The Visionary Directors of APL: Creating and Nurturing a National Resource

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ABSTRACT

An institution is shaped by its leaders, and in the best of circumstances their influence moves that institution toward greater achievements and strengthens its foundation. But in more challenging circumstances, good leaders can become great leaders. Each of APL's directors came at a critical time for the Laboratory, and history shows that when they stepped down, Johns Hopkins wisely chose the right person for the next era of challenges. Each director took his predecessor's accomplishments and made APL an increasingly formidable division of the university. Each has made an indelible mark on APL and its national security mission. This article tells their stories, their challenges, and the impact they have had on the 75-year-old national asset that is the Johns Hopkins University Applied Physics Laboratory.

MERLE A. TUVE (APL DIRECTOR 1942–1946)

The Applied Physics Laboratory did not exist in 1940—but the need for it was growing. Merle Tuve, a physicist in the Carnegie Institution of Washington's Department of Terrestrial Magnetism (DTM), was watching the increasing aggressions in Western Europe and worrying about the ill-prepared U.S. military. So when Vannevar Bush, Carnegie's president, set up the National Defense Research Committee (NDRC), Tuve eagerly joined the challenge to create new defense technologies.

Growing up in South Dakota, Merle A. Tuve had a passion for radio and electronics, which he nurtured with degrees in electrical engineering and physics from the University of Minnesota, and then a doctorate in physics from Johns Hopkins that focused on radio wave propagation. At DTM, Tuve worked on the production of high-energy particles, made some of the first measurements on nuclear fission, used the principles of radar to confirm the existence of the ionosphere, and helped develop the first cosmic ray telescope—experience that would serve him well.

With this background, as well as a brilliant mind and a tireless work ethic, it was no surprise that Tuve would lead the efforts of NDRC's Section T (*T* for Tuve) to develop an anti-aircraft artillery shell that could take out an enemy plane without a direct hit—a challenge that so far had eluded U.S., British, and German scientists.

Bush was concerned about conflict of interest if he headed both Carnegie and the NDRC, so Johns Hopkins University was asked to sponsor the Carnegie effort with Tuve at the helm. And on March 10, 1942, Johns Hopkins signed a contract with the U.S. Office of Scientific Research and Development giving the university official management responsibility over APL. Tuve and about 100 DTM staff then set up shop in APL's first home, a repurposed garage at 8621 Georgia Avenue in Silver Spring, Maryland.

Merle A. Tuve (APL Director 1942–1946)

Tuve oversaw the rapid development of several fuze designs, racing to beat enemy scientists to a similar weapon. The most promising design approach used radio waves to "sense" the target and, when close to it, detonate its shell. Tuve called the device the VT (variable timed) fuze, rather than the radio proximity fuze, to conceal from the enemy the type of technology it used. Proof of the fuze's viability came in January 1943 on USS *Helena* when, in a wartime demonstration, the fuze exceeded the Navy's goal of a 50% success rate—and downed a Japanese war plane when it unexpectedly fired on the ship. With that success, the Navy was full in, authorizing further fuze development and production in enormous quantities to protect the U.S. Pacific Fleet from attack by Japanese kamikaze planes, and later to protect London from the devastating German "buzz bombs."

During the frenetic fuze development process, Tuve was a demanding taskmaster with high standards but also a penchant for not getting in the way of talented people. He once said, "Tell the worker . . . what the *need* is, invite them to contribute in the best way they can, and let them help you and help each other meet that need."[1] He judged his staff on results, saying, "A man's rank is determined by his competence in his field, not by his position on the organizational chart."[2] Under Tuve, APL was very democratic, with staff-wide authority, long workdays, and many pithy "Tuvisms": "I don't want any damn fool in this laboratory to save money, I only want him to save time"[3] and "We don't want the best unit, we want the first one." Although it was not called systems engineering then, Tuve's process—end-to-end development and testing—was just that. And because it was wartime, some APL staff members were commissioned into military service so they could teach proper fuze use in the field.

Tuve's message to the people working on the fuze was simple: "Our moral responsibility goes all the way to the final battle use of this unit; its failure there is our failure regardless of who is technically responsible for the cause for failure. It is our job to achieve the end result."[4] And they took it to heart. Under Tuve's strong leadership, the VT fuze was developed and produced in sufficient quantities to secure Allied victories not only in the Pacific (where the VT fuze was said to be six times more effective than mechanical timed fuzes) and in London but also in the Battle of the Bulge in December 1944.

As more ships were equipped with the VT fuze, it was discovered that the older ship gun directors were compromising the fuze's success rate, and the Navy asked APL to develop a new anti-aircraft gun director. But as usual, Tuve and his colleagues were one step ahead, having already created a preliminary design for the MK 57. By January 1945, the new gun directors were being installed on ships.

Japanese kamikaze attacks against Allied naval vessels in the Pacific continued, and the Bureau of Ordnance asked Tuve if APL could develop technology to keep military ships safe. The university was hesitant to escalate its military involvement but agreed to the new Task F contract with the code name Bumblebee. This task was a perfect opportunity for Tuve to use his expertise in electronics, ionospheric science, and radar to lead the creation of a guided missile system. He challenged his staff to design and develop ramjet propulsion and missile control and guidance at subsonic and eventually supersonic speeds. They experimented with captured German V-2 rockets packed with APL instruments, and in April 1945, they successfully demonstrated sustained ramjet thrust in flight at Island Beach, New Jersey. With V-2s in scarce supply, Tuve decided to build a smaller, less-expensive Aerobee rocket for future research.

By June 1945, Tuve had succeeded in his mission to give the Allies the technology they needed to win the war, growing APL's staff to 800 to make it happen. Under Tuve's formidable leadership, APL developed the DTM's basic fuze design into a fierce weapon. The MK 57 gun director greatly increased ship safety, and ramjet development was soon to make guided missiles possible.

Tuve returned to Carnegie's Department of Terrestrial Magnetism (DTM) as its director, but before he left APL, he had the foresight to provide funding that would help retain the brilliant scientists and engineers of the fuze era who were conducting fundamental research in theoretical physics. This group would grow and later become APL's Research Center.

National Academy of Sciences Director Philip Abelson captured Tuve's essence when he said, "Tuve was a dreamer and an achiever, but he was more than that. He was a man of conscience and ideals."[1] Ralph Baldwin, a colleague of Tuve, said, "It was Tuve's good fortune to be placed in charge of the proximity fuze program. It was the nation's good fortune that he accepted the challenge of 'a job that couldn't be done.'"[5]

Merle Tuve not only gave the Laboratory its name and gathered its amazing technical wartime staff, but he also gave APL an international reputation as an institution that could do the impossible; this reputation continues to this day.

