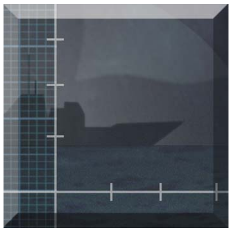

Responding to a Dynamic Environment

G. Daniel Tyler Jr.

The National Security Technology Department (NSTD) began with a single program and a single mission—the security of the Navy's strategic submarine force. Over the past 25 years of its existence, the department has evolved to successfully accommodate disruptive changes in the external environment. New missions emerged in areas closely aligned with existing endeavors such as undersea surveillance, as well as in areas unrelated to core activities of the department or even APL as a whole such as counterproliferation. New organizational structures and cultures followed. This transformation was accomplished through a combination of factors: dedicated staff, an enterprise culture that provided resources across the Laboratory, management with the foresight to encourage new activities, and visionaries who dared to venture outside the mainstream. Emerging theories of business strategy help explain NSTD's past performance, give insight into dealing with an uncertain future, and define a role for APL departments beyond management of their current business lines.

INTRODUCTION

The threat, which for decades had been the Soviet Union, changed rapidly to rogue states such as Iraq and North Korea, then to tens of thousands of terrorists with no specific national allegiance. The technology of war, which had been metal and munitions for the 761 years since Roger Bacon published the formula for gunpowder in 1242, now suddenly includes the serious use of "bugs, gas, and electrons." The national security strategy of engaging in a Cold War or arms race with the Communist Block was transformed into fighting two simultaneous major regional conflicts, and today includes defending U.S. soil itself. How do organizations that aspire to making critical contributions on a national level continue to serve traditional sponsors while also dedicating the resources necessary to be major players in new areas in a rapidly changing security environment (Fig. 1)?

EARLY SUPPORT OF A NATIONAL STRATEGIC MISSION

The National Security Technology Department (NSTD) owes its existence to a series of events beginning with a decision made in 1962 by then-Secretary of Defense Robert McNamara to radically change the strategy of the United States for fighting a global thermonuclear war. Unlike the preceding policy of General Curtis LeMay (Strategic Air Command) that relied on

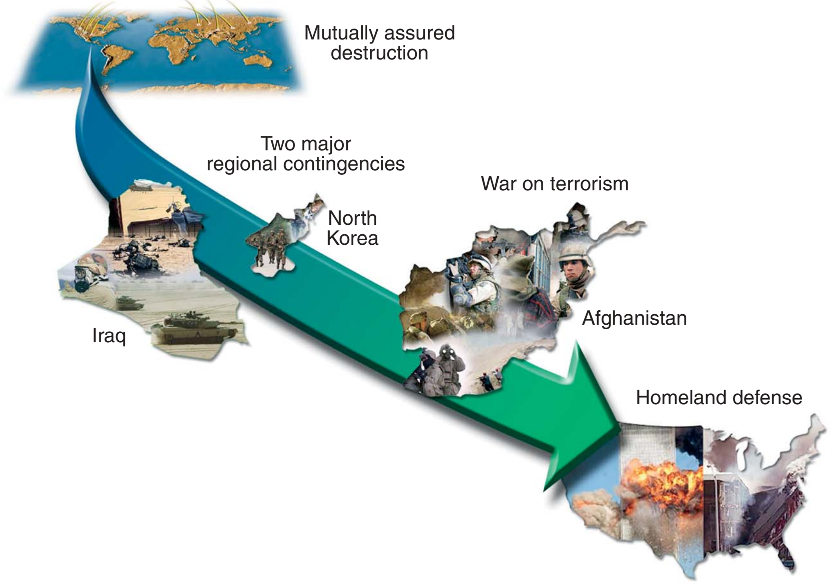

Figure 1. Threats, technologies of war, and defense strategies have changed rapidly. How should organizations respond?

outnumbering the enemy's arsenal of nuclear warheads, Mr. McNamara believed that the nation needed only enough warheads to ensure the ability to inflict unacceptable damage on an aggressor. This meant that in a worst-case scenario in which the United States suffered a preemptive first strike by the Soviets, enough warheads would have to survive to guarantee destruction of the Soviet Union. The Kennedy administration adopted this policy of mutually assured destruction in the mid-1960s as the nation's principal insurance policy for deterring all-out war with the Soviet Union. But by the end of the 1960s, Soviet technological advances placed at risk land-based missiles and manned bombers. This new technology threatened the policy of mutually assured destruction unless the survivability of the sea-based leg of the nuclear triad, SSBN submarines, could be guaranteed.

Earlier, APL's Strategic Systems Department (SSD) had a significant role in helping the Navy secure its position in strategic deterrence. When ballistic missiles were first integrated into the submarine platform, major issues existed regarding the reliability and accuracy of these untried systems in a marine environment, especially when compared with the more conventional silo-based ICBMs and manned bombers. The Navy and the Air Force were both vying for a place in the nation's strategic mission. Through the creative combination of instrumentation on the missile and submarine, modeling, and analysis, SSD gave the Navy a disciplined, independent, and comprehensive approach to testing and evaluation that served to verify the credibility of the sea-based nuclear deterrent. (The Navy and SSD recently conducted the 100th consecutive successful launch of the Trident II missile, the sixth generation of submarine-launched strategic missiles [Fig. 2]).

Because of its track record for supporting the Navy's strategic program, the Laboratory was asked again in 1970 to step up to a new challenge—this time ensuring that the sea-based deterrent would not only be reliable and accurate, but also survivable. Specifically, APL was asked to guarantee that U.S. missile submarines would be undetectable; that sea-based nuclear weapons would provide a reliable retaliatory capability, even after the nation endured a massive first-strike attack; and, as a consequence, that the concept of mutually assured destruction would continue to be viable. In this role, the Laboratory was being asked to make significant contributions to a problem that had a major influence on global stability during the peak of the Cold War.

The SSBN Security Program (originally called the SSBN Defense Program) was established within SSD in 1970. The broad range of skills required for addressing

Figure 2. In the early 1960s, the Strategic Systems Department helped the Navy secure its role in strategic deterrence by ensuring the reliability and accuracy of submarine-launched ballistic missiles. Shown here is the 100th consecutive successful launch of the Trident II missile.

all aspects of submarine detection, however, necessitated support from almost every APL department at that time. Because the program was created in response to a national imperative, it grew rapidly, and the creation of a separate department at APL soon became warranted. As a result, the Submarine Technology Department (STD) was established in 1977 to execute the SSBN Security Program. By policy, STD specifically dedicated itself to this single program, single mission, and single sponsor.

