and core UUV systems to operate in a complex ocean environment near harbors and high surface traffic locations. Key goals include doubling current UUV energy density, and using open architecture to lower costs, while enabling full autonomy in over the horizon operations. Achieving these goals will reduce platform vulnerability, while enhancing warfighter capability and closing gaps in critical mission areas. During FY 2013 sea trials, we will develop autonomous behaviors and demonstrate reliable battery and fuel cell power systems with a series of longer endurance tests.

The Autonomous Aerial Cargo/Utility System (AACUS) is developing intelligent, autonomous capabilities for rapid, affordable, and reliable rotorcraft supply in permissive, hostile and GPS-denied settings. AACUS-enabled aircraft will be supervised by field personnel with no special training from a handheld device. Challenges include dynamic mission management and contingency planning, as well as landing execution and obstacle avoidance under demanding conditions. AACUS is designed for open system architecture to promote modularity and affordability and could be used in Casualty Evacuation (CASEVAC), combat rescue, and humanitarian aid missions.

In addition to INPs, SwampWorks programs, although similarly high-risk and disruptive, are smaller than INPs and intended to produce results in 1 to 3 years. SwampWorks efforts have substantial flexibility in planning and execution, with a streamlined approval process. Although a formal transition agreement is not required, SwampWorks programs have advocates outside ONR, either from the acquisition community or Fleet/Force. SwampWorks products are frequently inserted into Fleet/Force experimentation and can provide impetus for new acquisition requirements.

Acquisition Enablers (Future Naval Capabilities)

Acquisition Enablers (AE) are the most critical component of our transition strategy. Most of the AE portfolio consists of our Future Naval Capabilities (FNC) program, with the remainder including USMC Advanced Technology Development (6.3) funds, Joint Non-Lethal Weapons

Directorate 6.3 funds, the Manufacturing Technology (ManTech) program, and Low Observable, Counter Low Observable funds.

FNCs are near-term projects, the requirements-driven, delivery-oriented portion of the S&T portfolio. FNCs deliver mature component technologies to acquisition sponsors to incorporate into systems that provide new warfighter capabilities. FNC investments use a collaborative process involving requirements, research, acquisition, and Fleet/Force communities to align the requirements-driven portion of the S&T portfolio with Naval Capability Gaps identified by the Office of the Chief of Naval Operations (OPNAV) and Marine Corps Combat Development Command (MCCDC). A gap is any capability required to achieve Naval objectives that are not achievable with current platforms, weapon systems, doctrine, organizational structure, training, materials, leadership, personnel or facilities and requires S&T investment to solve or overcome. Capability Gaps define the requirement, not how to meet it.

FNC projects are selected annually to address specific gaps, with final prioritization approved by a 3-Star Technology Oversight Group (TOG) representing OPNAV, Marine Corps (USMC), U.S. Fleet Forces Command (USFF), Assistant Secretary of the Navy (ASN-RDA) and ONR. FNCs are based on D&I investments where technology can be matured from Technology Readiness Level (TRL) 3 to TRL 6 within three to five years. Selection takes account of related work in the Defense Department (DoD), government agencies, industry and Naval centers of excellence.

Approved technology products are required to have Technology Transition Agreements that document the commitment of the resource sponsor, acquisition program, and ONR to develop, deliver and integrate products into new or upgraded systems to be delivered to the Fleet/Force. Every FNC product is annually measured against technical and financial milestones. All FNC products must meet required transition commitment levels for S&T development to continue. This practice helps make every dollar count. Products that no longer have viable transition paths are terminated with residual funding used to solve problems with existing projects, or start new projects in compliance with Navy priorities, charters, business rules and development guidelines. The measure of FNC success is whether projects meet technology requirements and exit criteria, and whether acquisition sponsors have transition funds in their programs to accept and integrate FNC products. Products with planned transition funds usually transition after risks are mitigated, a definitive plan finalized, and required funding programmed.