LAWRENCE R. HAFSTAD (APL DIRECTOR 1946–1947)

Lawrence Hafstad had much in common with his predecessor, Merle Tuve: Minnesota roots, a Johns Hopkins doctorate in physics, and a history at Carnegie Institution of Washington's Department of Terrestrial Magnetism (DTM). At Carnegie, they achieved the first U.S. demonstration of how to split uranium, a critical step in atomic bomb development; studied the effects of the ionosphere on long-distance radio waves; and paved the way for nuclear reactors. But as the drums of war intensified, they looked for a way to help the war effort.

When Hafstad was DTM's chief scientist, he thought the atomic bomb could not be developed quickly enough for World War II, so in 1940, he took temporary leave from Carnegie to join the wartime National Defense Research Committee (NDRC) as vice chairman of Section T. He worked with Tuve to prove the efficacy of a radio proximity fuze, and in 1942, when APL was stood up as a temporary entity to produce the fuze, Hafstad served as Tuve's assistant director. Hafstad said he and Tuve were complementary, Tuve being the idea man and he, the technician. "We could argue and I could talk back to him . . . He accepted it,"[6] Hafstad said.

Lawrence R. Hafstad (APL Director 1946–1947)

But Hafstad was also a critical thinker. Success with the VT fuze that was used in 5-in. shells led the Navy to ask for a fuze for its 12-in. shells. Hafstad urged the Navy to think beyond current technology and convinced the service to support development of a more versatile guided missile. He would later say the guided missile was his most complex military device challenge because radar guidance technology was in its infancy, supersonic flight was just an idea, and rockets big enough to launch an effective warhead did not exist.

When the war ended, scientists started to leave APL and Tuve thought the "temporary" Laboratory would soon close. But Hafstad again pushed back. Although much of Hafstad's research revolved around weaponry, it was peace that he sought—and he believed military preparedness was the key to peace. In 1947 he wrote, "If there is another war, all indications show that it will be shorter, more violent, and 'much faster breaking' than those of the past. Only that nation can survive which is adequately prepared for just that kind of war. Next time, the gadgets must be ready when the shooting starts."[7]

When Hafstad became APL's director in 1946, he maintained close ties to the military. He knew APL's unique position and capabilities allowed it to more quickly respond to military needs and field solutions faster than was possible for industry contractors or government offices, given their tighter restrictions. Hafstad also took a long view of APL's future and its funding, and he saw a need to move beyond exclusive Bureau of Ordnance sponsorship. He promoted securing separate contracts with military units to provide APL with more stability in the event of a single funding source collapse.

During Hafstad's directorship, in 1946, APL researchers bolted a 35-mm motion-picture camera onto a captured German V-2 rocket and took the first pictures of the curvature of Earth from space. And the Laboratory's ramjet propulsion testing and rocket steering and control development laid the groundwork for future guided missiles. Hafstad also oversaw development of the smaller, less-expensive Aerobee rocket that Tuve had proposed for high-altitude research once the few remaining V-2 rockets were gone.

Hafstad left APL in July 1947—just months before Johns Hopkins, after several years of sponsorship, made the Laboratory a permanent division of the university. Over his storied career, he went from a telephone lineman in high school to a world-renowned leader in guided missile development and nuclear research. He strongly believed in peace through strength and that APL's role in peacetime would be as critical to the nation as it had been in wartime. Were it not for Hafstad's ability to make that case, APL's history might have been a mere 5 years, not 75 years.

After leaving APL, Hafstad coordinated research and development activities for all branches of the military as executive secretary of the Joint Research and Development Board and became a Johns Hopkins University trustee.

RALPH E. GIBSON (APL DIRECTOR 1948–1969)

Ralph Gibson left England in 1924 for the Carnegie Institution's Geophysical Laboratory in Washington, DC, with a doctorate in physical chemistry and a fascination with pressure geochemistry. When World War II was intensifying, he became part of the National Defense Research Committee's rocket propulsion section, then director of research at the Allegany Ballistics Laboratory. In 1946, Gibson joined APL's nascent postwar guided missile research effort and 2 years later became the Laboratory's third and eventually longest-serving director.

One of Gibson's earliest achievements was a historic change to APL management oversight. While Gibson was acting director in Lawrence Hafstad's absence, he fought against the decision to have an outside corporation manage APL's administrative and engineering operations, saying such oversight would undermine APL's relationship with the Navy. Persistent appeals from Gibson led to the corporate connection being severed and Hopkins making APL a permanent regular division of the university in March 1948—less than a year after Gibson became the Laboratory's director.

Gibson's physical chemistry and ballistic research background meshed well with APL's needs. Under his lead, the Laboratory found ways to strengthen fleet air defense. When guided missile research required propulsion expertise that APL did not have, Gibson brought in experts from the Allegany Ballistics Laboratory who would become future APL leaders: Alexander Kossiakoff, Frank McClure, Richard Kershner, and William Avery. Under their expertise and Gibson's leadership, the Laboratory conducted the world's first experiments on supersonic ramjets, opening the door to the development of the Bumblebee anti-aircraft missiles.

Ralph E. Gibson (APL Director 1948–1969)

Gibson approached a challenge by thoroughly understanding the technology, the environment, and the complete system involved. It was that philosophy that led to the successes of the Bumblebee program's Terrier, Tartar, and Talos missiles and the more sophisticated Typhon weapon system, which demonstrated advanced technologies despite not being deployed.

In 1950, when the Korean War broke out, Gibson pushed final development of the beam-riding Terrier missile. Then, in keeping with the systems engineering approach, APL went beyond missile development to integrating weapon systems and conducting operational evaluations in the field. The experience gained in this work would later help APL provide critical upgrades to radar equipment during the Vietnam War. At the end of the Korean War, more than half of APL's work was in support of Navy weapon systems, and the Navy was counting on APL for original ideas and advice on future weapon systems.

By the mid-1950s, a growing need for more space and privacy than the 8621 Georgia Avenue facility could provide led Gibson to find a new campus in Howard County with room enough for future facilities such as a propulsion laboratory, missile guidance and tracking facilities, and spacecraft development facilities. With a new home and strong leadership, APL moved beyond its World War II accomplishments and expanded into the world of submarines and spacecraft. When Russia launched the Sputnik satellite in 1957, the Laboratory tracked it and the seeds of an APL Space Department germinated.

Seeing value in building on APL's high-altitude research experience, Gibson provided additional funding for the Laboratory's space effort that would soon lead to rapid production of satellites and instrumentation and a program called Transit—the world's first navigation-by-satellite system. The work attracted NASA funding at a good time—when missile development dollars were declining. Much of APL's success can be attributed to Gibson's vision, his top-notch scientific and engineering staff, and a decade of guided missile development that gave APL its in-depth systems engineering discipline.

