

PIPELINE: Penn State Intern Pipeline Links to Navy Engineering

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As national security threats change and technology evolves, the Department of Defense (DoD) must have an agile, modern workforce with the ability to operate effectively in a knowledge-based environment and take advantage of emerging technologies. The DoD faces workforce challenges, including identifying new skill requirements and career fields, recruiting, training, and retaining people with the right mix of skills and abilities for the wide range of DoD missions. The dynamic threats and associated significant investments in research and development require more personnel with science, technology, engineering, and math (STEM) skills. The DoD has a gap in the STEM workforce needed to develop emerging technologies and conduct research and development [1]. These critical skills are in high demand and often bring higher pay in the private sector than at the DoD. An example of such a skill gap is in the research laboratories supporting the US Navy. There is an urgent need to increase the flow of highly trained research and development engineers into Navy laboratories and supporting organizations. The College of Engineering at Penn State has developed and executed an integrated research and critical skills development pipeline that motivates and connects U.S. students to careers in the technical workforce of the Naval Research and Development Establishment (NR&DE). This paper highlights lessons learned and best practices from reflection and student survey data to improve the educational and research experience of both undergraduate and graduate engineering students participating in Navy related research and work.

Keywords: Internship, Undergraduate Research, Graduate Research, Industry Partnership

Introduction

PIPELINE is an Office of Naval Research supported program that connects undergraduate and graduate students with opportunities to work with the Pennsylvania State University's researchers and gain exposure to civilian careers supporting the Navy. This involves engagement with external campus partners, recruitment of students to undergraduate and graduate research opportunities (including Research Experiences for Undergraduates or REUs and graduate assistantships), matching students with advisors, scoping projects that support Navy-relevant research, interacting with Navy research personnel, and placing students in Naval Research and Development Establishment (NR&DE) roles. Undergraduate research opportunities are considered a high impact practice for engineering students, and experiential learning programs are a renewed priority at Penn State [2]. An internship or graduate assistantship with the program gives students valuable exposure to the defense research and development field and training to build critical skills for a career in that field. Students have opportunities to engage in hands-on research, collaborate with experienced faculty and Navy researchers, and contribute to projects with real-world impact. They build a strong professional network, gain insight into career pathways in defense technology, and enhance their academic and professional prospects, including roles in the Navy technical workforce. In addition to working directly with researchers, students benefit from engaging guest speakers, being assigned professional mentors [3]-[4], and participating in targeted site visits to naval research centers. These experiences provide valuable insights into the field and showcase the broader impact of their work as potential future civilian employees supporting Navy research.

Background

The Department of Defense (DoD) is the nation's largest employer, with more than 700,000 civilian employees. Civilian employees of the Department of the Navy play a critical role in keeping the Navy / Marine Corps team operating to protect American interests around the world. The civilian workforce is technologically savvy, talented, and critical to mission success, providing round the clock technical capability [5].

In a 2019 report to Congress, the Office of the Under Secretary of Defense for Research and Engineering identified the need for 7,500 more personnel in priority technology areas [6]. To maintain an advantage over strategic competitors and ensure that the DoD leads in various technology fields, the DoD must continue to identify the need for specific STEM skills and determine the best way to use its funding to recruit and retain the required workforce. A 2021 RAND Corporation report on talent management for DoD further found that nonfinancial incentives, such as meaningful work and the opportunity for lifelong learning, were powerful incentives for knowledge workers and were potentially more influential than financial incentives [7].

Because of the timescales associated with specialized higher education and research training – there could be ten years between starting an undergraduate degree to completing a PhD – this requires a sustained long-term outlook. Accordingly, there is an urgent need to increase the flow of highly trained research and development engineers into Navy laboratories and supporting organizations (the “Naval Research and Development Establishment” (NR&DE)) [6].

In 2023, Penn State partnered with NR&DE to develop and execute an integrated research and workforce development pipeline that motivates and connects U.S. students to careers in the technical workforce of the NR&DE. The institution knew this would involve both undergraduate and graduate research opportunities, engaging campus partners, recruiting students into graduate school, matching students with (teams of) faculty members supporting DoD-relevant research (perhaps in timely targeted thrust areas, e.g. “quantum”), interacting with DoD program managers, and placing students in DoD labs (perhaps meriting the pursuit of security clearances).

This project focuses on two questions:

1. How can the institution attract highly talented technical undergraduate and graduate Students in Navy/DoD related work?
2. Can the institution motivate student researchers towards careers supporting Navy/DoD priority technology areas?

Approach

The general approach brought together three major themes: exposure to the defense R&D profession, performance of defense-relevant research, and education. These themes for talent development are detailed by the Center for Creative Leadership, recognizing the power of experience and using training and coursework to focus and amplify learning. Their framework explains how people learn with a blend of hands-on experience in challenging experiences and assignments, some from developmental relationships with others, and some from formal coursework and training [8].

