

Global Engagement at APL: An Introduction

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This issue of the APL Technical Digest highlights the contributions of APL's Global Engagement Department (GED) to the national security of the United States. Created only 5 years ago, GED is the consolidation of the Laboratory's strike warfare programs, including both nuclear and conventional missile programs as well as electronic attack and the key enablers of the so-called "kill chain," such as intelligence, surveillance, and reconnaissance and command and control.

INTRODUCTION

As recently as 10 years ago, strike warfare was principally defined by the weapons used on the battlefield, and strike warfare programs were focused on the continual improvement in the capabilities of those weapons. APL has played a major role in the testing and evaluation of the Trident II strategic weapon system with its unprecedented long-range capabilities and in the development and testing of advanced Tomahawk missiles. The string of fully successful Trident missile launches as well as the dramatic battlefield footage from Iraq of Tomahawk missiles flying into enemy windows testify to the success of these efforts.

Today the effectiveness of our strike weapon systems is not determined solely, nor even primarily, by the capabilities of the weapons themselves but by the integration of the weapons with the information required to accurately deploy them and a decision path rapid enough

to allow a weapon to reach the target in a timely fashion. This kill chain defines strike warfare: detection, control (decision making), and engagement (weapons). The challenge on the modern battlefield is to match the accuracy and reliability of the information collected with the accuracy and reliability of our weapons to achieve the effects desired as rapidly as possible.

Moreover current and future weapons do not just deliver ever larger explosive warheads. With the great concerns in urban areas over collateral damage, smaller warheads delivered precisely to attack our enemies while sparing noncombatants often are preferred to large, more indiscriminate weapons. Also, tactical operations may benefit more from disabling a town's electrical system for a week than from disabling it outright. The Global Engagement Department's (GED's) experience in electronic attack has demonstrated the value and efficiency

of disabling adversary systems by nonkinetic means rather than by attacking them with explosive weapons. At the other end of the spectrum, strategic nuclear weapons such as the D5 submarine-launched ballistic missile (SLBM) have the capability to inflict massive damage on a potential adversary so as to deter countries from using weapons of mass destruction, thereby forming a cornerstone of national policy.

GED is composed of two business areas: Strategic Systems and Precision Engagement. The first has focused for more than 50 years on the nation's sea-based nuclear deterrent with recent emphasis on the testing and evaluation of the Trident II strategic weapon system. The Precision Engagement Business Area has supported the development and testing of the Tomahawk tactical cruise missile and has played a major historical role in the support of electronic attack systems for the U.S. Navy. These traditional roles emphasize the fundamental mission of APL as a Navy-sponsored University Affiliated Research Center (UARC). The majority of GED staff directly support government sponsors as trusted agents with technical knowledge of specific strike systems and broad understanding of the science and engineering underpinning strike warfare.

The traditional roles of the GED business areas, while continuing to be critically important to the nation's defense, do not themselves provide a strong rationale for consolidating the tactical and strategic areas into a common department. Rather, the technologies underlying the historical support of tactical and strategic strike warfare, and the physics-based understanding of those technologies resident in the GED technical staff, provide a strong capability base for addressing a wide variety of emerging strike warfare problems, both today and tomorrow. This blending of strategic and tactical capabilities can be seen in U.S. defense trends in the last decade. Our nuclear weapons, although still critical as a deterrent against near-peer powers, is less relevant against terrorist cells; nevertheless serious analysis has been initiated by Strategic Command and others to evaluate the potential of Trident II D5 and other long-range missiles configured with conventional warheads as Precision Global Strike (PGS) weapons in the War on Terror. At a higher level, national leadership is looking to the potential roles of fast, accurate, long-range conventional weapons in deterring adversaries without having to resort to nuclear warheads.

GED has stated as its vision "to be a nationally recognized trusted center of excellence for achieving desired kinetic and nonkinetic effects"; this entails both maintaining our historic roles in supporting existing strike systems within new warfare constructs and expanding our roles across the kill chain and across the spectrum of conventional and nuclear strike systems. In our brief 5-year existence, we are leveraging the expertise in our two business areas in critical areas such as precision

navigation, sensors and signal processing, unmanned vehicles, end-to-end system testing, command and control, and modeling and simulation. We also have expanded our sponsor base to include support to Strategic Command and Air Force programs.

This focus issue of the *Technical Digest* is intended to give the reader an overview of the past and present work addressed in GED. However, because of both classification issues and space limitations, only a portion of the GED projects and programs are presented here.

THE ARTICLES

The core capabilities in GED have been developed over decades of support to two key programs: the Trident II Strategic Weapon System and the Tomahawk cruise missile. The first article, by John Gibson and Joseph Schissler, reviews the histories of these important efforts. As you will read, the legacy of the Precision Engagement Business Area goes back to the late 1940s and early 1950s when APL first contributed to the field of cruise missiles and their application to strike warfare. The Strategic Systems Business Area's history started in the summer of 1958 with the formation of the Polaris Division in APL. The article describes nearly six decades of work in providing the Navy with unequalled land-attack capability from surface ships and submarines and increasingly capable fleet ballistic missile weapon systems.