Under Gibson's leadership, APL built and launched nearly three dozen spacecraft and many more instruments to study Earth's geodesy and magnetic field; these missions and programs also established the shape of Earth, took the first color pictures of Earth from space, investigated high-energy particles, pioneered oscillators for spacecraft stability, and provided the technology that led to satellite navigation for civilians around the world. The Transit system also gave the Polaris nuclear submarines a critical navigation capability and APL a new specialty in submarines.

In the early 1960s, Gibson's leadership was augmented by a computer age that was beginning just in time to meet the needs of space exploration and the increasing complexity of weapon systems' performance. Through all of the technical success, Gibson stayed true to his belief in the value of education, as he oversaw the creation of a part-time graduate program on the APL campus, in partnership with the Johns Hopkins University. As a physical reminder of his passion for education, APL's library (now decommissioned) was named in his honor in 1969.

Gibson encouraged the Laboratory to apply its engineering skills to biomedical challenges, which by the 1970s would result in devices such as the first heart pacemaker, a robotic arm, and a low-radiation X-ray device. He also championed collaboration between APL and the Hopkins School of Medicine, and after leaving APL he became a professor of biomedical engineering at the school.

But the Gibson years also had setbacks, such as the cancellation of the Triton, Typhon, and the land-based Talos missile programs. Although the losses impacted APL, the resilient organization that Gibson and his predecessors had created weathered them and moved on. The institution reflected Gibson's philosophy that scientific understanding must be the basis of all practical development efforts and that a spirit of adventure fosters creativity.

Gibson was known for dropping in on researchers and querying them with intense interest. "I was privileged to have him drop in to my laboratory on many occasions. Usually, he would ask me what we were doing, and I would bring him up to date on our latest scientific endeavor (or misadventure). In the ensuing discussion, he would typically ask incisive questions on the problem and would often tell us of related work being done elsewhere,"[8] recalled Samuel Foner, of the Research Center.

His most valuable gifts were said to be his ability to choose and lead talented people and his vision for APL's direction. On the occasion of APL's 40th anniversary, in 1982, Gibson said, "As the years go by, may the Laboratory never forget its primary mission of public service. As one generation succeeds another may it renew its enthusiasm to carry out this mission with wisdom and integrity."[9]

When, in 1969, Gibson was awarded the Medal for Distinguished Public Service—the Defense Department's highest civilian honor—his leadership was described as "a rare combination of an inquiring and disciplined mind of a scientist and scholar with a consuming interest in the solution of practical engineering and operational problems. He brought together science, engineering, and a profound understanding of operational problems and an organization which could react quickly to new challenges."

Carl Bostrom, who would become APL director in 1980, said his predecessor "was not only a renowned scientist; he was classically gracious, a gentleman of the old school, and he ingrained these traits into our institution."[10]

Gibson accepted the challenge of directing a postwar institution, tripling APL's staff over 21 years and broadly expanding its technical capabilities. He transformed APL, moving it from a narrowly focused wartime resource to a developer of sophisticated ordnance systems and a pioneer in space science, biomedical engineering, and basic research.

ALEXANDER I. KOSSIAKOFF (APL DIRECTOR 1969–1980)

By the spring of 1969, Alexander Kossiakoff had served nearly 3 years as deputy director and was greatly respected for his ability to meticulously evaluate a problem, pick the right people to solve it, and instill in them a passion to succeed. He was intimately familiar with APL's three divisions—Fleet Systems, Polaris, and Space—and had been given the keys to a well-run and healthy institution, making for a seamless transition. Even the staff size was stable because of a 2600-employee ceiling that was in place. He had, a colleague said, "deep technical knowledge, immense curiosity, tremendous

Alexander I. Kossiakoff (APL Director 1969–1980) breadth of experience and . . . inordinate dedication." It was no surprise when he was chosen to be APL's director.

Kossy, as he was known to everyone, came to APL with a storied past. Born in Russia to a father who was an officer in the czar's army, Kossiakoff and his family fled the 1917 Bolshevik Revolution when he was three, leaving St. Petersburg on a horse-drawn sleigh, traveling through Siberia to China. He was nine when his family finally got visas to the United States. As a young man, he earned degrees in physical chemistry at the California Institute of Technology and Johns Hopkins before beginning his professional life at the Allegany Ballistics Laboratory. There he worked for Ralph Gibson, who would later become APL's director, and with colleagues Frank McClure and Richard Kershner, who became, respectively, heads of the Laboratory's Research Center and Space Department.

Kossy was on the ground floor of rocket ballistics and "temporarily" came to APL with McClure and Kershner to plan the development of a rocket that could push missiles to cruising speed. He liked APL's collegial atmosphere and enthusiastic staff and in 1946 decided to stay. A rare expert in the new arena of guided missiles, Kossy was tapped to give presentations around the country in Launching Panel meetings for contractors and Navy personnel—a task that also established APL's leadership in the emerging field of missile technology.

But it was his extraordinary insight into a stubborn problem with the Terrier missile that proved his analytical expertise. He proposed a "sectionalization" approach that involved building and testing the missile in independent sections so each could be perfected independently without affecting production of other sections prior to integration. The result greatly advanced missile development and earned Kossy the Navy's Distinguished Public Service Award.

APL was so consequential to the technologies of guided missile air defense that the Navy expanded the Laboratory's role from technical direction of missile development to technical oversight of the entire Terrier, Talos, and Tartar air defense weapon systems. With Kossy's personal technical involvement, APL also developed the AN/SYS-1 integrated, automatic radar detection and tracking system to distinguish and maintain computer-generated tracking of aircraft in natural clutter and adversary jamming environments, and APL also played a key role in the successful test of the Aegis Weapon System on USS *Norton Sound*.

Although the Laboratory was financially sound, Kossy was aware that DoD was increasingly cost conscious and funding for weapon systems was becoming less dependable, as evidenced by missile program cancellations under APL's previous director. With fleet defense accounting for about half of APL's work, Kossy sought to broaden the Lab's sponsor base, although the government's budgetary environment was a challenge.

Kossy was especially interested in physics and ocean chemistry, which were essential to undersea warfare technology programs. He allocated significant resources to instrument design, at-sea tests, and analysis of vast amounts of oceanographic data. The work was advanced by new microprocessors—a technology that fascinated Kossy and one that he persuaded other programs to use.

APL's space research continued to grow as the Laboratory launched satellites to conduct advanced geodetic research that provided the first X-ray and gamma-ray surveys of the sky from space and the first detailed survey of the Earth's magnetic field. The two Voyager spacecraft, launched in 1977 and carrying APL energetic-particle detectors on their mission to the outer planets, became the first spacecraft to leave our solar system and are still sending back data today.