Our investments focus on the most pressing capability gaps, with changes in funding for FNC products based on successful transitions, reprioritization, new starts, and evolving Naval needs. As FNC products mature, Technology Readiness Levels (TRL) change, moving products from 6.2 to 6.3 PEs. Year one is predominantly 6.2; the final year predominately 6.3 – with a mix of 6.2/6.3 between. As products transition to from S&T to Advanced Component Development and Prototypes (6.4) and Engineering and Manufacturing Development (6.5) funding, responsibility for continued development shifts from ONR to acquisition commands.

Quick Reaction S&T

ONR maintains a quick-reaction capability involving projects of 12 to 24 months duration that respond to immediate requirements identified by Fleet/Force or Naval leadership. TechSolutions provides short-term solutions to immediate operational and tactical requirements. Accessible via the Internet and SIPRnet, TechSolutions accepts recommendations from Sailors and Marines at a tactical level about ways to improve mission effectiveness through the application of technology. TechSolutions uses rapid prototyping to meet specific requirements, with each project structured around definable metrics, and appropriate acquisition/test systems by an integrated product team. While neither a substitute for the acquisition process nor a replacement for systems commands, TechSolutions provides prototypes that deliver solutions to address immediate needs that can be easily transitioned by the Fleet/Force acquisition community.

The problem we are trying to solve is that the pace of technology development is often faster than the DoD Planning, Programming, Budgeting and Execution (PPBE) process can respond. Our Technology Insertion for Program Savings (TIPS) program is structured to provide current-year funding (inside the PPBE process), eliminating the time lag inherent in the PPBE cycle. The general scope of the program is funding up to $2 million for development efforts taking no more than two years to complete, coupled with strong Fleet/Force support and resource sponsor commitment to fund moving the technology into the acquisition Program of Record (POR) or operating system. TIPS focuses on improvements that substantially reduce operating and support costs for warfighting systems.

In partnership with ONR, Naval Warfare Development Command (NWDC), Naval Postgraduate School, Naval War College and Marine Corps Warfighting Lab (MCWL) assess new warfighting concepts and emerging technologies. Initiatives in support of our maritime strategy are applied, tested, analyzed and refined through war games, exercises, experiments and operational lessons learned.

S&T Highlights

The Naval S&T portfolio includes a range of projects and supporting programs entering or about to enter the Fleet/Force. Following are examples of these efforts, noting the impact they will have on Sailors and Marines, today and in the future.

Expeditionary Maneuver Warfare and Combating Terrorism

With your Marines, "expeditionary" is a force no larger or heavier than necessary to accomplish the mission. Missions are temporary operations from forward land or sea bases with temporary support in the face of hostile resistance across the spectrum of combat to non-combat missions, with intent to withdraw when the mission is accomplished. This can best be achieved through creation of a Future Middleweight Force which can launch from and return to the sea, reclaim Navy's role as the premier expeditionary force, and project power in increasingly sophisticated anti-access, area-denial (A2/AD) environments.

Key to establishing this Middleweight Force is the requirement to "Lighten the Load" for every individual Marine, as well as the Marine Air-Ground Task Force (MAGTAF). In S&T, this involves research into technologies that will increase speed, agility and operational range across

difficult terrain - while reducing fuel consumption. It includes reducing vulnerability to Improvised Explosive Devices (IEDs) and mines, and developing advanced materials for lighter body armor, improved helmets and better eye protection. We are investing in significantly enhanced over-the-horizon, beyond line-of-sight, restricted environment communications, as well as netted, adaptable sensor systems that can detect, classify, indentify, locate and track low level entities in urban clutter to improve situational awareness and enhance real time tactical decision making.

We also invest in research about ways to improve training efficiency based on cutting edge, neuro-cognitive, psychologically-driven instructional strategies. Improving the proficiency with resilience of Marines enables them to more effectively, efficiently observe, orient, decide and act (OODA) during complex, stressful combat conditions enhances their ability to precisely locate and defeat enemy targets in urban areas. At the same time, we are exploring new technologies that provide autonomous air logistics delivery from the Seabase to Distributed Operations Units, as well as enhance self-sufficiency in fuel and water use, and improve maintenance capabilities. Research in resiliency will enable Sailors and Marines to survive and prosper in the brutal environment of close combat, as well as to retain their emotional and mental health after they leave the traumatic stress environment.

