Navy Innovators Reveal Revolutionary Research to Counter Emerging Threats

DAHLGREN, Va. – Navy inventors are confident that their latest research in quantum physics, artificial intelligence, and cyber security – to name a few – will ultimately impact U.S. military and homeland security efforts. The innovations and their potential military applications were introduced and explained by the researchers at a recent event, Naval Surface Warfare Center Dahlgren Division (NSWCDD) announced Oct. 12.

In all, principal investigators presented 20 research projects with the titles of their discoveries ranging from "Cyber Security for the Internet of Things" and "Electrochemical Destruction of Bulk Chemical Warfare Agents" to the "Dynamical Non-Locality Induced Effect in Quantum Interference."

Navy technical managers, engineers and scientists networked with representatives from academia, industry, transition partners, and other key stakeholders to see and hear more about these new innovations at the In-house Laboratory Independent Research (ILIR) and Independent Applied Research (IAR) End of Year Review at the University of Mary Washington Dahlgren Campus, Sept. 25.

Funded by the Office of Naval Research (ONR), the ILIR and IAR program fosters fundamental and applied research at the Navy Warfare Centers to counter emerging threats by connecting technological needs with current and emerging capabilities.

The NSWCDD principal investigators identified challenges, objectives, accomplishments and future benefits while answering questions and briefing the ILIR and IAR projects they've been working on over the past year.

“The program helps to ensure a next generation of technically competent scientists by supporting masters and doctoral dissertation research, and research in the areas that are essential to our future mission,” said Dr. Jeff Solka, NSWCDD ILIR/IAR program director. “Our ILIR and IAR process is a means to develop the next generation of Navy scientists and engineers capable of addressing key warfighter challenges to ensure the Navy maintains a leading edge in science for national defense.”

Many of the projects presented at the ILIR and IAR event have the potential to result in Cooperative Research and Development Agreements. This legal agreement provides a means for NSWCDD and a private sector partner to cooperatively conduct research and development in a given technical area and share in the technical results.

“We have three strategic thrusts for ILIR and IAR programs,” Solka said, in reference to the programs at NSWCDD. “We provide funding for science, engineering, mathematics and statistics students to complete their graduate studies. New researchers can develop their own science and technology projects and portfolios. In addition, world-class researchers have the ability to develop revolutionary ideas.”

For example, world-class principal investigators Scott Spence and associate investigator Dr. Dan Parks developed a revolutionary idea for their quantum physics project, titled, “Dynamical Non-Locality Induced Effect in Quantum Interference.” The potential military applications of their research include anti-tamper cybersecurity, invisible security fences and highly sensitive vibrometer technologies.

“Dynamic non-locality is more robust than kinematic non-locality,” said Spence, pointing out that dynamical non-locality will provide an enabling technology for future quantum devices.

Principal investigator Dr. Joseph Hunt's work – "Synthesis and Characterization of Carbon Nanotube-Metal Organic Framework Composites" – could be used to develop new electromagnetic materials with enhanced, tunable properties with applications in electromagnetic offense and defense, and electric weapons in addition to chemical, biological and radiological protection.

"The Metal Organic Framework nanotube composites could be transitioned to a variety of operational areas in which thin layers of material with high electromagnetic lossiness is desired," said Hunt. "The other permittivity and potential electronic properties could be used in electric weapons or directed energy projects."

Hunt's project – performed to produce composites with enhanced properties by combining carbon nanotube and reticular chemistry – advance the state of the art by exploring how the material properties of Metal Organic Framework are affected by the incorporation of increasing amounts of carbon nanotubes.

"This work enables future weapon systems by providing control over the electromagnetic properties of the material as well as providing the improved conductivity necessary for sensors and other electronic systems utilized by the Navy and Department of Defense."

Principal investigator Kimberly Zeitz – an NSWCDD scientist and Ph.D. student at Virginia Tech – presented a new security technique in her project, "Cyber Security for the Internet of Things," that has the potential to protect data from sensor devices utilized for wartime communications.

Zeitz focused on limiting the time attackers may conduct reconnaissance on low-powered embedded system devices while considering the challenges such as resource and performance constraints. Low-powered, low-resource devices cannot use traditional security methods.

“This Micro Moving Target IPv6 Defense obscures communications of these devices through address rotation,” said Zeitz, regarding her research at NSWCDD, which is closely linked to ongoing research conducted within the Virginia Tech Information Technology Security Lab.

“Past and ongoing research includes a Moving Target IPv6 Defense and its applications in enhancing network security,” said Zeitz. “This security technique can be catered for use with different applications on different embedded devices. The ability to select the hashing algorithm used allows it to be adapted for a best fit and also to stay current as new has algorithms are developed.”

Dr. Elizabeth Haro’s research on data visualization support resulted in a tool that will be transitioned to the Aegis Readiness and Training Center for use in in training Sailors. Her research project – “Data Visualization Support for Creation of a Numerical Table: Effects on Training and Performance” – can result in novel visualization techniques, including 3D visualizations to optimize delivery and utilization for the human users.

An incorrectly developed ship doctrine can lead to catastrophic events. Currently, the system includes a tabular display of completed doctrine statements on the Aegis Display System and the doctrine comparison capability in 2D. There is no graphical representation to aid the warfighter in the development of doctrine.

“This technology is a visual-based doctrine system that could enable the ability for centralized Fleet level doctrine creation and tactics in real time,” said Haro, the team lead for the NSWCDD Human Systems Integration Science and Technology Team. “It can reduce Sailor workload by minimizing the required sectors that a warfighter must monitor for each ship based on the global coverage area of the fleet doctrine.”