The early culture of STD was influenced by a combination of the unique needs of the SSBN Security Program and the philosophy of the Laboratory as a whole. The objective of the program was to determine the limits of submarine vulnerability imposed by the laws of physics and state-of-the-art technology (Fig. 3). In the words of RADM R. H. Wertheim, Director, Strategic Systems Projects Office: "In the absence of understanding, anything is a threat." Researchers and engineers joined forces, accommodated each others' approach for attacking problems, and ultimately forged a common culture. While inputs from the intelligence community were not ignored, they were not a driver in determining the direction of the program. The department developed competencies in relevant physical sciences such as acoustics, hydrodynamics, electromagnetics, and optics, as well as in engineering, signal and information processing, and operations research. With a high ratio of Ph.D.s by APL standards, STD conducted "first principles" research and analysis and, importantly, performed major at-sea exercises to provide definitive assessments of submarine vulnerabilities. The capability of the department for conducting extremely complex, lengthy sea tests developed into a distinguishing hallmark.

In addition to the Laboratory's strong value system of excellence and integrity, its proven capability to develop operationally sound solutions, and its trusted relationship with the Navy, STD inherited a problem-solving ethic that was born in the early APL efforts of World War II. The current APL Director, Richard Roca, describes the Laboratory's approach in overview briefings: In 1942 Hopkins engineers met the Navy's requirement for a proximity fuze that would detonate within 75 ft of a threat aircraft only to discover during testing that Navy gunners had great difficulty vectoring a shell so close to a target. The engineers went beyond the stated requirements for the fuze and developed an engineering solution for the overall targeting and fire control system. They recognized that their job was not to produce journal articles on the technology or even to produce a fuze—it was to enable the Navy to bring down a plane. This early approach was so potent that the success rate for anti-aircraft fire improved by 2 orders of magnitude—from 200 shots to bring down an aircraft to 2 shots.

At its inception, STD embraced the APL culture of problem solving and systems engineering and sought close interactions with the warfighter and ultimate users of its products. The department worked hand-in-hand with the operational submarine force in addressing the full range of its problems in science, technology, systems engineering, tactics, training, and test and evaluation. During the height of the Cold War, when the Navy had 41 operational SSBN submarines, STD staff participated in exercises onboard all 41 U.S. platforms plus 2 British submarines. By 1980, the department had adopted an authoritative approach for tackling problems, ranging from basic first principles, to in-depth understanding, to at-sea testing and validation. Having developed broad scientific, engineering, and analytical skills, STD remained committed to a "vector strategy" for its business model; i.e., to be the nation's lead laboratory in submarine security. This strategy was to change, however.

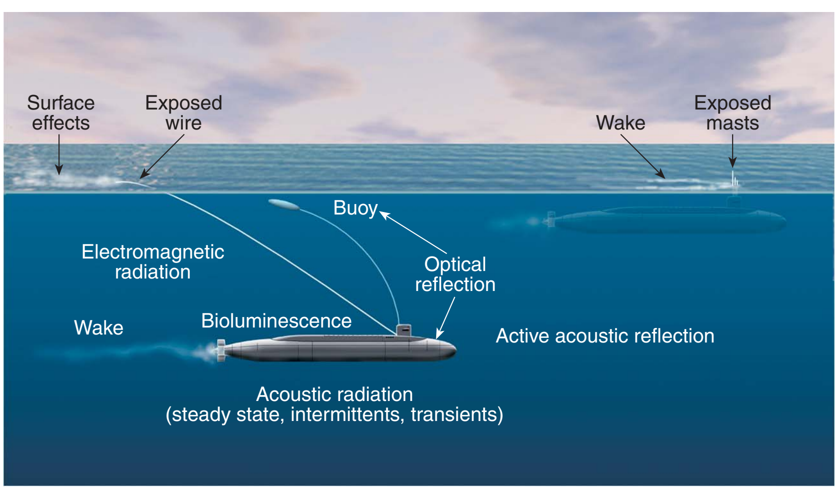

Figure 3. In 1970, the Navy asked APL to ensure the security of the sea-based strategic deterrent by investigating the physics and technologies associated with submarine detection. The SSBN Security Program eventually warranted its own department. The Submarine Technology Department was formed around this single program and Navy mission.

EXPANSION INTO UNDERSEA SURVEILLANCE

In the early 1980s, an intensified period of the Cold War, the performance of the Navy's anti-submarine warfare (ASW) forces decreased suddenly and dramatically. The Navy historically had an excellent undersea surveillance capability for tracking Soviet submarines in the Norwegian Sea, the North Atlantic, and the North Pacific. However, new classes of Soviet submarines, starting with the improved *Victor III*, were extremely hard to detect. These platforms could cruise the

Atlantic and Pacific basins with relative impunity. The Walker/Whitworth spy activities had furnished the Soviets with communication codes that allowed them to determine their submarine vulnerabilities. They responded by developing and procuring quieting technologies that were implemented in new submarine classes (Fig. 4). As the Soviet undersea order of battle became quieter, the Navy's Integrated Undersea Surveillance System (IUSS) became more ineffective. This had profound strategic implications. The United States was unable to locate and target a growing percentage of Soviet submarines. Additionally, it was feared that undetected Soviet SSBNs could position themselves off U.S. coasts, providing drastically reduced flight times and associated warning times for attacks on civilian, military, and political targets.

Although APL had traditionally played no role in the Navy's undersea surveillance mission area, the Laboratory had unique expertise derived from the SSBN Security Program for addressing the detection of very quiet submarines; i.e., STD had been investigating the detection of extremely quiet U.S. submarines for 15 years. The IUSS Program Office requested APL's help in restoring undersea surveillance capabilities. At the same time, the Navy's Chief of Naval Operations (CNO) established a national initiative in ASW called CUARP, the CNO Urgent ASW Research and Development Program. STD responded by changing policy to allow support for the ASW mission and establishing an undersea surveillance program area in 1985. Within 5 years, ASW tasks grew to become fully half of the department's business base (Fig. 5). STD efforts addressed surveillance technologies and systems such as very long towed arrays, multiline arrays, low-frequency active sonars, and advanced deployed systems.

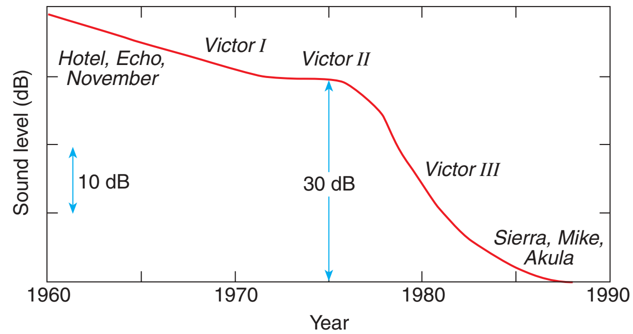

Figure 4. Decreases in Soviet submarine signatures in the 1970s and 1980s cast doubt on the U.S. Navy's ability to locate and hold at risk their sea-based strategic weapons.