Exposure to the defense R&D profession would begin as early as practical in a student's program of study. High-visibility defense systems will be connected to the real people who create and steward them. Undergraduate students at several of the institution's campuses will have opportunities for meaningful internships at Navy labs and the DoD University Affiliated Research Center (UARC). Graduate students will have similar opportunities – with emphasis on research, working side-by-side with Navy researchers.

The experiences of PIPELINE students will be enhanced by direct connection to the defense *research* ecosystem, guided by faculty advisors and NR&DE mentors. Undergraduate students will have opportunities to participate in summer and academic-year REU (Research Experience for Undergraduates) activities as well as the previously mentioned internships. UARC-specific job fairs will increase exposure to growth areas in the R&D profession. Graduate students will undertake thesis research on topics relevant to future defense needs, perhaps taking them to the prototype stage, and will have opportunities to address real-life challenges during research internships at NR&DE labs.

The *educational* experiences of PIPELINE students have a foundation in Penn State's existing engineering degree programs. Defense-specific projects will enhance these experiences, as will internships and research experiences. In addition, student understanding and appreciation of professional and personal ethics will be deliberately reinforced. The field of defense R&D is replete with topics that demand ethical thinking. Examples include: warfare and conflict, safety, privacy, global business norms, and conflicts of interest in business. Every student interested in a defense R&D position should have the opportunity to confront such topics first in the university classroom.

Specific elements of our approach include:

- A team of faculty and staff members from:
 - Penn State's main campus (College of Engineering and supporting offices);
 - Penn State's UARC; and
 - Penn State's satellite campuses
- An evolving leadership team consisting of active representatives of NR&DE. This board will advise the program concerning areas of outreach emphasis (special lectures and tours), potential organizational sponsors of NR&DE internships, and research topics of particular interest to the future NR&DE.
- An open group of faculty members dedicated to furthering defense-related research and student placement, with emphasis on those earlier in their careers. These faculty members will be drawn from the institution's faculty at the main campus and other campuses as well as the UARC research faculty.
- Undergraduate engineering degree programs, including honors programs, enhanced to provide defense-related projects, research experiences, internships at Navy labs, foundational ethics, and cohort experiences (seminars, tours, etc.) that bring together multidisciplinary groups of participants. Early outreach will motivate interest in defense R&D careers.
- Graduate engineering degree programs enhanced to provide defense-related thesis topics with Navy researchers/mentors, foundational ethics, and cohort experiences that bring

together multidisciplinary groups of participants. We will recruit grad students from other Penn State campuses and institutions. Teams of faculty advisors will be formed by connecting NR&DE research emphasis areas and student interest.

- Supported students will be expected to interact with representatives of the NR&DE community and to present research results to them annually. Developing people is as important as advancing research.
- In some situations, when it is appropriate for students to obtain deeper insights into their specific research project, a DoD security clearance may be pursued through the UARC's contract with the government on that project. This would also provide such students with a seamless transition to the NR&DE upon graduation.
- Potential for multi-campus (graduate) education. The institution's satellite campuses are a larger source to attract some underrepresented student populations (demographics, first generation, etc.).

The organization of this PIPELINE effort would resemble a research center-like approach, where teams of faculty and engineering researchers have developed unique facilities, teased out new science, created and transitioned technology into products, and educated several generations of engineers who will lead the NR&DE enterprise.

Objective and Goals

The objective of this program is to develop and execute an integrated research and critical skills development pipeline that motivates and connects U.S. students to careers in the technical workforce of the Naval Research and Development Establishment (NR&DE). This will involve undergraduate research opportunities, engaging the university community, recruiting students into graduate school, matching students with faculty members, supporting Department of Navy (DoN)-relevant research, interacting with DoN program managers, networking students with DoN personnel and facilities, and placing student graduates and interns in DoN labs.

The PIPELINE Program strives to achieve three (3) major goals:

1. Attract & Excite Highly Skilled Technical Undergraduate and Graduate Students
2. Expose Students to Navy-Relevant Mission Critical Needs
3. Place Students in NR&DE and Industries Supporting the Navy's Mission

Accomplishments and discussion of the goals follow in this section.

Goal 1: Attract & Excite Highly Skilled Technical Undergraduate and Graduate Students Recruitment Growth.

Undergraduate interest in the program grew significantly from 2024 to 2025, Figure 1a. Applications increased by 345%, rising from 84 to 290, reflecting the program's growing visibility and recognition among top technical students. To meet this rising demand and achieve proposed goals, the program expanded its capacity, increasing undergraduate acceptances from 14 to 22 positions. This growth underscores the program's momentum, broadening access to hands-on, Navy-relevant research opportunities while continuing to attract and enroll highly qualified students.