Marines operate from a forward-deployed posture to provide immediate crisis response capabilities when U.S. citizens, interests or allies are threatened. Our viability as an expeditionary force hinges on our ability to address challenges involving the way we train and equip our force. In S&T, this involves research into technologies that enable extreme agility from the individual to the MAGTF resulting in total maneuver dominance over the battlespace. On-demand and reduced logistics enables a sustained high tempo of operations, allowing the Corps to out-maneuver any enemy. Marines will out-perform and out-think the enemy through our ability to understand the battlespace in greater detail, make operational and tactical decisions with greater understanding of enemy intentions, with respond to enemy decisions more rapidly by getting inside the enemy decision cycle. To help achieve these goals, we are creating a generalized, small unit, leader-centric training framework based on codified learning models and theories and delivering technology and knowledge products for the USMC Training and Education Command (TECOM) that maximize learning and skill acquisition at minimal cost.

Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)

The most critical enabler of rapid, accurate decision-making is having a clear picture of the dynamics of the battlespace. Automated development of this picture becomes critical at the tactical edge where decisions must be made in real time. However, critical pieces of information often reside in proprietary and mission networks and are not easily shared with other missions or integrated with other data. This leads to inefficient use of band-width – and if the same or similar data is required by several different missions on separate networks, multiple transmissions of the same data often result. Since accurate decision making is all about the data, access to critical relevant data regardless of source requires that we pursue a data-focused information architecture/environment, as opposed to the current individual systems architectures.

To achieve this goal, ONR is working with the Deputy CNO for Information Dominance (N2/N6) and Program Executive Officers (PEOs) to develop Naval Tactical Cloud reference implementation that is scalable across platforms and meets the critical timelines of tactical environments. While cloud technologies for environments connected by fiber optics or other high bandwidth connectivity are commercial products, clouds at tactical levels (such as ships and platforms operating in Disrupted, Detached, Intermittent, and Limited bandwidth environments) require significant enhancements such as automation in information discovery; data synchronization across a distributed cloud; dynamic, automated, policy-based, information prioritization; automated identity and authentication management, and synchronization. For this, we can leverage much of the basic cloud architecture from the Intelligence Community and Army, and focus S&T on enhanced technologies and data science to automate much of the underlying sense-making.

The underlying technologies that integrate the operational and tactical pictures require significant advances in ingesting numerous, disparate data types such as Communications Intelligence (COMINT), Signals Intelligence (SIGINT), Electro-Optical/Infrared (EO/IR) images, radar, Human Intelligence (HUMINT), and financial and social transactions into a common structure – and developing the advanced analytics to extract the critical factors that enable rapid, accurate decision making. In addition to building these rich operational and tactical pictures for the warfighter, a rigorous mathematical schema for computing the associated confidence level in resulting pictures due to uncertainty, incompleteness, imprecision, and contradiction in the underlying data is required. Improving confidence levels often requires optimized refocusing of limited sensing, computational, and human resources on specific mission picture elements for acquiring data the system does not have. Resolving these issues requires considerable resources and often cannot be done within a mission's tactical or strategic timelines without significant automation.

This is only one aspect of our effort to focus on Cyber Threats to Naval operations and respond with robust efforts to develop the technology to operate in Cyberspace and across the electromagnetic spectrum as emerging war fighting domains – and enable operations in an A2/AD environment. ONR's goal is to partner with network defenders, acquisition sponsors and Fleet/Force operators to develop advanced capabilities to defend networks and assure operational capability and resilience in Cyberspace.

Ocean Battlespace Sensing

One of the Navy's premier goals is to exploit the environment to our advantage by accurately predicting and adapting to ocean, air, littoral and riverine environments on tactical and strategic time scales. To achieve this goal, we invest in S&T to provide mobile autonomous environment sensing, match predictive capabilities to tactical planning requirements, and develop systems that will adapt to environmental variability. In short, we are working to integrate atmospheric and ocean models to enable better forecasting.

