

PennState Applied Research Laboratory

2023 Annual Report



ALLAN SONSTEBY Executive Director Applied Research Laboratory



A Message from the Executive Director

AN EVOLVING FUTURE

Change, it has been said, remains the only constant. As we embark upon another fiscal year, I'm pleased to report that despite a year of worldwide economic turbulence, the Laboratory remains both technically and financially strong. As we endeavor to meet the needs of our research sponsors and increase collaborations across our internal offices and with our external partners, ARL's talented workforce has remained united in pursuit of our national security mission. I am grateful for their agility, creativity, and resilience as we navigate an evolving future.

EMERGING LEADERS

After a pair of national searches, I'm proud to welcome two new members of our senior leadership team. First, Dara Sanoubane, Ph.D., has accepted the role as our chief diversity officer. Under Dr. Sanoubane's leadership, the SOAR program (Student Opportunities in Applied Research) has flourished, providing historically-underrepresented students from across the United States with hands-on research opportunities.

Second, Meghan Flannery Hayes, an ARL Fellow and recipient of the 2023 ARL Award for Inclusive Excellence, has accepted the role of ARL deputy director and head of our Communications, Information, and Navigation Office (CINO). Ms. Hayes brings national recognition and more than 17 years of research and leadership experience across a wide breadth of disciplines to the role.

I am confident that these exceptional women will offer the leadership, knowledge, and dedication necessary for the Laboratory to thrive.

RENEWAL AND RENOVATION

July 2023 marks the final phase of the four-year Garfield Thomas Water Tunnel (GTWT) renovation project. Research done at the GTWT, a Historic Mechanical Engineering Landmark designated by the American Society of Mechanical Engineers, has benefited our nation in a variety of areas, including national defense, biomedical devices, and renewable energy. The renovations to the GTWT would not have been possible without close collaboration between our research and enterprise operations teams, who are working in harmony to ensure a successful outcome. More about the project can be found in our "Project Spotlight" on page 12.

As always, I am grateful to our research sponsors, the Penn State community, and the extraordinary people of ARL who have helped us deliver excellence in research, discovery, and innovation for more than 78 years.

It is with great pleasure that I present this year's annual report.

Be well,

Allan



OUR PEOPLE

The cutting-edge research and innovative technologies ARL produces would not be possible without our talented team. As we build the next generation of ARL employees, we seek intellectually curious, conscientious, and creative people to solve complex problems pursuant to our national security mission.

ARL embraces diversity, equity, inclusion and belonging as mission imperatives and in the best interests of our sponsors. We insist on treating all Laboratory staff, vendors, subcontractors, collaborators, and sponsors with civility, compassion, fairness, and respect. It is not enough to simply say, "We support diversity." Instead, we actively cultivate an environment where diverse perspectives and identities are celebrated, not just included.

When we say, "You belong at ARL", we mean it, and our actions reflect our commitment to that mindset. We recognize that our people drive the success of any endeavor we pursue, and we remain committed to nurturing their personal and professional growth.



OUR RESEARCH GOALS

Reporting to Penn State's Office of the Senior Vice President for Research, ARL plays a critical role advancing the University's mission of teaching, research, and service with pride. In University Fiscal Year (UFY) 2022, ARL's research expenditures made up 27 percent (est.) of the total research expenditures at Penn State.

As part of our strategic, long-term relationship with the Department of Defense (DoD), ARL maintains core technology capabilities of critical importance to our sponsors, free from real and perceived conflicts of interest. Acting as trusted advisors, we offer objective, independent guidance and counsel, access to information and proprietary data, and extensive operational experience in our areas of expertise. We strive to maintain a culture of scientific discovery and consistently leverage our agility to adapt to evolving sponsor needs.

We serve as subject matter experts in our areas of competency, offering world-class research capabilities to attract the next generation of students, researchers, scientists, and industry professionals.