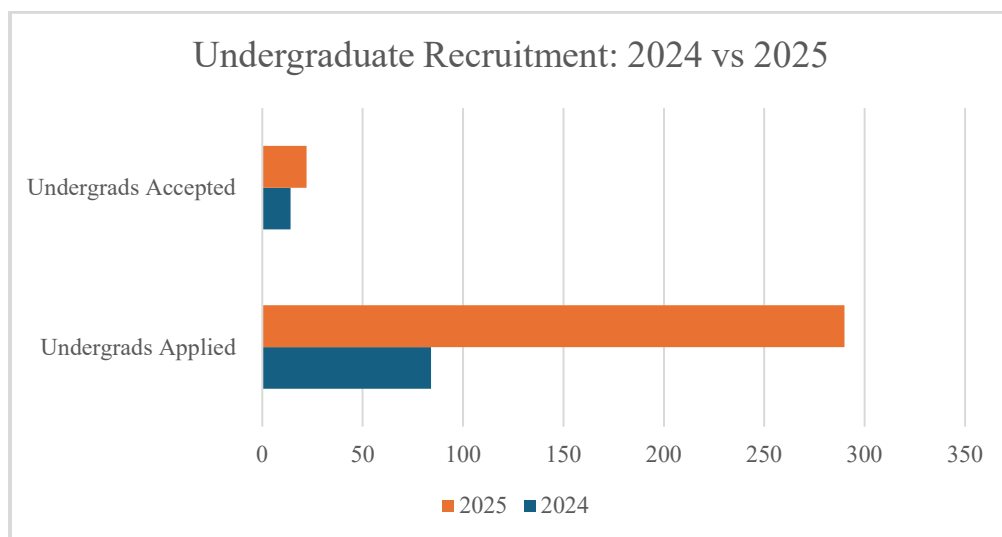


Figure 1a: Undergraduate Recruitment: 2024 vs 2025

Graduate recruitment in 2025 became more targeted, focusing on selection of high-value candidates, Figure 1b. While applications and acceptances were lower than in 2024, this was largely due to the continuation of multi-year graduate research positions from the prior year and targeted recruiting initiatives. Many 2024 students remained active within the program through ongoing projects and research partnerships, allowing the 2025 recruitment process to emphasize quality hires exceeding the overall program goal. This approach ensures sustained engagement from top-tier graduate talent while aligning new opportunities with long-term research and mission critical initiatives.

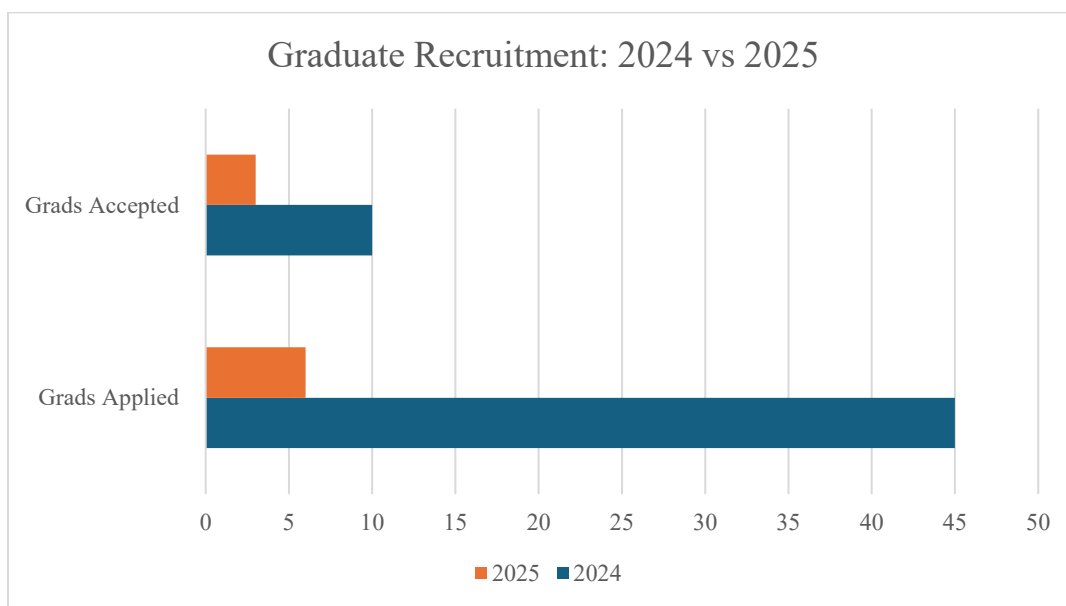


Figure 1b: Graduate Recruitment: 2024 vs 2025

Goal 2: Expose Students to Navy-Relevant Mission Critical Needs Project Technical Domains.

The projects supported by PIPELINE highlight the program's growing impact and interdisciplinary strength, Figure 2a. Projects in 2025 spanned technical domains including acoustics (9), additive manufacturing (6), aerospace (5), computing (2), electrical (5), energy (1), materials (4), and systems (1).