In partnership with the National Oceanic and Atmospheric Administration (NOAA) and academic partners, we developed the Hybrid Coordinate Ocean Model (HYCOM), a numerical model data assimilation system to provide daily to weekly forecasts of global ocean conditions.

We developed the next generation Tropical Cyclone Forecast model, which will provide improved intensity forecasts. Additional research investments include developing a better understanding of how surface winds affect upper ocean dynamics and energy fluxes across the ocean boundary layer, as well as improving knowledge of Arctic environments and the ability to forecast operational conditions with longer lead times. Construction has begun on the newest University-National Oceanographic Laboratory System (UNOLS) Ocean Class Research Vessels. Auxiliary General Oceanographic Research Ship (AGOR 27) *Neil Armstrong* will be delivered in 2014 and assigned to Woods Hole Oceanographic Institution, while AGOR 28 will be delivered in 2015 and assigned to Scripps Institution of Oceanography.

In addition, we are developing rapid, standoff mine countermeasures to support unencumbered maneuver of combatants, assure access, ensure strategic mobility and sustainment, decrease mine countermeasure (MCM) hazards to ships, sailors and Marines, and increase the standoff range of combatants from minefields. ONR experiments with sensing and autonomy technologies help enable small vessels to operate at night, in all weather, at higher speeds, with significantly less difficulty and risk over very large, poorly mapped riverine systems. Our Advanced Undersea Weapon System (AUWS) will deliver and distribute targeting sensors and remotely controllable or autonomous weapons into chokepoints or channels to neutralize maritime threats for extended periods. Coupled with Advanced Sonar Technology for High Clearance Rate MCM in the surf zone and autonomous minehunting payloads for Unmanned Surface Vehicles (USV), ONR is reducing timelines associated with detecting, identifying and clearing floating, drifting, moored and bottom mines in shallow water.

Finally, ONR supports research to improve anti-submarine wide area surveillance, detection, localization, tracking, and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. We continue to provide S&T to mitigate the effects of Naval acoustic systems on marine mammals to facilitate Navy acoustic training and operations. We provide S&T to improve probability of kill (Pk) capability of undersea weapons, and enable new undersea weapon concepts of operation. Associated projects include the Remote Aerial Sonar and Communications Laser (RASCL), Affordable Compact Bow Sonar for large deck surface ships, holding threat submarines at risk in forward areas, screening transiting battle groups, and providing torpedo defense for individual ships.

Sea Warfare and Weapons

ONR's major focus in this area is to improve surface, submarine, ground, and air platforms, as well as undersea weapon performance to meet future requirements and maintain technological superiority. S&T provides Naval options for advanced electrical systems and components, and for survivable, agile, mobile, sustainable, manned and unmanned, surface and sub-surface sea platforms, and undersea weapons. ONR also supports research to improve aircraft survivability and rotor/prop performance across a wider flight envelope. In addition, we invest in S&T to develop energy dense, safe and reliable energetic materials, as well as to explore the entire spectrum of power and energy technologies.

An important focus of ONR's Advanced Naval Materials research is Integrated Computational Materials Engineering (ICME) which links basic research in physics and chemistry to reliable, cost-effective materials processing and manufacturing design to meet critical Naval requirements. ICME advances experimental capabilities that move material science from the analog to digital age by emphasizing model-guided experimentation at nano-, meso- and macro scales to discover and articulate materials interactions. It also explores the development of high performance functional and structural materials, including metals, cellular and composite materials, welding and joining, and bulk nano-material processing.

This effort supports the Materials Genome Initiative for Global Competitiveness, coordinated by the White House Office of Science and Technology Policy. Goals include building the Materials Innovation Infrastructure, supporting more collaborative, concurrent materials development and system design, and establishing educational underpinnings necessary to support these changes.