Our faculty and staff are active in the Penn State academic community through chairing graduate committees, advising students, and teaching courses.

Our Year at a Glance

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SPONSORS FY 23

- 1 NAVSEA 48%
- 2 ONR 16%

3 DARPA 8%

4 USG 8%

5 OTHER DOD 5%

6 DTRA 4%

7 OTHER NAVY 4%

8 OTHER ARMED SERVICES 3%

9 OTHER USG 1%

10 USMC **1%**

11 JIATF-S 1%

12 INDUSTRY 1%





FY 2023

\$1.19_B

TOTAL AMOUNT OF PROPOSALS

453 PROPOSALS SUBMITTED 249 AWARDS

RECEIVED

\$416м

TOTAL AMOUNT

OF NET FUNDED

AWARDS

123 SPONSORS



Significant Contributions



SSN-795 Rod Cold Spray Repair

In a landmark effort to address crevice corrosion damage on the future SSN-795 U.S.S. Hyman G. Rickover, ARL developed the first in-situ Cold Spray repair of a component internal to a ship, performed in-situ Cold Spray repair on a SUBSAFE component, completed repair of a damaged component on a new construction vehicle, and performed life extension and component enhancement using Cold Spray. ARL supported the Norfolk Naval Shipyard in performing repairs pierside at the General Dynamics Electric Boat.

Our rapid response capabilities enabled the project to go from start of development to completed and approved repair in seven weeks, a time savings of more than five months over unplanned dry docking repair.

Communications and Signal Processing

ARL researchers demonstrated critical communications technologies during two INDOPACOM Fleet Exercises.

Visualization and Decision Support

ARL provided support for the discovery, demonstration, and experimentation of innovative solutions and emerging technologies to enhance DoD logistical and operational energy. Areas of focus included global logistics, agile logistics distribution, sustainability, resilience, and demand reduction capabilities.

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STEM Student PIPELINE for the Navy

In partnership with Penn State's College of Engineering, ARL was awarded a five-year Navy contract termed PIPELINE: Penn State Intern Pipelin**E LI**nks to Navy Engineering. Hoping to propel U.S. students to careers in the technical workforce of the Navy, particularly in advanced undersea technology development, this joint effort will support future ARL research scientists and engineers.

Advanced Cyber Capabilities

ARL developed key modeling and simulation infrastructure advancements that will enable the DoD to standardize campaign planning, identify capability gaps, and increase force readiness.

SSN(X)

ARL was awarded a multi-year contract from Naval Sea Systems Command for the development of advanced technologies for the next generation fast attack submarine.

Defense University Research Instrumentation Program Award

ARL received a Defense University Research Instrumentation Program award from the Office of Naval Research for a new test section for the 12 inch diameter water tunnel.



The **Communications, Information, and Navigation Office** (**CINO**) develops solutions and champions the transfer of advanced technologies to the DoD, Intelligence Community (IC), and other government and industrial sponsors. Our portfolio encompasses the research, development, prototyping, and delivery of advanced sensing, communications, cyber, geospatial, analytic, and visualization capabilities.

In the past year, we built upon our efforts to expand and enhance the capabilities sought by our sponsors. Some of these efforts include assessing government systems; developing tools and applications in support of the national geospatial intelligence mission; investing in foundational quantum research; and delivering of operational hardware and software at critical government locations.

Finally, our teams delivered faster-than-real time simulation capabilities to the Defense Advanced Research Projects Agency and successfully demonstrated the Broadband Navigation Sonar System. Featuring advanced analytical tools (including target maneuver detection), this system provides highly accurate underwater velocity and positioning data.



🕸 FDAO

The **Fluid Dynamics and Acoustics Office (FDAO)** performs basic and applied research in experimental and computational fluid dynamics and acoustics, propulsor and pump design and testing, and engineering education.