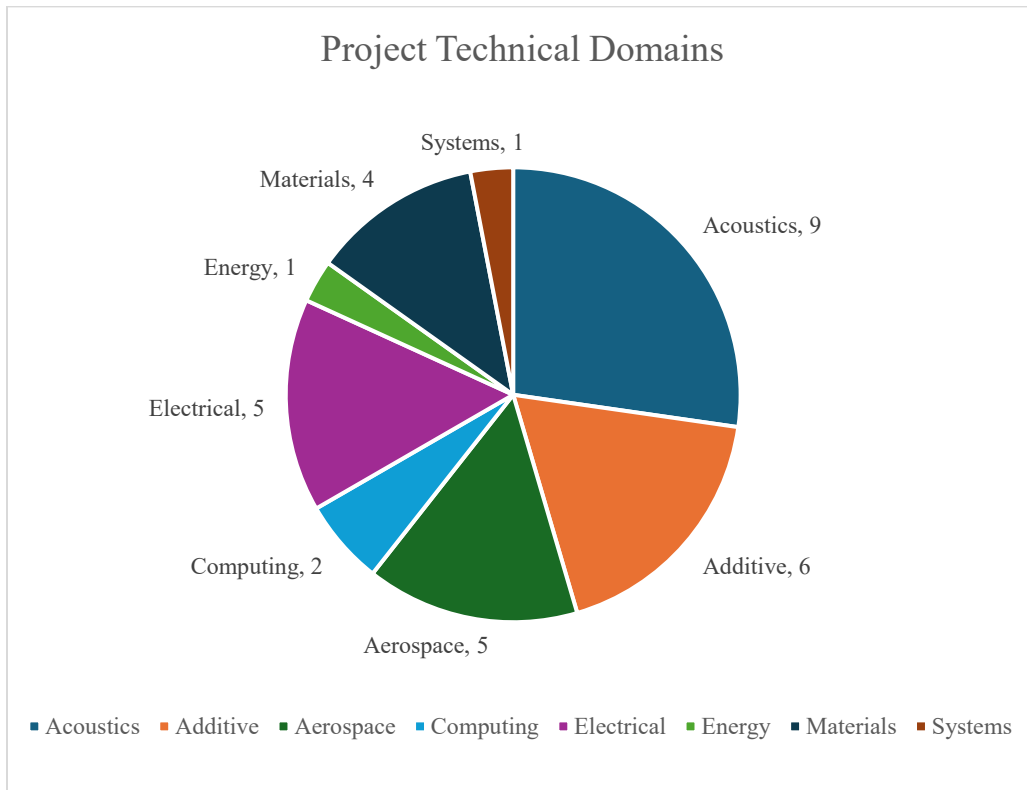


Figure 2a: Breakout of 33 Project Technical Domains

Figure 2b shows the PIPELINE program supported a wide array of majors with students representing degrees in Acoustics (5), Aerospace Engineering (6), Chemical Engineering (1), Computer Science (1), Cybersecurity Analytics and Operations (1), Electrical Engineering (2), Electro-Mechanical Engineering Technology (1), Engineering Science (5), Mechanical Engineering (10), and Industrial Engineering (1). This mix builds collaboration, innovation, and problem-solving skills that mirror critical needs across the Naval enterprise. Together, these outcomes reinforce PIPELINE's mission to develop adaptable, systems-oriented engineers who are ready to meet evolving national security and technological challenges.