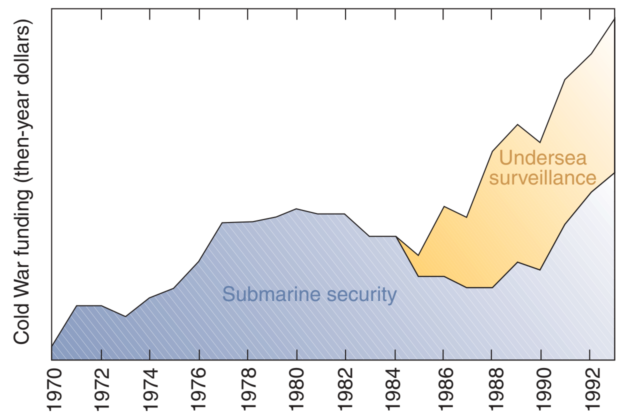

Figure 5. Responding to Navy needs in 1985, STD organized to support a second Navy mission—undersea surveillance. Tasking grew rapidly.

EMERGENCE OF NEW MISSIONS AFTER THE FALL OF COMMUNISM

In the decade after the fall of the Berlin Wall, the U.S. security condition changed rapidly and dramatically. Without the Soviet threat, both of STD's core missions—strategic deterrence and undersea surveillance—declined in priority, with commensurate decreases in Navy funding. Accommodating these changes, STD managed to apply its technical base and competencies to successfully grow in both core and new mission areas.

The department's efforts in ASW during the 1980s had been dominated by long-range surveillance against Soviet submarines in deep-water basins. New problems in ASW, however, emerged in the 1990s. The proliferation of modern diesel submarine technology, the rise in importance of Third World threats, the loss in performance of U.S. tactical sonars against a new generation of Russian submarines, and mandates to find ways to reduce costs increased the Navy's interest in a number of new areas.

Being responsive to Navy program managers and possessing a broad spectrum of undersea warfare (USW) skills applicable beyond surveillance, STD developed significant increases in tasking in submarine and surface ship sonar, combat systems, basic research and development, sensors (acoustic and nonacoustic), C4ISR (command, control, communication, computers, intelligence, surveillance, and reconnaissance), and the application of advanced technology for signal and information processing, automation, and training. Importantly, APL became a key player in helping the Navy develop a "build-test-build" process for reducing the cost and time to introduce new capabilities while improving performance (Fig. 6). At the same time, STD responded to evolving issues for its traditional submarine security sponsors by developing efforts in submarine survivability, SSN security, force protection, and security in and near port.

Although Navy funding for USW declined considerably in the mid-1990s, STD tasking recovered from

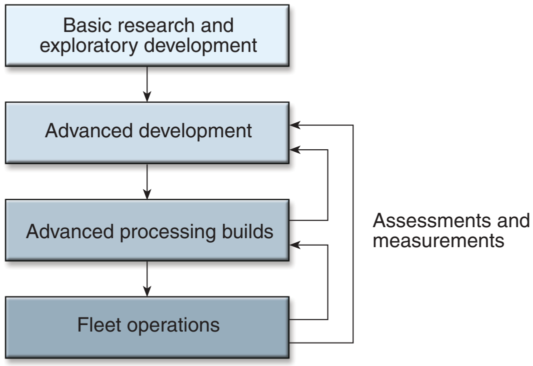

Figure 6. Responding to new anti-submarine warfare priorities in the 1990s, STD helped the Navy pioneer a "build-test-build" process for sonar development. The process significantly decreases the acquisition cycle by harvesting the most promising technologies from the sonar community, implementing rapidly, and getting Fleet feedback. This is one of many new areas the department entered after the end of the Cold War.

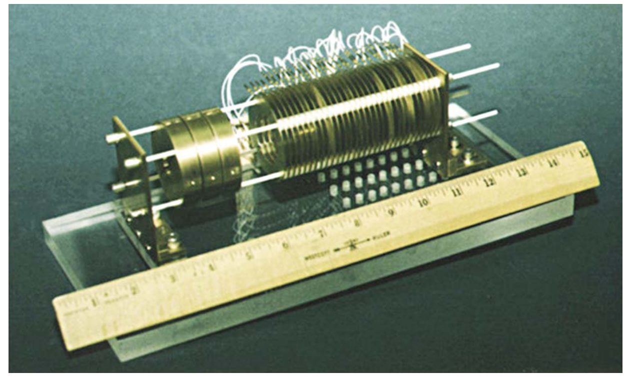

Figure 7. In the early 1990s researchers and engineers in the Research Center and STD developed a miniature mass spectrometer for detecting chemical and biological agents. This spawned interest in both departments in research and development for countering weapons of mass destruction—an area outside any APL core mission at the time.

this initial downturn and has realized healthy growth since 1998.

ENTRANCE INTO COUNTERPROLIFERATION

During the 1990s, the official business strategy of STD was to promote continued development of its core mission areas in USW, including submarine security, ASW, and to a lesser extent, mine warfare. While the department's mainstream efforts were consumed in addressing recovery from decreased priorities and funding and in developing responses to newly emerging USW requirements, a "bottoms up" initiative was emerging in an area unrelated to any core STD or APL mission area at that time. Researchers and engineers in multiple departments began developing technologies for detecting chemical and biological agents. Under an Internal Research and Development (IRAD) project, MEMS (microelectromechanical systems) technology was investigated in 1992. In the same year, staff from both the Research Center and STD worked together to develop a separate IRAD project to exploit a newly published technique for performing mass spectrometry with energy from a laser. The new technique had the promise of producing a small, inexpensive sensor for detecting and classifying a broad range of chemical and biological agents (Fig. 7). This initial effort led not only to the development of a family of miniature mass spectrometers, but also spawned interest in both departments in science, technology, and systems associated with countering weapons of mass destruction. APL soon developed a biosensors program for the Defense Advanced Research Projects Agency that allowed the Laboratory to look at many technology and system-level issues.