In the past year, we provided leading edge science and technology for the U.S. Navy's current and future submarine fleet, including contributions to the VIRGINIA, COLUMBIA, and future SSN(X) class submarines. Working closely with the Office of Naval Research, our project areas include computational structural acoustics, acoustic materials, vibration and noise reduction, and computational fluid dynamics codes.

As part of our partnership with Penn State's College of Engineering (CoE), FDAO faculty and staff worked with CoE faculty on multiple joint research projects, taught classes, and participated in collaborative forums such as the Fluid Dynamics Research Consortium and the Center for Acoustics and Vibration. Funding from a recently accepted CoE and ARL STEM proposal will help to support graduateand undergraduate-level students.



The **Materials and Manufacturing Office (MMO)** develops integrated solutions that combine optimized material properties with advanced processing and manufacturing techniques. Our robust expertise allows us to address supply chain challenges and enable rapid, cost effective system development and sustainment. Our researchers also provide critical support to the Navy and other federal sponsors in the areas of directed energy, lasers, and electro-optic technologies.

In the past year, MMO performed fundamental material development, process development, and technology transition for our sponsors. We developed innovative processes in additive manufacturing and cold spray, qualified processes for use in repairing Naval components, and transitioned them to U.S. Navy shipyards. As we expand our research portfolio, we have served as a test and integration partner for new DoD enterprise information systems and have developed health monitoring solutions for critical Navy platforms.

We are proud to contribute to the affordability and speed of acquisition of major weapons systems through our three Office of Naval Research ManTech Centers of Excellence: the Institute for Manufacturing and Sustainment Technologies, the Electronics Manufacturing Center, and the Electro-Optics Center.



🗳 USO

The **Undersea Systems Office (USO)** serves as a trusted resource and system developer in critical undersea technology areas including undersea weapons, uncrewed undersea vehicles (UUVs), and advanced sonars. Over the past year, we conducted crucial system testing, fleet exercises, and design reviews to support the Navy's three undersea weapons programs.

The MK48 Mod 9 heavyweight torpedo completed two highly successful propulsion system tests while the MK54 Mod 2 Advanced Lightweight torpedo completed two of four critical design reviews required for its Milestone B acquisition decision. The Compact Rapid Attack Weapon began transition to the Navy's industry partner.

Our Large Test Vehicles supported Navy fleet exercises, providing an invaluable platform for technical demonstration, concept of operations development, and capability risk reduction. Pursuing new frontiers in textured ceramics, our sonar research division provided groundbreaking development and implementation into legacy Navy piezo-electric applications and continued to be a leader in Synthetic Aperture Sonar sensor development and image processing.





© ENTERPRISE OFFICES

Ensuring seamless operation of a multifaceted research organization presents unique challenges, and the 11 ARL Enterprise teams offer a wealth of experience to deliver solutions. From amplifying ARL's success stories (Corporate Communications); to building and certifying cutting-edge intelligence platforms (Information Technology Services); to optimizing the ARL training process (Compliance), Enterprise Operations works in concert with our research offices in support of ARL's mission.

As the Laboratory continues to grow, we've built a solid foundation for our future scientists, engineers, and research professionals. The collaborative efforts of the Leadership, Culture, and Student Programs hub and the Human Resources team ensure that ARL continues to attract the brightest minds to foster a prosperous future.

With more than 1,500 ARL employees occupying more than 860,274 square feet of building space, our Engineering Services team leads the mammoth task of ensuring safe, secure facilities for our employees to thrive.

Our Security Services team received the prestigious Defense Counterintelligence and Security Agency Award for Excellence in Counterintelligence for 2022. As one of only four organizations to receive the award from more than 10,000 cleared organizations, this honor highlights the relentless vigilance required to secure and protect U.S. defense and national security technology—a mission they execute in collaboration with the Special Program Security team.

As researchers embark on their projects, the Business Services team ensures that the resources, processes, and services required to achieve success are readily available. The new Enterprise Project Management team offers transparency, guidance, and accountability across a portfolio of research and enterprise offices to ensure on-time and within-budget delivery.