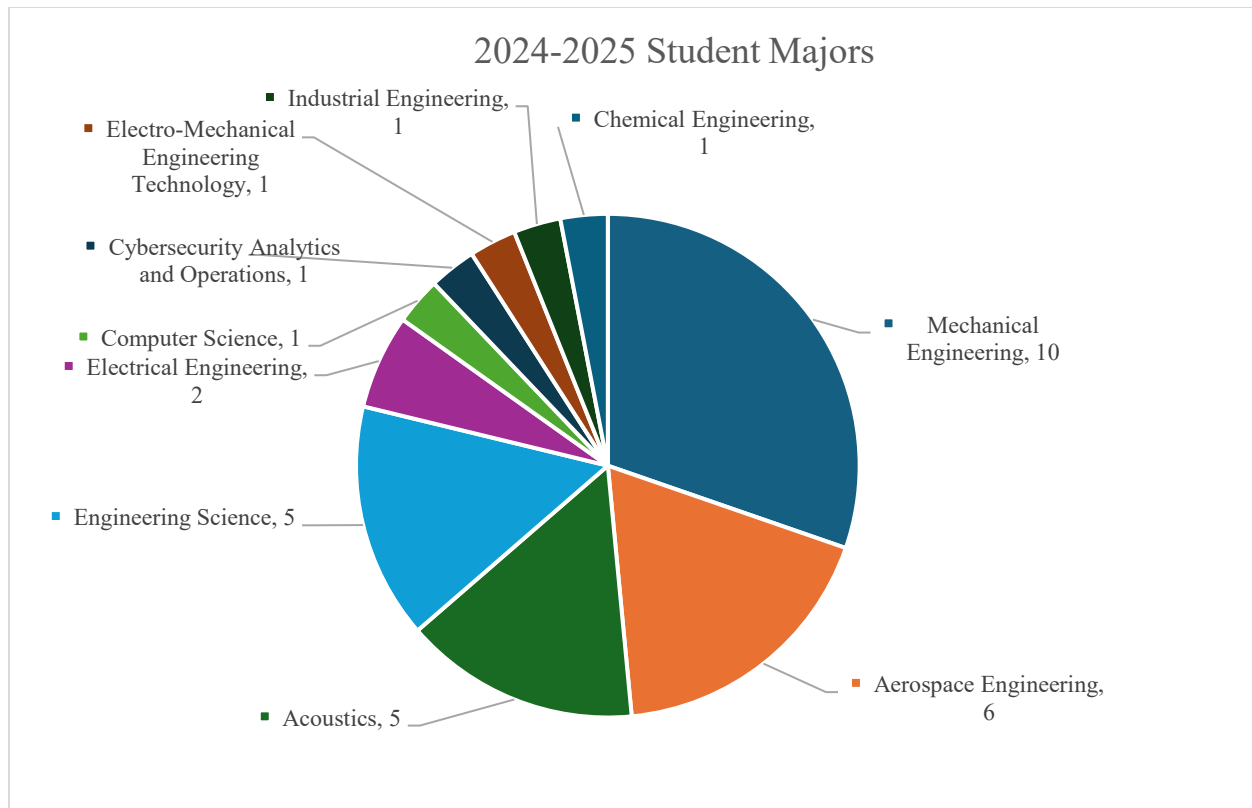


Figure 2b: Representation of 33 Student Majors

Goal 3: Place Students in NR&DE and Industries Supporting the Navy's Mission.

As students prepare to graduate, PIPELINE remains focused on facilitating career placement within the NR&DE and industries that directly support the Navy's mission. To date, 62% of PIPELINE graduates have transitioned into Navy or DoD positions, demonstrating the program's effectiveness in preparing and exciting next generation technical talent.

Survey data revealed a significant increase in student awareness and interest in pursuing Naval research careers, underscoring the value of direct exposure to the Navy's mission and operations. Through initiatives such as security clearance workshops, facility tours, and mentorship opportunities, students have gained a clearer understanding of how their technical expertise contributes to national priorities.

The PIPELINE program continues to focus on successfully placing current students in Navy and DoD-related positions, Figure 3. The cohort at the end of 2025 included a total of 34 students. Of those, 12 are planning to continue graduate studies in 2026, four (4) are considering either graduate school or full-time employment, 11 are seeking full-time employment, and seven (7) are seeking a summer internship. PIPELINE students are actively completing applications with DoD programs such as SMART and NREIP while also pursuing direct hire opportunities with Naval Warfare Centers and DoD Industry Partners.

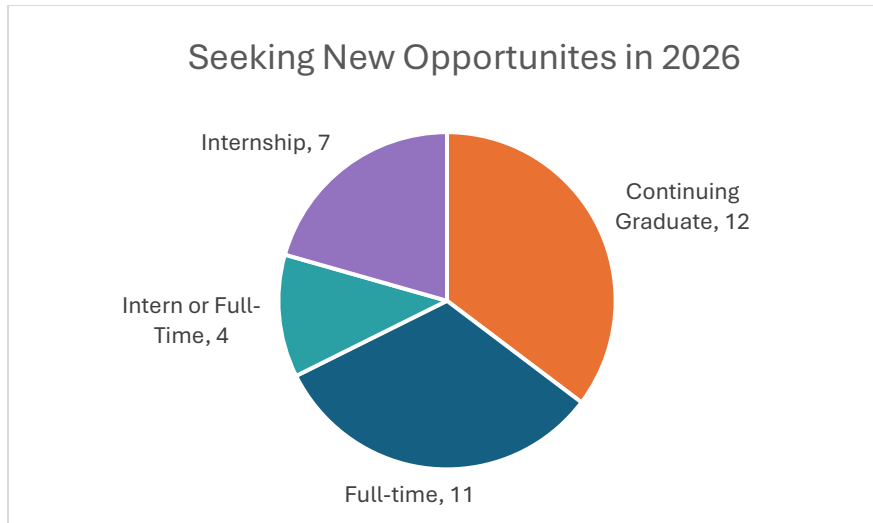


Figure 3: Student Job Preferences for 2026 (n=34)

Educational Experience

In order to assess and improve the PIPELINE program, student surveys were administered to the 34 participants in 2025, much like an institutional end of course survey. Each of the survey results in the following sections shows over an 80% response rate except the speaker series (~47%) since students could not make all the speaker events. Coupled with the student free text responses, this data offers some areas for improvement as well as others that indicate strengths of PIPELINE.

Speaker Series and Facility Tours

The summer program featured a robust Speaker Series with presentations from Navy personnel, research leaders, and industry experts, along with facility visits to NSWC-Philadelphia Division, the Pentagon, and a Navy Research Water Tunnel Facility. Students concluded the summer session with the annual Project Showcase, presenting their research to Navy partners, faculty, and peers. Figure 4 shows that students' favorite tour components at the Naval Sea Warfare Center (NSWC) were the Land Based Engineering Site (LBES) and the associated Control Room. At this facility, students gained valuable insight into different research efforts conducted by Navy Engineers and some exposure to the implementation for the end user.