While the Lab tackled the technical aspects of weapon systems and space research, during the Vietnam War era, Kossy was faced with a new challenge: demonstrators calling for APL to shut down entirely or at least divert its funding toward nonmilitary programs. But his good relationship with Johns Hopkins leadership, and the university's belief that APL's work was both critical to national security and aligned with the university's public mission, created a united front to protest activities.

Education was a priority for Kossy, and under his guidance, the Laboratory created science and engineering opportunities for people of all backgrounds by launching the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM) for graduate students and the Mathematics, Engineering, Science Achievement (MESA) program for precollege students.

Kossy's 11 years as APL director brought broad and impactful accomplishments in the areas of space, geodesy, oceanographic exploration, and biomedical engineering—the latter initiative capitalizing on the capabilities of APL engineering and Johns Hopkins Medicine to produce technologies such as a rechargeable cardiac pacemaker and a computer-controlled medication system. His vision helped produce Navy missile systems that were more effective and submarines that offered greater strategic deterrence. And in 1976, with well-earned nostalgia, Kossy authorized the official closing of APL's wartime location at 8621 Georgia Avenue in Silver Spring, Maryland.

When he stepped down as APL's director in 1980, Kossy started a new career as the Laboratory's chief scientist, concentrating on graduate-level education in the Johns Hopkins University's part-time engineering program at APL. He created master's degree programs in technical management and systems engineering and wrote a seminal systems engineering textbook.[11] Many of his students have gone on to leadership positions in industry, government, and academia.

In 1982, when looking back on the Laboratory's accomplishments, Kossy said, "The secret of APL's enduring vigor and vitality is the spirit of its staff. . . . There was a drive for doing great things, a spirit of adventure and a sense of urgency, with a subordination of personal recognition to team effort and a willingness to take on whatever job most needed to be done."[12]

The Lab celebrated Kossy's dedication to graduate education in 1983, naming its new conference and education center in his honor. For the remaining two decades of his life, he continued as an enthusiastic mentor for, and a much admired colleague of, APL staff, Kossiakoff Center students, and future Laboratory directors.

CARL O. BOSTROM (APL DIRECTOR 1980–1992)

In the spring of 1960, Carl Bostrom was at Yale finishing research for his doctoral thesis in nuclear physics when APL came looking for exceptional scientists. The opportunity to join the new field of space science was too tantalizing to pass up, and by fall he was at APL. The Lab needed good nuclear physicists to provide insight into the harsh environment of Earth's recently discovered Van Allen radiation belts, and Bostrom fit the bill.

Bostrom found the Lab a relaxed but hard-charging environment. His quick mind, practical approach to challenges, and gentlemanly charm soon put him on a meteoric rise in Laboratory management. In 1974, he was named the Space Department's first chief scientist; 5 years later, department head; and in 1979, the Lab's assistant director for space systems.

His first major Space Department challenge came in 1977 when—just 9 months from launch—production stalled on the Low Energy Charged Particle (LECP) instruments that APL was building for NASA's Voyager 1 and 2 missions. Bostrom took over the program's management, drastically reorganizing the effort and pulling in resources from around the Lab. APL successfully delivered the LECP instruments on time, and today the Voyagers are beyond Earth's solar system with both Lab instruments still operating.

After less than a year as Space Department head, Bostrom was asked to serve as deputy director until Alexander Kossiakoff retired in 1980 and to then succeed him. Bostrom might have been quiet and introspective, but he was not afraid of a challenge. His "change of command ceremony" was characteristically low-key, involving a handshake from his predecessor and a simple direction, "Don't screw it up."[13]

Bostrom's early days at the helm were stable ones. His new leadership team was in place—replacing many of APL's historic wartime leaders who were leaving—and the Lab had recently signed a 5-year contract with the Naval Sea Systems Command (NAVSEA). The Lab enjoyed equality with other Hopkins divisions, collaborating on many cross-divisional projects in biomedicine, physics, and engineering. Bostrom described it as a time of positive benign neglect. Budgets were good despite 13% inflation nationwide and a self-imposed cap that kept staffing levels at 2800 plus about 800 contractors to give APL budgetary flexibility.

One of the Laboratory's main programs at the time was the Aegis Weapon System. In 1981, after years of development, the first Aegis ship, USS *Ticonderoga*, became operational with the capability to simultaneously track and engage multiple targets. Bostrom saw the Lab's emphasis broaden from developing individual ship defense systems to officially becoming a trusted technical advisor for Aegis and the technical direction agent for the Cooperative Engagement Capability program, a system to network and enhance the detection, tracking, and identification capabilities of an entire carrier battle force.

APL's missile development was also in high gear. The Navy had been impressed with APL's work to ensure the capabilities of missiles such as Tomahawk, Standard Missile, and Pershing and had named APL to official trusted roles, including technical direction agent, beginning in the early 1960s. The Tomahawk system, in particular, played a key role in Operation Desert Storm in 1990–1991. Bostrom also invested in new facilities and upgrades that included the Guidance Systems Evaluation Laboratory to test and evaluate potential advances to various versions of Standard Missile.

Technology was evolving rapidly in the 1980s, and under Bostrom APL was quick to take advantage of it. Integrated circuits designed at the Lab led to unprecedented miniaturization, and the ability to create and process data grew exponentially. But the biggest game-

Carl O. Bostrom (APL Director 1980–1992) changer of his directorship, Bostrom said, was the personal computer.

Bostrom did not immediately embrace the idea of a personal computer on every desk, but he soon learned their value. Hopkins President Steven Mueller had told him that while the university supported construction of the Kossiakoff Conference and Education Center and a modern building for space integration and testing, APL could not build any more for at least 5 years. Bostrom, who was set on upgrading APL facilities, was temporarily stymied. But as luck would have it, IBM gave him a new computer to try out. He taught himself Lotus 1-2-3 and was thrilled to learn he could run spreadsheets with income and expense calculations projected 30 years into the future. He covered the walls of the director's conference room with long rows of paper printouts that showed the Lab's stable finances and invited Mueller to a presentation. Bostrom convinced Mueller that APL was not a financial risk, and the building construction and upgrades continued. By the end of his term, besides the Kossiakoff Center and the Building 23 space integration building, new buildings included 24, 25, 47 (now demolished), 48, 13, and 31, plus several additions to buildings.

Bostrom placed new emphasis on analysis, creating the Naval Warfare Analysis Department and the Warfare Analysis Laboratory (WAL) for war gaming, showcasing APL's reputation as a place that both identified *and* solved force-level operational problems. The Lab improved Trident II nuclear submarine accuracy with the SATRACK program, led research to ensure continued SSBN security against adversary detection, and leveraged the detection research for new sponsors to advance the capabilities of tactical undersea warfare. Under the Bostrom administration, departments broadened their sponsor bases and became more agile and financially secure, and the director pressed leadership to include more staff in the decision-making process and to give them authority along with responsibility.