An example of the way we do business worldwide is the Asia-Pacific Technology and Education Program (APTEP). APTEP's goal is to promote commerce and partnerships in the Asia-Pacific region through advances in alternative energy research, technology development and education. This includes development of U.S. research capabilities, a U.S. workforce to develop and implement appropriate technologies, and a U.S. economy providing technologies to meet Asia-Pacific needs. In addition, APTEP promotes partnerships with Asia-Pacific nations to encourage the open exchange of technology advances and educational opportunities.

Another example of how we do business is the Energy Systems Technology Evaluation Program (ESTEP), which demonstrates advanced energy technologies using Navy/Marine Corps facilities as test beds. ESTEP data is used to evaluate performance and reliability of energy technologies under various environmental and operating conditions and provide baseline data required for inclusion in energy efficiency systems and equipment procurement specifications. The focus is on innovative pre-commercial and nascent commercial energy technologies obtained from open market sourcing, including companies from the venture capital and small business communities.

Each ESTEP project requires participation by DoN civilians, and military personnel or veterans in key technical and business roles in order to provide training and educational opportunities for the DoN energy workforce. Participants include students in technical and business studies at the Naval Post Graduate School (NPS). NPS, Navy Facilities Command's Engineering and Expeditionary Warfare Center (EXWC), and Space and Naval Warfare Systems Command (SPAWAR) San Diego, have key roles in education, development of information networks, installation design, construction, and security – and lead implementation of the ESTEP program. In addition, a veteran's outreach effort is being developed for the San Diego region, with special emphasis on building links to veteran's programs already established at San Diego State University, including the Troops to Engineers program.

When implementing technology demonstrations at Naval installations and in the private sector, the greatest hurdles are not necessarily technology challenges, but regulations, restrictions, and permits, not to mention fiscal constraints, policies, and other institutional hindrances that can delay and prevent implementation. Therefore, a thorough knowledge of this complex technical,

financial, institutional, and bureaucratic environment by project managers will facilitate project implementation and enable experienced, well-trained energy managers to improve the process.

After the House of Commons was destroyed by one of the last bombs in the Battle of Britain, Winston Churchill encouraged parliament to rebuild, saying, "We shape our buildings, and afterwards our buildings shape us." That is a principal reason ONR is exploring ways to include Wounded Warriors in Renewable Energy Architectures for Cultural and Human Environments (REACHE) programs – so future facility designs and architectures provide optimal work and living environments for those with disabilities. Such approaches eliminate older architectural design and building techniques that restrict and inhibit human potential. As energy efficiency and technology are already major components for architectural design and building technologies, energy career choices by Wounded Warriors can bring unique personal knowledge to advance the development and implementation of alternative energy architectures.

Warfighter Performance

Warfighter Performance S&T requires that ONR identify and exploit key principles from nature to design, control and power autonomous systems; provide improved processes, materials and sensors; and to develop synthetic biology tools and applications to support the Naval force. Biocentric technologies offer a variety of enabling capabilities, including bio-inspired autonomous vehicles, acoustic/seismic discrimination systems, microbial fuel cells for sustainable power, engineered plants that produce energetic material precursors, and diagnostic tools to assess the health of marine mammals.

Human Factors and Organization Design Systems improve small team, platform, task force, and battle group operations by enabling technology development to accommodate human capabilities and limitations. ONR S&T initiatives include advancing system technologies that incorporate state-of-the-art social and cognitive sciences into existing and developing systems. The goal is to enhance performance, improve the timeliness and quality of operational decision making, develop strategies to mitigate high workload, resolve ambiguity, reduce manning requirements, and improve situational awareness and speed of command through a deeper understanding of human capabilities and limitations.

Training technologies provide S&T to design virtual networked learning environments to increase a sailor's and marine's skill, knowledge, expertise and experience in critical warfighting tasks. ONR objectives are to enhance Navy and Marine Corps ability to effectively and affordably train in classroom settings, simulated environments, and while deployed. System and personnel readiness are enhanced by matching the right people with the right skills to systems designed for safe, effective, and efficient operation.