Figure 5 shows the students' favorite presentations, where the Security Clearance process presentation is the highest, and the Resume Presentation is the lowest. All the students have had resume preparation in some of their engineering courses and felt some of this presentation was redundant.

Throughout the year, PIPELINE strengthened collaborations with other Navy programs, including Naval Engineering Education Consortium (NEEC), and built partnerships with the Engineering Ambassadors Network along with researchers at George Mason University. Through these partnerships, the PIPELINE program exposed students to leadership training

opportunities and promoted Navy full-time and internship opportunities to students as they actively pursue the next steps in their careers.

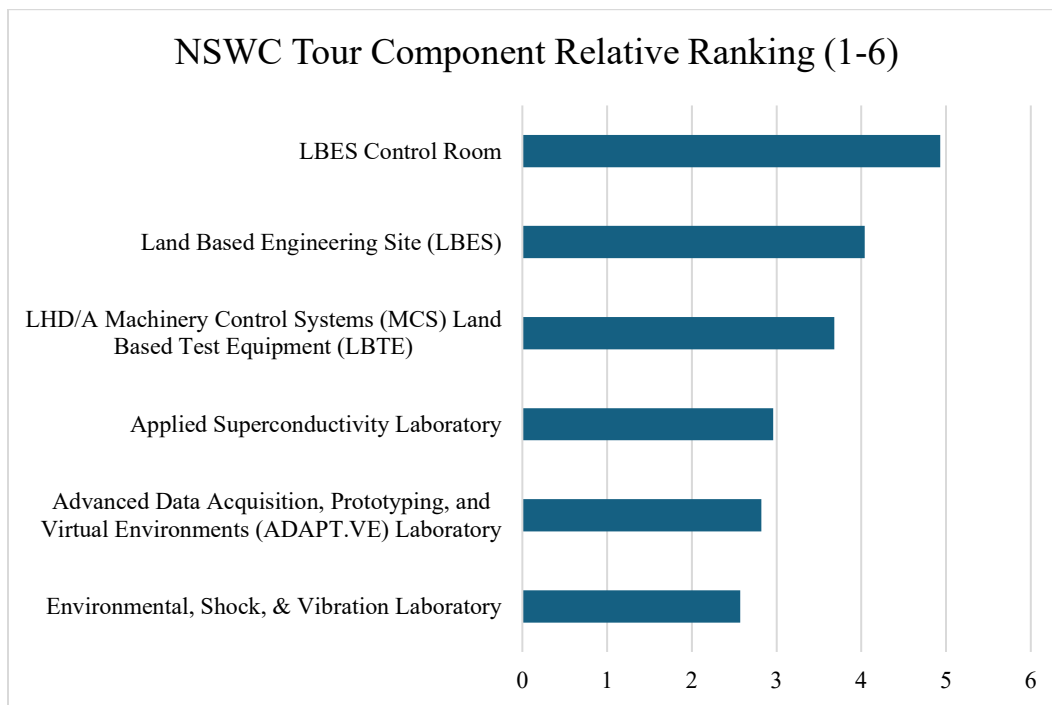


Figure 4: Student Value Ranking of Tour Components (n=28 responses)

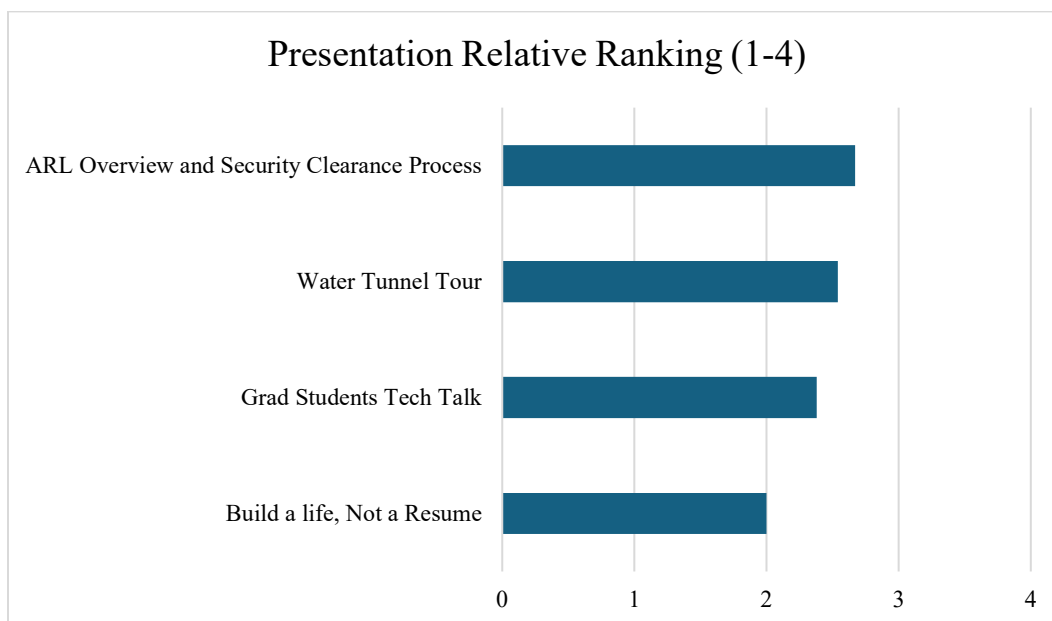


Figure 5: Student Value Ranking of Presentation Series (n=16 responses)