Early APL efforts impressed then-Under Secretary of the Navy Richard Danzig, who encouraged the Laboratory's involvement and visibility. Years before the attacks of 11 September 2001, APL scientists, engineers, and analysts in multiple departments were cultivating skills and growing funded tasks in chemical and biological sensors, syndromic surveillance, point and area warning systems, background monitoring and measurement, detection and classification of underground facilities, development of concepts of operation for first responders, "immune building" technologies, etc. In 1995, the STD strategic plan identified counterproliferation as a significant growth area because of its national security importance and because the department could provide the needed capabilities and skills. On 12 March 2001, the APL Executive Council recognized the increasing importance of work in this field and voted unanimously to establish and fund an enterprise strategy in counterproliferation. The events of the following September validated this decision and accelerated APL's growth in this area.

The original researchers and visionaries at the Laboratory had the foresight to develop concepts, technologies, and capabilities that positioned APL for an uncertain future. As national priorities changed rapidly, the Laboratory was ready to contribute to emerging mission areas for defending against weapons of mass destruction, countering terrorism, and ensuring homeland security (Fig. 8).

RESPONDING TO DISRUPTIVE BUSINESS CHANGES

What accounts for the ability of an APL department, originally a single-mission organization with a "vector strategy," to successfully adjust to a changing external environment in which the core business declined dramatically? Do current theories of business management offer insight relative to dealing with disruptive environmental changes? What lessons learned from STD's experience can be applied to future strategies?

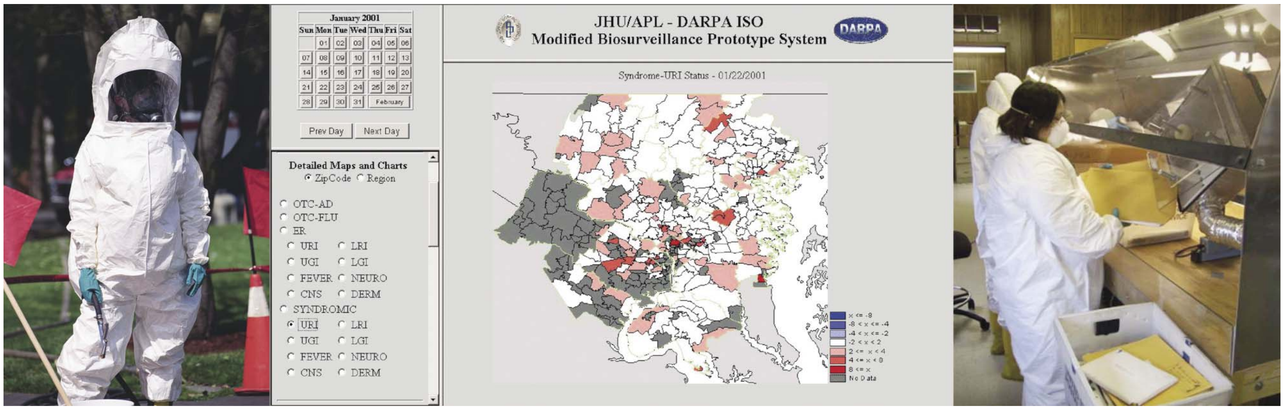

Figure 8. Initial interest in chem/bio defense generated by development of the miniature mass spectrometer, coupled with the national imperative following September 2001, has produced a new core business activity at APL in counterproliferation. This includes support for first responders (left), biosurveillance for the spatial and temporal monitoring of health indicators to support timely detection of the use of biological agents (center), and mail screening (right).

During its first 15 years, STD had successfully positioned itself as the Navy's lead Laboratory for submarine security by following straightforward management practices. Success here, as with most viable business activities, derived from strong customer relationships, an embedded culture, corporate alignment, and proven strategies. Paradoxically, it is now believed that these characteristics often increase the chances of an organization's failure over the long term. In *The Innovator's Dilemma*,[1] Christensen describes how dedication to core businesses and responsiveness to current customer demands can blind an organization to the emergence of disruptive technologies. These technologies, while suboptimal in the short-term, evolve to produce the obsolescence of long-standing, successful products and services. In *Winning Through Innovation*[2] by Tushman and O'Reilly, the authors extend this concept beyond technologies to encompass more general changes in the business environment, e.g., customers, business processes, regulations, and competitive strategies.

In a Darwinian sense, organizations that best optimize to their current environment are the most successful, as long as that environment is stable. In a dynamic environment, however, adaptation, not optimization, determines winners and losers (see the boxed insert). Ironically, those organizations that have produced the best match to their environment typically have the most difficulty in changing long-held successful strategies, corporate culture developed and indoctrinated in staff over decades, and hard-won corporate alignment.[2]

According to Tushman and O'Reilly, to avoid the "success syndrome," organizations must somehow learn to sustain incremental change in their current core businesses while simultaneously leading revolutionary change in promising new areas. "Great managers must be architects, network builders, and jugglers that understand how to employ these roles to foster a culture that celebrates both *stability and change* in order to ensure future success."[2] Moreover, they emphasize that the key to corporate reengineering through major disruptive environmental change is the "ambidextrous organization," i.e., firms or business units within firms that support different competencies, structures, cultures, and processes. In the dynamic environment in which the Laboratory finds itself today, it is particularly appropriate to question how an ecosystem can be provided that is uncompromising in its support of traditional business lines while also aggressively accommodating a changing national agenda.

The STD decision in 1985 to support the Navy's undersea surveillance mission and the establishment of a formal organizational structure to "own" this new area were critical events that positioned the department for changes that were to come. To accommodate two mission areas—submarine security and undersea

THE TYRANNY OF SUCCESS: PRODUCT CLASSES IN WHICH LEADERS FELL VICTIM TO THEIR SUCCESS

Leading firms, faced with a period of rapid change, often become losers. New business theories maintain that the key to corporate reengineering through major disruptive environmental change is the "ambidextrous organization"—firms or business units within firms that support different competencies, structures, cultures, and processes.

Market	Established product	Disruptive product
Photography	Silver halide film	Digital cameras
Retailing	Brick and mortar stores	Online retailing
Automobiles	Competition based on style/cost	Competition based on quality
Video	Film	Video recorders
Watches	Mechanical movement	Quartz, electronic
Printing	Typewriters	Computer printers
Hearing aids	Behind the ear	In the ear
Tires	Bias ply	Radial

surveillance—STD had become ambidextrous, developing two sets of strategies, organizational structures, competencies, and cultures. Later, when the department was given the opportunity to enter into the emerging area of chemical and biological defense, the establishment and accommodation of new structures, strategies, competencies, and cultures followed naturally.

Consistent with APL policy, departments are responsible for providing resources for executing the Laboratory's business areas, coordinating activities across the enterprise, and ultimately ensuring the success of APL's business lines. In 2001, STD's name was officially changed to the National Security Technology Department. Importantly, this not only recognized the role of NSTD in counterproliferation, but signaled acceptance of the department's additional responsibility for providing an ambidextrous organization in order to maintain commitment to core business areas while simultaneously nurturing the development of new activities (e.g., activities synergistic with existing department business or competencies).