But Bostrom's directorship was not without challenges. Funding under the 5-year Navy contract was authorized 1 year at a time, making long-term planning difficult. And he saw a disturbing trend in which the Lab was being treated more like a contractor than a partner, which could hurt its ability to be a national resource. He believed APL was at its best when it was presented with something that did not work and was allowed to both find and fix the problem rather than be told what to do.

At the same time, APL's independent research and development work was limited by a government-imposed budget ceiling, which forced the Research Center to become more creative and diversify its sponsor base with non-Navy programs. Soon, Lab researchers were exploring gas pipeline corrosion, high-temperature superconductor materials, and biomedical advances that included developing a programmable implantable insulin-delivery system and a nonreusable syringe. Other civilian programs included highway safety analysis and Chesapeake Bay research.

The anti-military protests that frustrated Bostrom's predecessor continued, but with renewed vigor. Throughout this time, the university steadfastly supported the Lab and its mission to maintain "peace through military strength." Bostrom explained, "Our national security and quality of life of the American people depend in very direct ways on the programs of the Laboratory."[14]

After two decades of plentiful space research and spacecraft development opportunities, the work grew sparse enough in the early 1980s that Bostrom wondered whether APL's Space Department had a future. But that concern evaporated in 1983 when President Ronald Reagan stood up the Strategic Defense Initiative (SDI) to prove the concept of a space-based anti-missile system. DoD, knowing the Lab's reputation for success with difficult challenges and short launch schedules, asked for APL's help to demonstrate an in-orbit missile intercept in a very short period of time. Convinced that APL was doing something substantive, Bostrom agreed to take on the program commonly called "Star Wars." APL built and launched—in just 3 years—the Delta 180, 181, and 183 spacecraft, creating a space test range over the Pacific Ocean. The program's success is thought to have influenced the Russians to later sign a new arms-control agreement.

While staff members could not share the details of SDI and similar programs with the outside world, Bostrom recognized the value of publishing unclassified science and engineering work and encouraged staff to do so. He also created a sense of community, starting traditions like recognizing exceptional staff through Principal Professional Staff dinners and honoring former staff members and keeping them apprised of APL activities through retirees' homecoming luncheons.

Reflecting on his term as director, Bostrom said, "The best thing that I have been able to do is to maintain and improve the general environment that encourages the kind of creativity and innovation you find here."[15] He retired in 1992 having earned a reputation for professional competence, integrity, and a wry sense of humor. He had overseen the Lab's 40th and 50th anniversaries; he was director when the space shuttle Challenger exploded and the Berlin Wall fell. When bureaucracy crept in the door, he helped APL learn how to cope with it. Under his guidance, construction expanded APL's campus and new technology transformed its programs.

But he said one thing that had not changed was the Lab's character. APL remained a place where people met their commitments and worked as a team for the good of the nation.

GARY SMITH (APL DIRECTOR 1992–1999)

Gary Smith was serving as a National Research Council postdoctoral research associate at the Naval Research Laboratory when, in 1969, he heard about an interesting APL program in submarine fleet security. By the next year, he was a member of the Laboratory's staff, and his intellectual curiosity and quick grasp of submarine detection technologies soon led to management positions in the Strategic Systems and Submarine Technology departments. In 1989, he became the Laboratory's assistant director for research and exploratory development, and soon after, he was overseeing all Laboratory programs.

By 1992, he was serving as APL's associate director under Carl Bostrom, who by then was thinking about retirement. Bostrom said Smith was one of the most insightful and talented people he'd had the pleasure of working with at APL. He possessed "the will and the wisdom"[16] to lead the Lab, which made Bostrom's decision to retire much easier. The Johns Hopkins president and board of trustees agreed with his assessment, and in July 1992, Gary Smith became APL's director.

Despite the nation being on the cusp of the longest era of financial growth in U.S. history, the Lab faced serious fiscal challenges when Smith became director. It was a time of changing budgets and military priorities, many linked to the breakup of the Soviet Union just months earlier. The government's administration and Congress were aggressively pursuing a "peace dividend"—a shifting of funds from defense to domestic programs now that the Cold War was over.

Gary Smith (APL Director 1992–1999)

Smith was initially confident that strong sponsor support for APL's heritage programs—missile systems, submarines, and space—would help protect the Laboratory. Its nuclear submarine expertise made it a major player in worldwide low-frequency acoustics testing and development and in advanced towed arrays. Its work on arc fault detectors was making submarines safer.

Although space research funding was more variable than funding for other work being done at the Lab, it was still an important part of the Lab's budget thanks to APL's management of the Midcourse Space Experiment (MSX), Advanced Composition Explorer (ACE), and Near Earth Asteroid Rendezvous (NEAR) missions. Also strong was the Navy's support of APL's role as a trusted advisor for upgrades to the Aegis Weapon System and as the technical direction agent in Standard Missile upgrades. And the Lab served as technical direction agent for the Cooperative Engagement Capability program, which was about to revolutionize the concept of networked battle systems. It was an era of tremendous technology advances in computers, telecommunications, and the World Wide Web—all of which fueled the Lab's research. While Smith quickly recognized the potential in these technologies and embraced their applications, he viewed APL's future with guarded optimism, seeing ominous budgetary signs on the horizon.

Smith sought to make APL more resilient to future budget challenges. He and program managers from across the Lab met with sponsors to hear their concerns and priorities and to scope the evolving defense environment so APL could better align its work with sponsor needs. He then led an internal strategic evaluation of Laboratory operations to identify strengths and weaknesses. But hopes of APL maintaining its budget posture were dashed in early 1994, as Smith became more aware of just how impactful the external environment would be on the Laboratory. "It would be foolhardy for us to assume that we can stay completely unchanged," he told the staff. "We recognize that we will have to diversify selectively, carefully, in a way that doesn't compromise what we *are* and what we *do*."[17]

Smith worked closely with Laboratory leaders to design and roll out the APL Improvement Initiative, which began with a rigorous evaluation of the Laboratory's processes and work. It included procedures that would lead to more timely responses to sponsors and more efficient teamwork, plus it streamlined processes to reduce costs. Dealing with the unexpected became the norm: one day it was a Navy Competition Feasibility Panel being set up with the power to compete some of APL's work; the next, a surprise NASA announcement that APL was being awarded the NEAR mission, just when work funded by the Ballistic Missile Defense Organization was decreasing.

But by early 1995, it was apparent that APL's belt-tightening measures would not be enough, and Smith braced staff for a bumpy ride. "We are surrounded by dichotomies that affect us . . . dangerous world events in some countries and new peace accords in others; a new Republican Congress that means a diminished role for [some] APL supporters . . . but increased status for others; the loss of APL advocates through defense personnel changes, but the potential of [new] support for [high-priority] defense programs; the signing of the Laboratory's contract with the Navy . . . but the continuation of negotiations to define contract tasks and release money for individual projects."[18]

To attract work from sponsors, APL aimed to reduce its costs. Smith struggled to control the uncontrollable, but by May 1995 he had to accept the inevitable consequences of funding shortfalls and announced the first Lab-wide reduction in force.