Students concluded the summer session with the annual Project Showcase, presenting their research to Navy partners, faculty, and peers. Similarly, students experienced several professional presentations for additional exposure to ongoing DoN research efforts and facilities to further their own professional development.

Mentorship

Every undergraduate and graduate student was paired 1:1 with a professional mentor. The mentorship cohort represented a wide range of expertise across the defense, aerospace, energy and technology sectors including leaders from the US Navy, Boeing, Blue Origin, Lockheed Martin, Siemens, Hewlett-Packard Enterprise, NAVSEA and the Federal Aviation Administration. It connected interns with professionals that had Navy-relevant experience, giving them real-world insight into the challenges and technologies shaping national security. Through these mentor relationships, students learned how their projects align with active defense priorities and gain a clearer understanding of how engineering and innovation supports mission critical operations.

Dissemination of Research

PIPELINE disseminated their research through showcases, journal publications, campus events, and national conferences, reaching academic audiences, Navy stakeholders, and industry experts.

Showcase

PIPELINE students shared their research outcomes through a variety of high-visibility platforms, ensuring their work reached both academic and professional audiences. The summer program culminated with the PIPELINE Final Showcase, where students presented their findings through oral presentations and poster sessions to Navy & Industry partners, Penn State faculty, and fellow researchers, Figures 6 and 7.

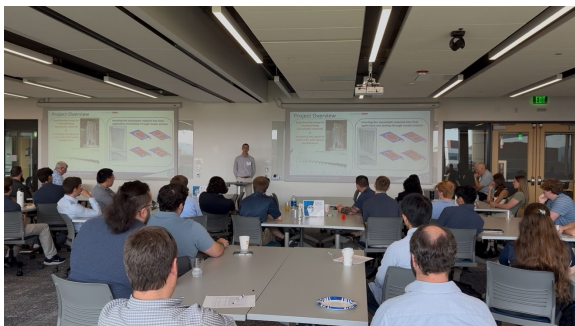


Figure 6: Student Presentation at PIPELINE End of Summer Showcase



Figure 7: Student Poster Presentation at PIPELINE End of Summer Showcase

Research summaries, project highlights, and technical details were also published on the program's website (<https://pipeline.psu.edu/project-showcase>) to make the work accessible to a broader audience and serve as a resource for future students and collaborators.

Interns presented technical results to Navy partners, faculty, and industry professionals, demonstrating clear alignment with Office of Naval Research priorities. Presentations highlighted technical progress, alignment with mission needs, and real-world applications. Students shared prototypes, models, and data visualizations, engaging directly with representatives from key defense organizations to discuss real-world applications of their work. The event advanced knowledge exchange, documented measurable outcomes, and supported PIPELINE's goal to disseminate technical findings while preparing students for NR&DE careers.

Symposium with Naval Subject Matter Experts

Mid-way through the summer program, PIPELINE students presented their research at a professional symposium hosted at George Mason University in partnership with the Office of Naval Research. They shared their projects with ONR program officers and engineers from the Navy Research Laboratory, highlighting how their work aligns with current and future defense and national security priorities. Through these presentations, students strengthened their communication and technical briefing skills, received valuable feedback from Navy subject matter experts, and expanded their professional networks. The experience reinforced PIPELINE's mission of preparing students to contribute to the NR&DE with innovation, technical depth, and confidence, Figure 8.



Figure 8: Students Present to Navy Leadership at Symposium hosted by George Mason University

Conferences and Publications

Many projects were presented at 18 other conferences throughout the year. Twelve projects advanced to peer-reviewed and technical publications. PIPELINE provided mentorship, facilities, and editorial support that helped students document methods and results, expand visibility with Navy partners, and contribute durable knowledge to their fields.

PIPELINE students and mentors earned multiple prestigious awards this year, underscoring the program's success in attracting and inspiring exceptional technical talent. Recognition spanned both academic and professional arenas, with students and advisors demonstrating excellence in research, innovation, and leadership.

When students were asked to rate their PIPELINE experience using a Likert Scale (1=strongly disagree to 5=strongly agree), the results were very favorable, Figure 9.