Continued successful execution of this responsibility requires NSTD to perform functions beyond those associated with existing core missions. These include monitoring and analyzing the external environment to identify disruptive changes, opportunities for new thrusts, and indications of a need to alter organizational competencies; identifying initiatives in areas beyond current business lines, formulating strategies for development of new thrusts, and incubating new efforts; allocating resources (staff, investment funds, infrastructure, facilities, etc.) for supporting new initiatives not in core areas and balancing priorities between existing core businesses and new initiatives; maintaining a culture that simultaneously recognizes and rewards performance in existing core business areas as well as potentially disruptive initiatives; aligning the organization along multiple vector strategies; and transitioning start-ups to legitimate core business activities. True to this philosophy, NSTD is committed to excelling in existing core mission areas and simultaneously pursuing, incubating, and transitioning new initiatives.

POSITIONING FOR THE FUTURE

In March 2001, APL's Executive Council revised the Laboratory's mission, vision, and strategic goals to address critical challenges for national-level issues and to make major contributions in those areas. This ambition "sets the bar" for the suitability of vision, direction, and strategic objectives in each of APL's core business areas.

Submarine Security and Technology

For three decades APL has been the Navy's lead laboratory for submarine security. As the use of the nation's strategic (SSBN) and attack (SSN) submarines evolves, and as a new cruise missile class of submarines (SSGN) is introduced, the Laboratory remains committed to addressing emerging security issues for these platforms (e.g., SSN/SSGN security in the littoral, force protection). But the submarine force and NSTD are at a critical juncture as the role of the submarine undergoes major scrutiny following the end of the Cold War. The period after World War II saw the development of technology enablers, such as nuclear power and Fleet ballistic missiles, that transformed the submarine force from one performing solely an anti-surface ship warfare mission to a force ready to play a dominant role in the Cold War. The nation, in fact, came to rely on submarines to address its highest-priority missions—strategic deterrence; ASW against Soviet SSBNs; and intelligence, surveillance, and reconnaissance.

Today's evolving technology enablers for the submarine force include cheap computer power, networking, automation, off-board sensors, directed energy weapons, etc. And submarine force operations are already responding to a new security calculus by effecting major changes in the employment of strategic forces, increasing littoral operations, supporting the land war, countering weapons of mass destruction, integrating the submarine platform with other forces, and supporting homeland defense. To align with the submarine force of the future, APL must be proactive in applying its knowledge of submarine technology, systems, and operations to help the Navy address the much broader issues associated with developing and accommodating new roles and missions for the submarine force (Fig. 9).

Anti-Submarine Warfare

As mentioned earlier, the nation's commitment to ASW, a high priority during the Cold War, decreased dramatically when the Soviet threat disappeared. In the 1990s, major changes occurred in both the characteristics of the threat and the Navy's ability to do ASW. Fleet operations today are envisioned to occur in the shallow littoral waters off the coasts of threat countries. Geography not only gives the threat the "home field" advantage in this scenario, but the harsh environment degrades U.S. ASW sensors and weapons. At the same time, the evolution of technology has significantly enhanced the threat. Modern diesel submarines are exceedingly quiet when operating on their batteries, and changing battery technology has improved both endurance and speed. Moreover, air-independent propulsion is a revolutionary technology becoming operational that will significantly improve endurance, speed, and the threat's ability to function in a stealthy posture. Importantly, the littoral is inherently asymmetric in that ASW forces must detect and counter an extremely stealthy diesel platform while that

Figure 9. APL and the submarine force are responding to a new security calculus in the 2000s by proactively developing new roles and missions for the submarine force that are being enabled by the next generation of technology.

same platform need only find and target the noisy surface combatant. With the worldwide proliferation of modern submarines, torpedoes, and submarine-launched cruise missiles, the threat in a very real sense must be viewed as technology rather than a specific country. The consensus is growing that the Navy's ability to do ASW is inadequate to support Fleet access in the littoral or to counter other threat submarine operations such as mine laying and deployment of special operations forces.

Consistent with the desire to make significant contributions to the Laboratory's core mission areas, APL is committed to helping the Navy address the ASW problem and is well suited for this undertaking. Decades of Navy research and development and billions of dollars of funding have produced a new understanding of the physics of continually improving technologies. No single ASW system or platform type, however, offers the promise of making the oceans transparent or producing an acceptable ASW capability. It is therefore reasonable to investigate ASW as a "team sport" (Fig. 10). Currently working across platform boundaries, APL is able to add value to the efforts of Navy laboratories that focus on air, surface, subsurface, and surveillance systems. In addition, the Laboratory's systems approach to problem solving can build on the Navy's investment in science and technology. Just as the air defense community has applied a systems approach to dealing with evolving air threats (manned aircraft, cruise missiles, ballistic missiles), and the strike warfare community has applied the same systems approach to dealing with an evolving target set (fixed, mobile, and buried targets), APL is approaching the ASW problem by addressing concepts of operation, architecture, and systems engineering.

Homeland Security and Counterterrorism

Perhaps no other APL mission area has as much need for a broad spectrum of capabilities as counterterrorism and homeland defense. Because this national imperative is much less mature than traditional military missions (e.g., air defense, strike, strategic deterrence), there is a significant call for the development of policy, requirements, and concepts of operation along with more investment in science and technology than in systems engineering.

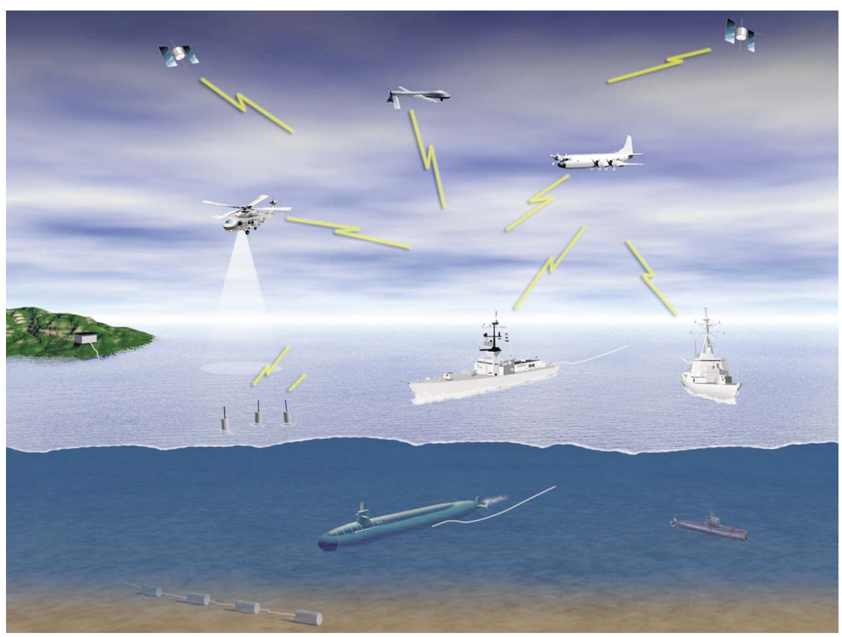

Figure 10. No single technology, system, or platform type offers the potential for making the oceans transparent today. Achieving an adequate ASW capability will require new concepts of operation, architecture, and systems engineering to effectively integrate ASW assets.