It was indeed a deeply challenging time for the Laboratory, but Smith's work with strategic cost-cutting and better alignment with sponsor goals had made APL stronger. By the end of the year, he was able to announce, with restraint, "We are in a considerably improved position from where we were just a few months ago. . . . New contracts are coming into place, initiatives are taking hold, and our relationships with the Navy, DoD, the university, Congress, and NASA are markedly improved."[19]

The upswing included new program areas—transportation and command, control, and communications—to expand APL's funding base and retain critical staff while creating less costly solutions that helped sponsors improve their own bottom lines. APL developed training simulations to replace big-ticket exercises and war gaming. It evaluated alternative weapon systems to determine the best value and capability. It appraised software effectiveness and proposed unmanned undersea vehicles. To better serve the Naval Air Systems Command, APL opened the Patuxent River Field Office, putting Lab staff in daily contact with sponsor operations. Smith also pursued separate contracts with the Department of Transportation, the intelligence community, the Army, and the Bureau of Engraving and Printing, and the Lab took on national challenges in biomedicine, information systems, and cyber warfare.

But perhaps the most significant change was when the Navy, with the concurrence of DoD and Congress, declared APL and certain other university laboratories working for the defense community to be university-affiliated research centers (UARCs). The designation gave a nod to the essential engineering and technology work UARCs did, set guidelines for their operations that reflected this role, and loosened oversight.

In 1997, Smith led a major reorganization that set up the Power Projection Systems Department to more effectively address integrated strike and associated command and control system needs across all military services. The APL-designed and technically directed Cooperative Engagement Capability program was honored by the Navy as "one of the most successful programs in the Department of Defense," and the Laboratory signed two 5-year contracts worth more than $2 billion with the Naval Sea Systems Command (NAVSEA) and NASA. Thanks to Smith's vision and determination, APL had clearly emerged from a very uncertain period.

Smith's final major initiative was a wide-ranging strategic planning effort, which would inform the Laboratory into the next millennium. The 1998 Strategic Plan identified important 21st-century challenges that would be appropriate for APL to undertake and expansion of the Lab's sponsor base in areas such as infocentric warfare, information systems, and counterproliferation, all of which would later grow into major Laboratory program portfolios.

In 1999, with the Laboratory finally on solid ground again, Smith decided it was time to move on. He had guided APL through a period of unprecedented defense and geopolitical upheaval and was leaving it with a strong footing for the future. During Smith's term as director, the Laboratory broadened its sponsor base to include national challenges in new areas. After 28 years at the Lab, and many significant contributions, Smith left APL to become the CIA's deputy director for science and technology.

EUGENE J. HINMAN (APL INTERIM DIRECTOR APRIL–DECEMBER 1999)

In 1962, Gene Hinman was about to complete a master's in electrical engineering at the University of Illinois, and he was wondering how best to apply his interest in automated control systems. He found the answer at the Applied Physics Laboratory, where senior managers recognized promise in the young engineer. Initially Hinman helped develop a bistable control system for the Standard Missile, and before long he was also working on such projects as a hover control system for Polaris submarines, submarine passive sonar signal processing, and automated transportation systems.

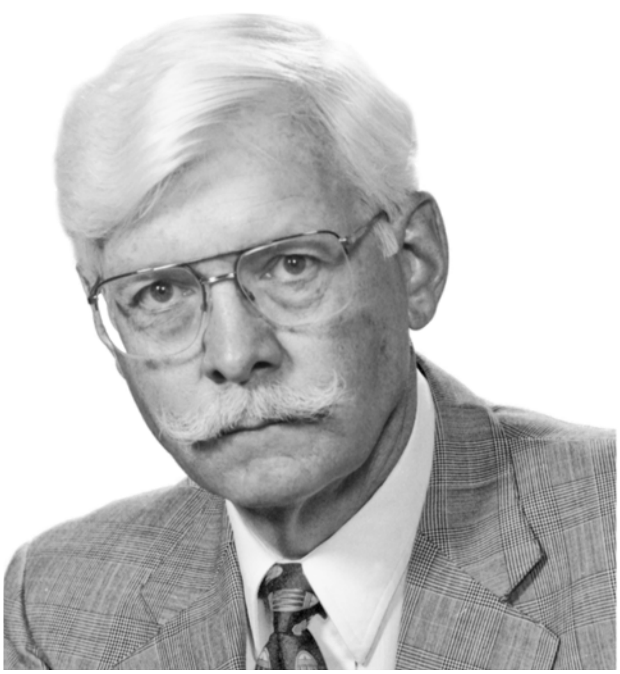
He proved to be a very effective supervisor, and by 1979 he was asked to manage the Fleet Systems Department's Missile Systems Branch, overseeing development of missiles that included Standard Missile, the Rolling Airframe Missile, Harpoon, and Tomahawk. He continued to move up in the department's management ranks and by 1985 became head of Fleet Systems, which was APL's largest department, with responsibility for air defense; strike warfare; and tactical, strategic, and satellite communications engineering programs.

His natural ability with both systems technology and the management of staff who worked with it caught the eye of APL Director Carl Bostrom, who in 1991 brought Hinman into the Director's Office as the assistant director for tactical systems. The next year, with Gary Smith as APL director, Hinman became the assistant director for all technical programs, giving him broad Lab-wide oversight. The timing was excellent. Sponsors were dealing with unsettled budget situations that meant serious fiscal challenges for APL, and Hinman gained a reputation as someone who could put together effective teams for addressing complex issues that sponsors were grappling with.

This experience prepared him to take on one of the Laboratory's most critical challenges. APL management was keenly aware that it had to undertake an in-depth examination of its technical direction to ensure APL's current and future relevance to its sponsors and the nation, and in 1998 Hinman was asked to lead a strategic planning effort that would do just that.

With that strategic plan in place and the Lab operating in a more stable budgetary environment, Gary Smith announced in April 1999 that it was time for him to step down as APL's director. Johns Hopkins University President William Brody asked Hinman to serve as interim director while the university conducted a national search for the next director. Gene Hinman "is an experienced, knowledgeable, and very able administrator," Brody said in a memo announcing the appointment.[20] "I am confident that the Laboratory is in good hands." Upon accepting the position, Hinman told APL staff that the Laboratory had a good plan in place for its future and that he planned to "keep things steady while we move ahead."