The next article, by Frederick Riedel and coauthors, describes the importance of guidance and navigation in delivering a weapon to a target accurately across a long range to produce the desired effect. The article includes a brief tutorial on guidance and navigation and the related concept of control. It describes GED's contributions to resolving issues associated with guidance and navigation as well as the breadth and scope of problems solved by GED.

Although the Trident missile system does not use Global Positioning System (GPS) navigation to achieve its operational accuracy requirements, APL pioneered the use of GPS translators on test missiles to determine with great precision the actual flight path of the missile. This approach has resulted in unprecedented confidence in the performance evaluation of the Trident II accuracy as well as a fundamental physical understanding of the performance of the various subsystems. APL developed the first GPS translator in the early 1990s and continues to develop and refine their performance. Michael Boehme's article describes events that led to the design and development of a field-programmable Miniature Analog Translator, the technology currently being used to reliably assess performance of Navy weapons systems during test and evaluation exercises.

Occasionally range-safety requirements mandate that the ship carrying the Navy Mobile Instrumentation

System (NMIS) during Trident missile tests be located over the horizon (OTH) when reentry bodies are flown. However, at that distance, the NMIS cannot collect telemetry or GPS translator data to impact. Carlyn Weaver's article describes design, development, and testing of a new NMIS subsystem, a prototype OTH buoy that provides the capability to acquire and record relevant data continuously to impact of the reentry body.

In the 1990s, the Navy decided to convert four Ohio Class submarines to carry up to 154 Tomahawk missiles as well a large contingent of Special Operations Forces. Based on our expertise with the Ohio Class submarine and its subsystems, the Strategic Systems Business Area was tasked with supporting the guided-missile submarine (SSGN) test program. The article by Greg Horstkamp et al. discusses the complexity, intricacies, and performance of the test instrumentation used in support of the demonstration and validation (DEMVAL) program.

The next article focuses on the command and control (C2) portion of the kill chain. Robert Leonhard et al. discuss the theory that the essence of command lies in the cognitive process of the commander. The authors analyze scenarios where, ideally, the commander has a prior concept of impending actions that cues both the commander and the C2 system to look for relevant pieces of information while easily discarding irrelevant data. They see the commander's need for an

information-pull environment as the starting point for thinking about ways of improving the cognitive process.

The Department of Defense is engaged in the development of the Global Information Grid (GIG), which is intended to dramatically change the way information is used to fight future wars. GED is addressing critical technological C2 challenges for the GIG and other military C2 programs, including the need for seamless information sharing, collaboration, and decision making across national, strategic, operational, and tactical levels in a net-centric environment. The article by Peter Trask et al. describes examples of GED work in meeting this category of challenges.

The rapid pace of technological innovation and development in recent years has transformed traditional system engineering and acquisition paradigms, particularly through novel implementations of physics-based modeling and simulation. The article by Timothy Frey and Matthew Valencia relates their experiences applying principles of agile software development. They also discuss the potential for reducing costs of development, increasing efficiency during development, and improving the likelihood of making "right" decisions throughout the design, development, and prototyping phases of acquisition.

These articles provide a sampling of the breadth and depth of GED's current activities and a look back at what we have achieved over the past 60 years. I hope that you will find them both interesting and informative.

The Author



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William A. LaPlante Jr. received his B.S. in engineering physics from the University of Illinois at Urbana-Champaign (1985), his M.S. in applied physics from The Johns Hopkins University (1988), and his Ph.D. in mechanical engineering at the Catholic University of America (1998). He began his career at APL in 1985 and has held various technical positions related to underwater acoustics, signal processing, and anti-submarine warfare. He is responsible for all of APL's work in support of offensive military effects, including conventional tactical and strategic nuclear weapon systems, their associated command and control systems, electronic attack, and related intelligence, surveillance, and reconnaissance systems. The Global Engagement Department consists of two business areas, Precision Engagement and Strategic Systems, and directs two

cross-enterprise initiatives, Command and Control and U.S. Strategic Command. Dr. LaPlante was appointed as member of the Defense Science Board in 2010 and is currently co-chairing a summer study on military adaptability. He also has participated in numerous senior defense panels sponsored by the National Academy of Sciences, the Naval Research Advisory Committee, the U.S. Strategic Command, and the Office of the Secretary of Defense (Acquisition, Technology, and Logistics). Before his appointment as Department Head in 2003, Dr. LaPlante was the Associate Department Head of the National Security Technology Department and the Business Area Executive for Undersea Warfare. Earlier he served as the Program Area Manager for the Strategic Submarine (SSBN) Security Program and was Chief Scientist and Technical Director for several large submarine security experiments. Dr. LaPlante is an adjunct lecturer in the Department of Mechanical Engineering at The Catholic University of America. Dr. LaPlante's e-mail address is bill.laplante@jhuapl.edu.

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