Conceivably in this business area, to a greater extent than in other APL endeavors, there is more to offer by using the diversity of resources that exist across departments. While this is challenging, aspirations for an APL role in a larger context are even more daunting.

As a division of The Johns Hopkins University, APL has the potential for collaboration with other members of the Hopkins community that collectively are well suited for supporting the national agenda. Johns Hopkins Medicine, the Bloomberg School of Public Health, the School of Advanced International Studies, and the Laboratory individually represent uncommon national assets. Collectively, they may be unique in the potential they offer in spanning the full range of expertise required to develop a national strategy. Under a single enterprise, JHU offers world-class expertise in epidemiology, emergency medicine, infectious diseases, military research and development, international law, immunology and virology, systems engineering, refugee and disaster studies, international relations, conflict management, biophysics and biophysical chemistry, and on and on. The challenge to the University is how to marshal resources that, by design, operate autonomously and have diverse cultures (Fig. 11).

Beyond the Johns Hopkins Enterprise, the mid-Atlantic region has a wealth of resources to apply to homeland security and counterterrorism, Government organizations include those in the National Capital Region (National Institutes of Health, National Naval Medical Center, Naval Medical Research Institute), and organizations in Fort Detrick (U.S. Army Medical Research Institute for Infectious Diseases, Armed Forces Medical Intelligence Center), and Aberdeen (Soldier Biological and Chemical Command, U.S. Army Medical Research Institute of Chemical Defense). Maryland has strong public and private educational institutions, and aggressively growing commercial interests in critical areas (e.g., biotechnology, information technology) dot the I-270 corridor. Collectively, the Mid-Atlantic Region could play a significant role in both developing and implementing a national strategy and architecture for homeland security and countering weapons of mass destruction.

The APL strategy for counterproliferation is both “bottoms up” and “top down.” Skills, capabilities, and programs are being developed Laboratory-wide to support basic research, development of technologies and systems, exploration of concepts of operation, and test and evaluation. Concurrently, APL is pursuing interactions at higher levels to influence decision makers, “shape the environment,” and support development of a national strategy. Attempting to pursue this agenda as part of a university or regional team is as promising as it is challenging.

Biomedicine

In January 2001, the APL Institute for Advanced Science and Technology in Medicine was integrated into NSTD. The institute’s mission was to develop and apply science and technology to solve biomedical research and health care delivery problems of national and global significance. Since 1965, Johns Hopkins Medicine physicians and researchers have teamed with APL engineers and scientists to develop more than

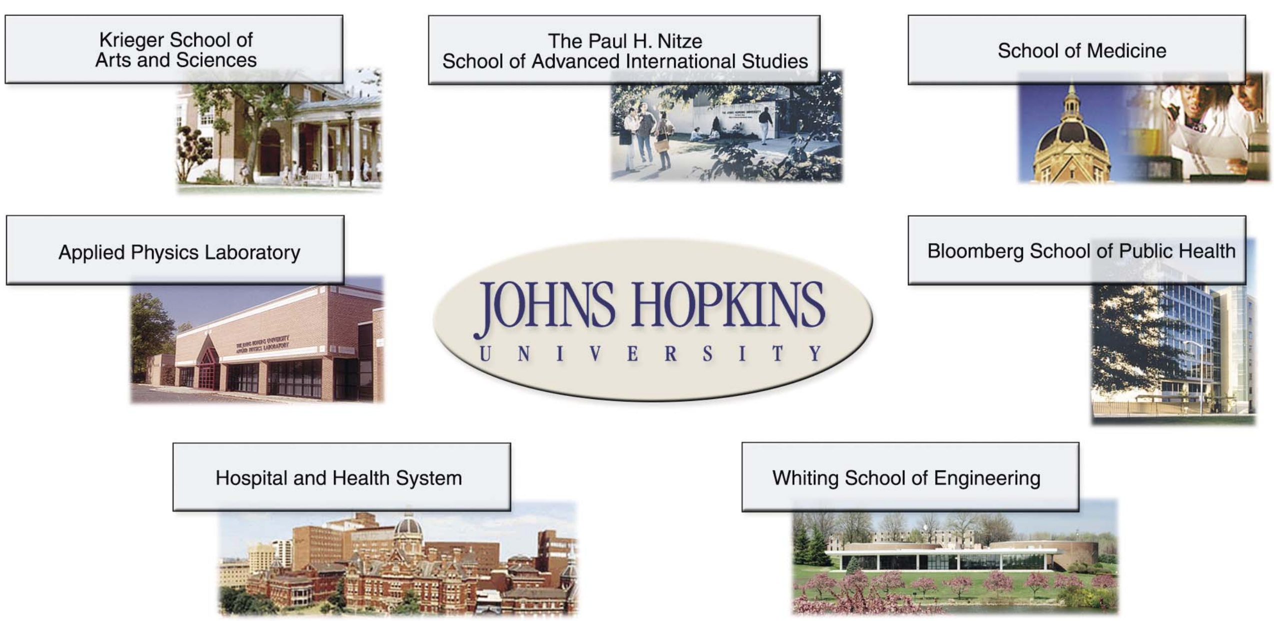

Figure 11. The “top-down” APL strategy for counterproliferation involves interactions with government decision makers, strategic teaming, and coalitions. The Johns Hopkins Enterprise, for example, may offer a unique collection of world-class capabilities.

100 products important to clinical care and to conduct physiological and clinical research. Major contributions have been made to the departments of Oncology, Neuroscience, and Ophthalmology, and to the Division of Cardiology.

APL staff members have typically undertaken biomedical research and development on a part-time basis, using strengths and skills developed in other core technical areas. Although the Laboratory has been involved in biomedicine for decades, its potential to become a core business area has only recently been recognized. Consistent with this, establishment of biomedicine as a business area represents the Laboratory's commitment to pursue a program focused on the human element of military and space systems as well as innovations in quality patient care.