As the Laboratory makes significant strides in research, innovation, and discovery, the Process Excellence team provides guidance on process optimization, leveraging LEAN methodologies, and facilitating collaboration.

All of ARL—including leadership, research offices, and enterprise operations—remains committed to strengthening our capabilities, exploring new technologies, driving organizational efficiency, and anticipating our sponsors' emerging needs.

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Enterprise Operations works in concert with our research offices in support of ARL's mission.



Project Spotlight

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23

GARFIELD THOMAS WATER TUNNEL RENOVATION

Few facilities embody ARL's storied history as well as the Garfield Thomas Water Tunnel (GTWT) building.

First designed in 1945 and completed in 1949, the GTWT is named in honor of Lt. j.g. W. Garfield Thomas Jr., a 1938 Penn State alumnus who died in battle during World War II and was posthumously awarded the Navy Cross and the Purple Heart. He was Penn State's first reported hero of the war.

A Historic Mechanical Engineering Landmark designated by the American Society of Mechanical Engineers, the tunnel was first filled with water and began operation in March, 1950. When completed, the GTWT was the largest such facility in the country. As of 2023, it remains the second largest operating water tunnel. Measuring 48 inches in diameter, the tunnel test section holds more than 100,000 gallons of water and is powered by a 2,000 HP motor. The building also houses 12 inch and 6 inch diameter test section tunnels as well as a glycerin tunnel.

In the years since initial construction, the GTWT has provided crucial support in the areas of marine propulsor and torpedo design, biomedical research, hydrodynamic and acoustic research, and renewable energy, but with the last major renovation completed in 1988, the facility required some critical upgrades.

To take the GTWT into its next phase of cutting edge research, a multi-year renovation project requiring collaboration across a host of departments and offices, including FDAO, Business Services, and Engineering Services, began with the design phase in January 2020. Planned upgrades include improvements to accessibility, safety, and code compliance while improving the facility's overall functionality. The \$34.3 million project, anticipated to be completed in April 2024, positions the GTWT to continue its legacy of success.

CONSTRUCTION PROJECT TEAM MISSION STATEMENT

Securely deliver a leading-edge research facility in support of national defense.



Our Future Outlook

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A promising future depends on meticulous, mindful planning, with a focus on preparing our next generation of leaders, researchers, scientists, and professionals. Through programs like SOAR (Student Opportunities in Applied Research), the Walker Graduate Assistantship, and partnerships both here at ARL and in the larger Penn State community, we've laid the groundwork to attract the best and brightest minds and prepare them for careers in national security.

At the core of everything we do is our mission, as we strive to support national security, economic competitiveness, and quality of life through education, scientific discovery, technology demonstration and transition to application. As we explore expanding our capabilities and pursuing new technological frontiers, the Laboratory is stronger than ever.

We continue to drive innovation through efforts like the Internal Science and Technology Program, which fosters and capitalizes on promising "good ideas"—ideas that align with our mission, expand our science and technology capabilities, strengthen our competencies, enable strategic opportunities, and address our sponsors' present and future needs.

Other efforts, like the ARL Fellows program, recognize outstanding and sustained achievements by ARL scientists and engineers. ARL Fellows, who serve a two-year term, are all exceptional individuals who have consistently demonstrated excellence in technical expertise, leadership, and innovation.

None of these efforts would be possible without the steadfast support of our sponsors, our friends, and our loved ones. We are profoundly grateful for the opportunity to serve our nation as we look forward to another successful year.

A promising future depends on meticulous, mindful planning, with a focus on preparing our next generation of leaders, researchers, scientists, and professionals.

1.558 TOTAL **EMPLOYEES**

BACHELOR'S

DEGREE

200 +STUDENT

EMPLOYEES

33% / 28% / 14% MASTER'S DOCTORAL

DEGREE

DEGREE

186 **DISCIPLINES REPRESENTED**

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