During Hinman's term as interim director, the Lab had many successes: NASA awarded APL the MESSENGER mission to Mercury; APL established its Office of Technology Transfer; and a contract was signed with the Department of Transportation to improve the efficiency, effectiveness, and safety of national transportation systems. The APL-developed Area Air Defense Commander prototype was a success in the Nimble Shield war games, and the National Highway Traffic Safety Administration provided funding for an on-campus sled test facility. The APL-built NEAR spacecraft was en route to a historic orbit around an asteroid and an unprecedented landing.



Eugene J. Hinman (APL Interim Director April–December 1999)

Hinman did indeed keep things steady until a new director, Richard Roca, took the helm in January 2000, and then he returned to his position as the assistant director of programs until his retirement at the end of the year. He had worked at the Lab for 38 years and was prepared and willing to serve as its interim director when asked. His experience, exceptional leadership capabilities, and dedication to APL had served the Laboratory well.

In his retirement, Hinman was awarded the Navy Medal for Distinguished Public Service, the Navy's highest civilian honor, for "inspiring the APL team to strive for excellence" throughout nearly three decades of leadership during the development of critical Navy warfighting capabilities.

RICHARD T. ROCA (APL DIRECTOR 2000–2010)

The Johns Hopkins board of trustees announced, in the fall of 1999, that it had selected APL's director, Richard Roca, who brought with him impressive credentials as a vice president of AT&T Bell Laboratories. "His unusual combination of hands-on R&D, senior management, and government experience makes him just the right person to maintain and even strengthen APL's leadership in service to the nation," noted Johns Hopkins President William R. Brody.[21]

Roca had spent more than 30 years at AT&T and found similarities between it and his new institution: both had a sense of professionalism, a sense of contribution, and most importantly, integrity. He had joined Bell Laboratories' research and development unit in 1966 and designed data communications products and networks while getting his master's and doctor of science degrees. He quickly made his way up the management chain and was the director of strategic planning during the Bell Systems divestiture that created the "Baby Bell" regional phone service companies.

Despite a rewarding career at AT&T, Roca was open to a new adventure when he was offered the opportunity to be APL's next director. His concerns about being the right person for the job vanished when he met APL managers, saw program demos, and experienced the Lab at work. AT&T and APL had similar cultures, and he realized his executive experience and subject-matter expertise were a good fit for the Lab. In January 2000, he became APL's new director.

It was a time of strong, enduring legacy programs at the Lab. APL was making significant contributions to the nation's air and missile defenses, and Standard Missile-3 was moving toward theater-wide capability. The Cooperative Engagement Capability program was entering formal evaluations to demonstrate using remote radar data for tracking and missile engagements among the latest versions of U.S. Navy ships, and APL continued to be a key player in Trident submarine testing and systems development, recently adding a training simulator to save time and money while ensuring better-prepared operators. APL was developing NASA missions to orbit Mercury, learn about solar eruptions, and examine Earth's upper atmosphere while refining its revolutionary low-cost approach to exploring the solar system that would result in the Lab being awarded NASA's first mission to Pluto.

For the first 3 months on the job, Roca simply listened. He met with sponsors, program managers, Lab management, and staff. He was looking for insight into whether the Lab should diversify beyond its traditional work and for clues to how APL determined success. What he heard convinced him that APL should "stick to its knitting" but accommodate new sponsor needs when critically necessary to the nation. Then in an off-site strategic planning meeting, APL's definition of success solidified. Success meant making critical contributions to critical sponsor challenges.

Roca saw that APL did amazing, impactful things but too often did that work in organizational silos. He thought that a sponsor should hear the best solution that *all* of APL could bring to a problem, not just one solution from one part of the Lab. To help the Lab think and work as a united entity, Roca decided that the role of a department should be to provide technical expertise and resources and that business areas—a new program-related structure that he created—would assemble expertise from various departments to accomplish specific goals for each sponsor. An additional benefit of the business area construct was its potential to develop future Lab leadership. The concept of business areas, today known at the Lab as mission areas, has proven to be a powerful organizational construct for APL and is a key component of its current foundation.

Richard T. Roca (APL Director 2000–2010)

Roca was also aware of a troubling global trend toward unconventional warfare, and he moved to support programs to counter biological, chemical, and nuclear national security threats. He created a chief information officer, an information technology department, and a cyber-focused business area in response to the growing importance of IT infrastructure and cyber warfare defense.

The value of APL's technical capabilities for the nation's security became evident yet again on a clear Tuesday morning in 2001—September 11—when terrorists slammed hijacked planes into the twin towers of New York's World Trade Center, then the Pentagon, and a fourth plane, believed to be headed for the Capitol or the White House, was brought down in Shanksville, Pennsylvania, by brave and patriotic passengers. In just over an hour, 2996 people were dead—including APL staff member Ron Vauk who lost his life at the Pentagon—more than 6000 were injured, and the nation was stunned.

Amid the heavy air of shock and sadness that permeated APL, there stirred a stubborn sense of purpose and renewed dedication to the Lab's vital work. At a national day of mourning on September 14, Roca told hundreds of staff members assembled outside Building 1, under lowered flags, "There's not a single [APL] department that hasn't been affected by this one way or another. . . . The enemy is closer than ever before . . . and we are up to the challenge."[22]

Sponsors fast-tracked many of the Lab's security-related programs, and over the next several years the homeland protection, infocentric operations, and special operations work expanded in response to 9/11 and the growing strategic importance of intelligence and networking capabilities. The Joint Warfare Analysis Department became the National Security Analysis Department, reflecting APL's focus on a fuller range of emerging national security challenges. Roca continued to evolve Lab structure and strategy to make sure APL was meeting its sponsors' needs.

On March 10, 2002, Roca paused the Lab's vital work to rally the staff in celebration of APL's 60th anniversary, encouraging pride in and inspiration from the rich history they were now a part of. Then it was back to making APL more effective, efficient, and sponsor friendly, a process he had started in 2000 by creating three senior management teams: an Executive Council to focus on APL's strategy and external environment, an Operations Council to provide infrastructure that would support the Lab's current and future work, and a Science and Technology Council to ensure the expertise to meet sponsor needs. A Quality Council was established to formally ensure that APL product quality adhered to nationally recognized standards.

Also during his tenure, Roca doubled internal funding for research and development projects to ensure their success. Among the more publicized R&D programs were Revolutionizing Prosthetics, which gave amputees dexterous hands and arms, and its spin-off, Robo Sally, a bomb-hunting robot that would save service personnel lives. Also receiving attention was the ESSENCE (Electronic Surveillance System for the Early Notification of Community-based Epidemics) health surveillance network that teamed APL with public health and homeland security officials. For some legacy programs, Roca increased the close connection between staff and sponsors by opening field offices in Crystal City and Norfolk (Virginia), as well as Huntsville (Alabama), Monmouth (New Jersey), and Fallon (Nevada).