The potential as a core business area is compelling. The country spends many times more on health care than on national security. At the same time, there is a virtual explosion in technical disciplines that can be applied to health care issues. The advancing age and increased mobility of the population, rising costs of health care, and increases in the number of patients discharged from hospitals sooner than in the past are drivers for developing technologies for services outside of hospitals, clinics, and physicians' offices. Particular areas of interest are patient surveillance, imaging and wound care, physiological monitoring, patient and family education, and patient record administration and management.

Biomedicine is also an area with application to military operating forces that are faced with the challenge of maintaining operational and combat readiness and delivering the best possible care in stressful environments. Challenges include complex processes and systems that significantly impact contingency planning, medical logistics, quality of diagnostics and health care in forward combat areas, and overall force effectiveness. Particular areas of interest are the interoperability and effectiveness of medical information systems in joint and allied missions, medical readiness reporting and tracking, delivery of medical care in areas near conflict, evacuation of the wounded, applications of biotechnology, and medical decision aids.

NSTD also performs biomedical research that supports NASA's Human Exploration and Development of Space Strategic Plan by seeking to prevent or solve health problems related to long-duration space travel and prolonged weightlessness. The University, including APL, is a member of the national Space Biomedical Research Institute, which investigates ways to deliver medical care on missions through new technologies and remote treatment advances. While addressing space medicine issues, there are plans to transfer discoveries in biomedicine that will benefit human health and performance on Earth. Areas of interest currently are bone loss, cardiovascular alterations, human performance, immunology, infection and hematology, muscle alterations and atrophy, neurovestibular adaptation, and radiation effects.

In summary, the specific objectives of APL's involvement in biomedicine are twofold—to support Johns Hopkins Medicine and to apply biomedical technology to support APL's core sponsors. NSTD is in a prime position to achieve these objectives by capitalizing on its association with the world-class divisions of the University, harvesting the technology and expertise across the APL enterprise (Fig. 12), and effectively teaming with the institutions that constitute Johns Hopkins Medicine.

Other Emerging Areas

Recognizing its responsibility to provide an environment in which new ideas are identified and nurtured, NSTD is proactively incubating a number of initiatives that may evolve into core mission areas. A few examples are given below.

The area of force protection encompasses the defense of U.S. forces, both domestically and forward deployed. In 1997, NSTD identified the in-port and near-port security of U.S. naval forces as a major concern. The bombing of USS *Cole* in 2001, regretfully, validated these concerns and focused national attention on this issue. NSTD's role today in this area is substantive and rapidly increasing. A serious national commitment to force protection is evidenced by the increasing recognition of this activity as a legitimate, core DoD mission area. Although initial short-term responses to the *Cole* incident necessarily capitalized on capabilities and technologies borrowed from other DoD areas, a top-down process for a long-term, disciplined approach to force protection is emerging that mimics other mission areas—requirements, concepts of operation, architecture, systems engineering, science and technology, etc. (Fig. 13).

The changing nature of ASW (quiet diesel submarine targets in shallow littoral waters) has resulted in decreased detection ranges for both active and passive sonar systems. Consequently, the development of sonars that use larger numbers of lower-performance (i.e., short detection range) sensors is preferable to attempting to develop high-performance systems. Traditionally, the high-performance sonar detection process was manpower intensive. The large numbers of sensors associated with the new paradigm, however, necessitate significant advances in automation as well as engineering to support autonomous operations—long-life power supplies, significant in-sensor processing capability, and reliable communications in all geographic areas of interest. Because of this, NSTD has been aggressively developing autonomous ASW sensor concepts. Interestingly, the war on terrorism has produced requirements for detecting objects, personnel, and facilities in far-forward locations where

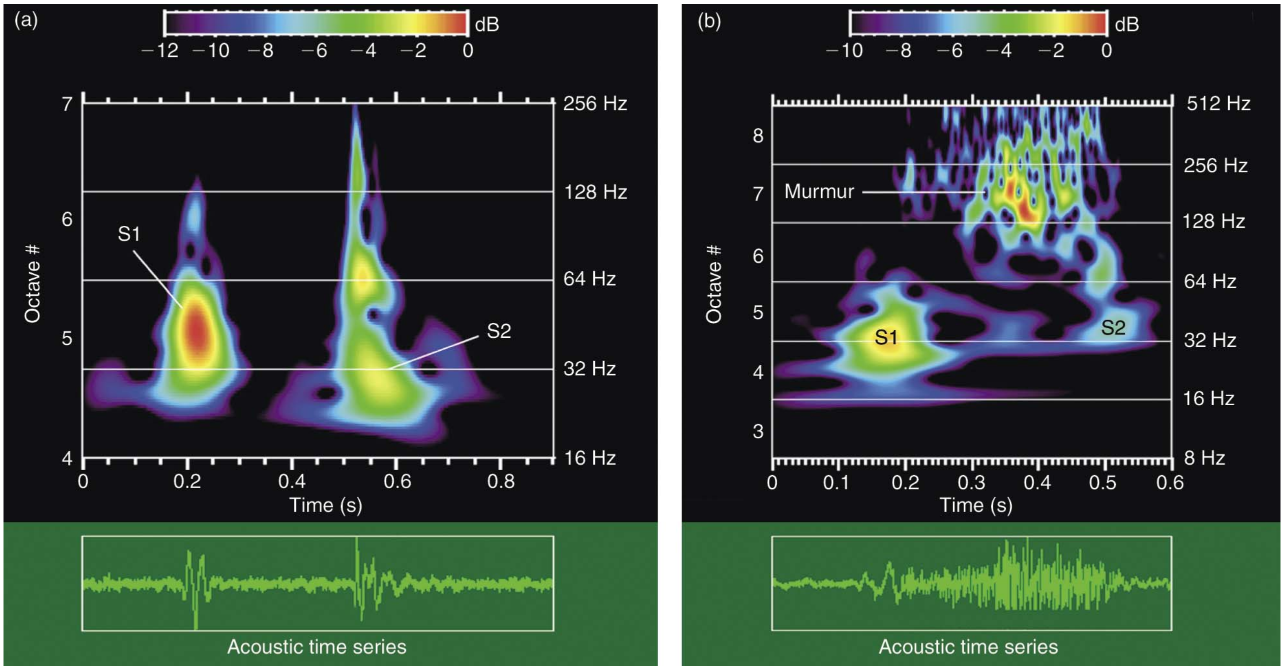

Figure 12. In biomedicine, APL is attempting to exploit Laboratory-wide resources developed in its defense and space programs for medical applications. Analysis of an infant's heart using sonar processing, for example, helps the physician identify a defect in the wall separating the two main chambers. Compare the sound spectrogram of a healthy heart (a) with a heart having a ventricular septal defect (b).

traditional sensors are inadequate (e.g., inside caves, underground). In many ways the use of autonomous sensors for supporting the land war mimics their use in ASW. While the full potential and range of applications for autonomous sensor technology are yet to be established, NSTD is vigorously positioning itself for exploiting these systems (Fig. 14).