Medical technologies provide S&T to improve the health, well-being, protection and survival of personnel in undersea, shipboard and expeditionary settings. They provide medical equipment, diagnostic capabilities, and treatments that improve safety and enhance warfighter performance and resilience under adverse conditions. For example, ONR develops solutions for hemorrhagic problems associated with combat casualty care, new approaches to prevent injury and disease in

hazardous environments, and continues to address noise induced hearing loss by reducing noise at the source, limiting exposure, and developing of protective technologies.

Human subject research is critical to support the Navy and Marine Corps warfighter, training and operational capability, and Navy Medicine. Many RDT&E activities designed to respond to Fleet/Force requirements necessitate human subject participation. As part of the DON Human Research Protection Program, ONR is responsible for implementation of human subjects protections in the Navy's systems commands, operational forces, training units, and at Navy-sponsored extramural institutions. ONR reconciles the competing priorities of conducting potentially risky research involving human subjects and compliance with federal, DoD, and DON human protection policies.

Naval Air Warfare and Weapons

ONR's Naval Air Warfare goal is to develop, demonstrate and transition technologies to expand Naval weapon system stand-off ranges and reduce engagement timelines to enable rapid, precise, assured defeat of moving land, sea and air targets. We are developing directed energy technologies for defense against advanced cruise missiles, small boats, and asymmetric threats. We invest in research to develop advanced propulsion for high speed weapons and demonstrate key technologies associated with high acceleration, high temperature and high strength materials. We are pursuing automatic and aided target recognition technologies and collaborative weapons behavior. ONR also supports research for standoff detection of Weapons of Mass Destruction (WMDs) and component nuclear materials on ships at sea.

Naval Research Laboratory (NRL)

ONR supports the DoN corporate lab, the Naval Research Laboratory (NRL). The NRL base program develops S&T to meet needs identified in the Naval S&T Strategic Plan and sustains world class skills and innovation in our in-house laboratory. The core scientific research at NRL serves as the foundation that can be focused on any area of interest to rapidly develop technology from concept to operation when high-priority, short-term needs arise. NRL is the lead Naval lab for space systems, firefighting, tactical electronic warfare, microelectronic devices and artificial intelligence. Among our greatest challenges is recapitalizing NRL infrastructure. I invite you to see this facility and learn more about the research undertaken there by the greatest scientists and engineers in the world.

ONR Global

ONR maintains offices in London, Prague, Singapore, Tokyo and Santiago, with our activities closely coordinated with the other services and the Assistant Secretary of Defense (Research and Engineering). We search the globe for emerging scientific research and advanced technologies that enable ONR to address current Naval needs, as well as requirements for future capabilities. ONR Global establishes contacts with international leaders in relevant research, allowing us to gain new perspectives, identify trends, and forecast threats. It also enables us to recruit the world's best scientists and engineers in partnerships that benefit the U.S. and our allies.

ONR Global programs include Science Advisors who communicate Fleet/Force capability needs to the Naval Research Enterprise (primarily Navy labs, warfare centers, affiliated universities) to facilitate development of solutions that transition to the Fleet/Force. Most participants are senior Naval engineers who coordinate experimentation, develop prototype solutions, define transition options, and collaborate with Fleet/Force to define S&T investments to meet future requirements. Our International Science Program provides scientists from academia, government and industry opportunities to engage leading international scientists and innovators. Our technical staff helps establish direct collaboration between ONR/NRL scientists and their foreign counterparts, and identify centers of excellence for Naval S&T. This strengthens our ability to avoid surprise.

Conclusion

The FY 2014 President's Budget request will enable us to continue moving toward enhanced capabilities, more effective partnership between research and acquisition, and strengthened partnerships the Army, Air Force, DARPA and other DoD research organizations – as well as performers outside the Naval R&D system. We strive to tap into the full spectrum of discovery and accelerate the transition of appropriate technologies to civilian use. Our S&T investments represent careful stewardship of taxpayer dollars that will achieve these goals and significantly enhance the safety and performance of warfighters as they serve in defense of the United States. Thank you for your support.