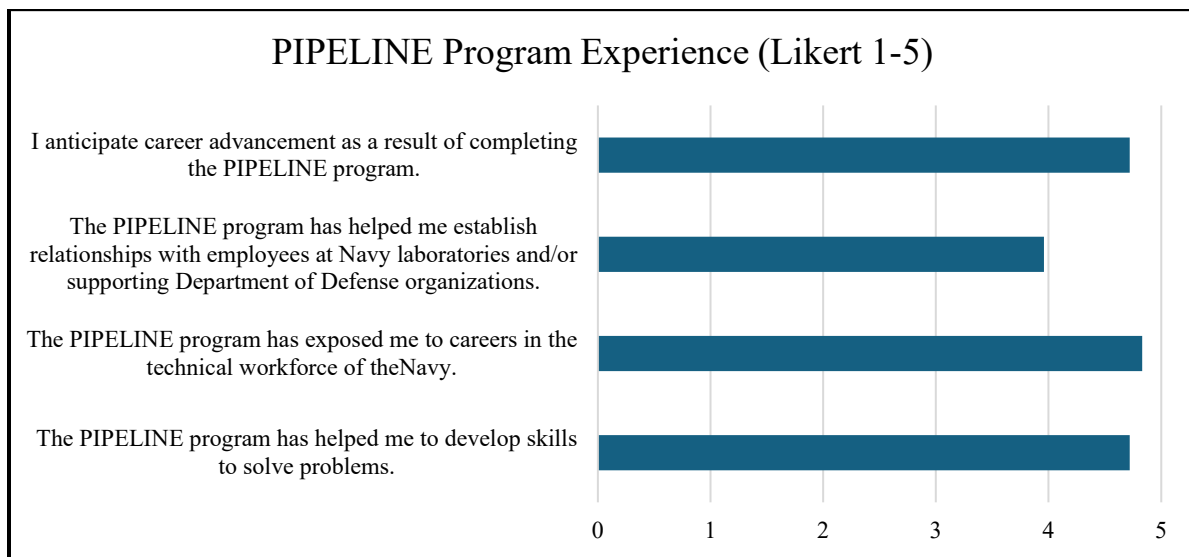


Figure 9: Student Exit Survey Results (n=30 responses)

The student satisfaction of their PIPELINE experience reflects the Workforce Alignment Framework from the Urban Institute that: Supports career decisions and navigation; Builds skills for work; and Connects to employment [9].

Lessons Learned

The previous sections provide the approach and evidence to answer the two research questions. First, through an integrated approach with the institution, the institution's UARC, and the DoN we can attract technical talent to conduct DoD related work. Providing authentic projects and connecting that work to larger research endeavors is significantly rewarding. Second, the exposure and networking do motivate students to potential careers supporting DoD priority technology areas. Although not all the students in the program wanted to or may be able to immediately start a career with NR&DE, some indicated they would, and many indicated they would be pursuing graduate school for additional research opportunities.

One goal of PIPELINE was to develop the DoN's technical talent, and the program was grounded in the Center for Creative Leadership's framework, recognizing the power of experience and using training and coursework to focus and amplify learning. This resulted in

many positive outcomes, detailed in previous sections. PIPELINE program managers recognize there are parts of the program to amplify and retain as well as others that need improvement.

1. Exposure, Experience, and Education Framework. Fundamental principles include task-centered, authentic, and active learning. The student experience prioritizes competency development, and use flexible, scaffolded, and collaborative approaches to ensure deep, lasting understanding.
2. Conferences and Publications gave students a means to validate their work externally and created a tangible ‘artifact’ of their work. This allowed them to gain additional exposure to potential hiring managers.
3. Tours of Facilities showed students the ‘bigger picture’ of why their work was important and exposed them to other areas of potential interests.
4. Speaker Series offered professional development opportunities, but students were not as enthusiastic about some topics. Availability of presenters and quality of presentations can be challenging to program leaders.
5. Scalability depends on many factors. With the growing interest from students, growing the program depends on funding from DoN, project faculty availability during the summer, and the PIPELINE administrators. Currently, PIPELINE is run by one engineering faculty and two UARC research faculty.

Future Plans

In the next year, the PIPELINE program will have three primary focus areas:

1. Mission Critical Talent Development
2. Driving Career Placements and Mentoring
3. Targeted Outreach and Conversion

Building on the success of Summer 2025, which brought together 34 undergraduate and graduate students for hands-on research, professional development, and site visits, PIPELINE will continue to grow its impact by aligning talent, mentorship, and partnerships with the U.S. Naval Enterprise. The program will support an undergraduate cohort of 24 total students along with 14 graduate assistants, ensuring a strong pipeline of skilled engineers ready to contribute to national defense innovation.

The upcoming year will center on driving Navy-specific career placement and building structured pathways for students transitioning from the program into defense roles. To achieve this, PIPELINE will expand mentorship opportunities with Naval partners, integrate career-readiness components into research projects, and facilitate targeted recruitment in mission critical fields. Additionally, the program will strengthen collaborations with the Office of Naval Research, their industry and academic partners, and other elements of the NR&DE to support technical dissemination, critical skills development, and post-program employment.

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