Figure 13. NSTD is investigating ways to protect U.S. naval forces in ports and during egress. The barriers above, for example, can help prevent incidents like the attack on USS *Cole*.

Counterproliferation is another emerging area. The Laboratory's involvement in counterproliferation has been dominated by sensors and systems associated with defense against chemical and biological agents. As the nation's new Homeland Security Department takes form, and as the country's strategy for homeland defense develops, APL's role will continue to evolve. For example, efforts are currently under way to further the Laboratory's involvement in critical infrastructure protection, operational concepts and technologies to support first responders, and security of transportation systems. Because of the significant possibilities for growth in this area, it is reasonable to examine the potential for counterproliferation as a principal core business area and investigate appropriate organizational constructs for managing this activity.

CONCLUSION

Over the 25 years of its existence, NSTD has successfully responded to changing national priorities (Fig. 15; compare with Fig. 5). This success is clearly derived from the skills, creativity, and dedication of the department's staff. Often overlooked, however, is the role played by the enterprise culture that is an integral part of APL's tradition. As asserted in

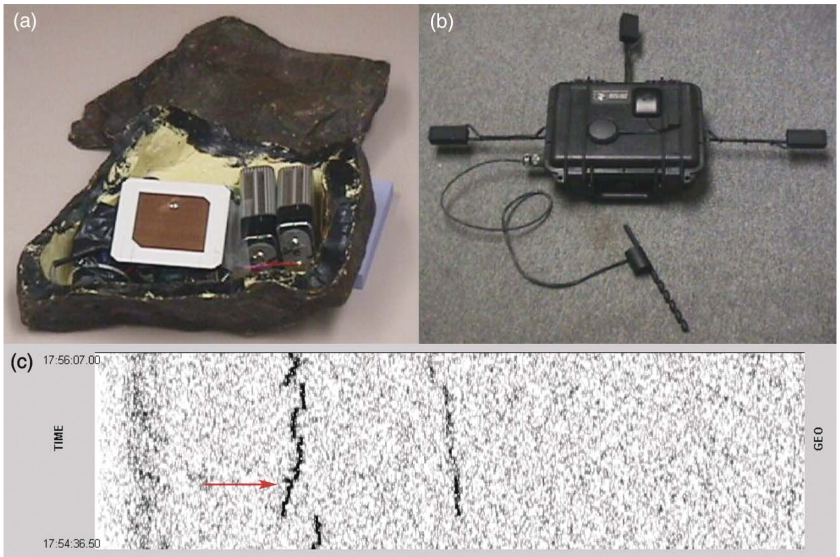

Figure 14. Autonomous sensors represent a promising new technology area being pursued by NSTD that can support undersea as well as land warfare: (a) sensor camouflaged as a rock, (b) hand-emplaced land sensor, and (c) spectral analysis of seismic data from a land sensor.

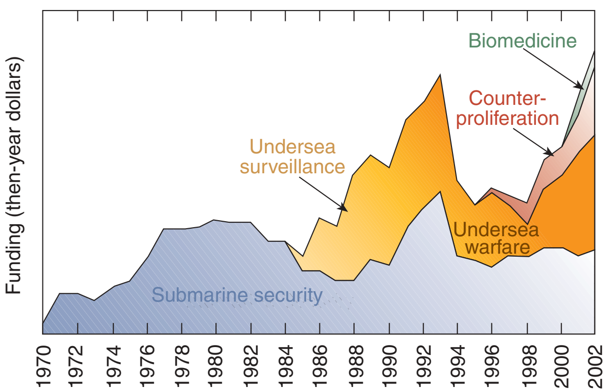

Figure 15. Responding to national priorities, NSTD evolved from a single mission—submarine security—to become an "ambidextrous" organization today.

contemporary business literature, successful organizations need to rely on existing capabilities to accommodate a dynamic environment. The effective development of new initiatives requires the selfless support of multiple organizations to champion the common good and the courage of visionaries to venture outside the security of mainstream efforts. NSTD's history gives evidence of this. The birth of the SSBN Security Program required not only the demonstrated capabilities of SSD, but access to expertise in basic phenomenologies that only existed across the Laboratory as a whole. The department's entrance into undersea surveillance necessarily exploited skills resident in the SSBN Security Program. The Laboratory's currently evolving role in counterproliferation is built upon the efforts of early innovators in multiple departments and the voices of advocates for a mission before it became a national mandate. APL's future missions depend on the foresight to encourage and incubate new activities and to draw critical resources from wherever they reside.

In December 2002, NSTD celebrated its 25th anniversary. It is appropriate that this issue of the *Johns Hopkins APL Technical Digest* commemorate the department's accomplishments in its traditional mission area—undersea warfare. Future issues will showcase Laboratory-wide activities in counterproliferation and biomedicine, two additional business areas for which NSTD is responsible.

REFERENCES

[1]Christensen, C. M., *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press, Boston, MA (1997).

[2]Tushman, M. L., and O'Reilly, C. A. III, *Winning Through Innovation: A Practical Guide to Leading Organizational Change and Renewal*, Harvard Business School Press, Boston, MA (2002).

THE AUTHOR

G. DANIEL TYLER Jr. is a member of the APL Principal Professional Staff. He received his B.S. degree in electrical engineering from MIT in 1970 and his M.S. in computer science from The Johns Hopkins University in 1974. He also attended the Stanford Executive Program, Stanford University, from June–August 2002. Mr. Tyler is a specialist in the underwater acoustic detection of submarines. His areas of research have included digital signal processing, automatic classification, submarine signatures, transmission loss and propagation effects, and signal coherence and array performance. He has been the Program Area Manager for Undersea Surveillance and Assistant Department Head for Programs, and on 1 June 1998 was named Head of the Submarine Technology Department. Since 1998 the department has undergone significant diversification, and was renamed the National Security Technology Department on 1 January 2002. In October 2001 Mr. Tyler was named to head 3 of the Laboratory's 12 business areas: USW, counterproliferation, and biomedicine. His e-mail address is dan.tyler@jhuapl.edu.