While the unexpected is an expected part of guiding a research laboratory, under Roca's watch, an event worthy of a James Bond movie plot played out when an errant U.S. government satellite, heavy with lethal hydrazine fuel, began falling toward Earth. APL was asked to help modify—in a matter of weeks—a sea-based missile system to successfully target and destroy the satellite. This first-ever technical feat, known as Operation Burnt Frost, was highly heralded by the Department of Defense and became an unforgettable event for APL and its director, while being totally under the radar to most staff.

But sometimes unwelcome events can be planned for, and Roca oversaw the creation of a business continuity plan that precisely outlined the steps that needed to be taken in all areas of the Lab if a disruptive event—environmental, security, major loss of funding, or physical plant mishap—threatened the functioning of the Laboratory and the safety of its people.

Other additions to the campus during Roca's tenure included seven new major buildings that included significantly modernized offices and research areas. This construction, and a need for still more office space, moved the Lab to expand into six leased buildings in the adjacent Montpelier Research Park and to begin construction on a space research building on the newly acquired South Campus property across Johns Hopkins Road. With great hoopla and festivities, the final much-maligned metal post–World War II Butler buildings—"temporary" structures that had stood since the 1950s—came down, making way for APL's new Central Green. Also coming down during Roca's term was record snow: 35 inches in March 2003 followed by 47 inches in February 2010, the latter closing the Lab for an unprecedented three and a half days.

Under Roca, APL was named a center of excellence in the fields of biotechnology and public health informatics and a major collaborating partner in a Hopkins homeland security center of excellence. And while sponsors frequently acknowledged APL's valuable contributions to national security throughout Roca's term, the Lab also received accolades for the culture he cultivated. *Washingtonian* magazine and the *Washington Business Journal* called APL out as one of the best places to work in the area.

Through it all, Roca brought strategic vision and stability to the Laboratory in a rapidly changing environment that challenged APL to stay ahead of the technology curve. He expanded research and education collaborations with the university; his vision and penchant for being on the leading edge revitalized the campus and its facilities; and his reorganization of management and program governance structures enhanced the Lab's function and effectiveness. But it was Roca's intelligence and decisive leadership, plus a genuine affection for his staff and the institution, that guided the Lab through good times and difficult times, and in the end made APL a better place. Roca continued to serve the Lab as emeritus director after handing over the reins to his successor, Ralph D. Semmel, in 2010.

RALPH D. SEMMEL (APL DIRECTOR 2010–PRESENT)

In 1986, Ralph Semmel—who would become APL's director nearly 25 years later—had a computer science passion and a military background (West Point graduate and Army officer) when Vince Sigillito, his advisor and professor in the Johns Hopkins Whiting School of Engineering computer science program, recognized how well his talents aligned with APL's work. He convinced Semmel to join APL.

It was an immediate match, and Semmel quickly rose in leadership positions, from principal investigator and group supervisor to deputy director of the Milton S. Eisenhower Research Center. His expertise in computer science eventually proved invaluable for addressing the ramifications of cyber and the challenge of countering terrorism that was proliferating around the world.

Semmel felt compelled to seek ways to develop practical solutions for the challenges posed by terrorists after 9/11. In 2002, he found his opportunity when a leadership position arose in a fledgling area known as information operations. Although in reality the position was an

Ralph D. Semmel (APL Director 2010–Present)

organizational chart demotion, Semmel was wise enough to see how important to the nation the opportunity was and he accepted the challenge, ultimately becoming the business area executive for infocentric operations. The research nurtured by Semmel and his team helped put APL into trusted roles with agencies in the intelligence community and DoD. Within only 4 years, this nascent but ambitious business area became a new department: the Applied Information Sciences Department (AISD). Among the many achievements of the department under Semmel's leadership was a system that used lidar to penetrate dense tree foliage with a single search aircraft's pass. With this capability, the military could detect potential adversaries and other items of interest hidden under vegetation. The military rapidly adopted and deployed the technology to support anti-terror efforts.

The formation of AISD was reminiscent of Richard Kershner's formation of the APL Space Department at the dawn of the Space Age in that it was the realization of a new strategic capability for the Laboratory. This blank slate gave Semmel latitude to forge his own path with AISD while following the mandate given by then-director Rich Roca for staff to create "critical contributions to critical challenges." Semmel soon established a diverse team to meet this challenge, and his directive was that "the only metric for success is that you eventually propose something that pushes me beyond even my comfort zone to cause me to say no." One highly successful effort with broad participation was what would today be called a hack-a-thon. It was a seemingly impossible challenge to break into a highly secure facility. To Semmel's surprise, all three teams successfully achieved the objective, giving security experts heartburn but also valuable information about vulnerabilities in their systems.

Semmel's achievements grew, as did his keen eye for strategy, and in 2010 he was selected to become APL's director. Stuart Janney III, chair of the APL board of managers, praised Semmel's accomplishments, saying he had a "proven ability to lead such a dynamic institution" as the Applied Physics Laboratory.

Semmel developed a bold strategy for navigating APL in a world that was increasingly "flat," where interconnectivity between nations, cultures, and adversaries was becoming seamless, and where the pace of science and technology seemed to be accelerating chaotically. It was also a time when more research and technology development was being funded not by governments but by commercial industries. Semmel foresaw that APL needed to be even more agile and connected, including with commercial industry. Every member of the staff needed to be empowered to innovate and develop increasingly disruptive solutions to critical challenges.

Through extensive collaboration with the executive leadership team and carefully chosen focus groups, Semmel began to express the Laboratory's vision, strategic focus areas, and annual execution priorities on a single page, known as the VSE. This deceptively simple approach, and subsequent alignment of resources with the strategy, provided the Laboratory with a clear and disciplined commitment to challenges of critical importance to the nation. The VSE, and more importantly the broad discussions that were necessary to converge on strategic priorities, was quickly adopted throughout the Laboratory.

With the Lab's VSE in place, Semmel reorganized the Lab into four large sponsor-facing, operationally oriented, and strategically aligned sectors, each with an average of 1000 staff members. He also refocused the analysis and research departments on more forward-looking projects to better bridge ideas between foundational research and practical operational implementation. He supported the creation of a senior fellows program in which thought leaders and former senior government officials gave strategic input to APL thinking and projects, which in turn increased APL's influence and impact.

Semmel saw that a mostly hierarchical structure was not well suited to the rapid change the Laboratory was experiencing, so he financially seeded alternative paths for staff to connect with each other and make critical and innovative contributions. In his stereotypically quirky way, he kicked off a new video collaboration program known as Tech Splash to allow staff to share information about their research. He changed the leadership council structure and replaced councils, except for the executive council, with three forums where program, line, and operations executives could meet to develop new innovation initiatives and streamline processes. He introduced initiatives similar to some he had successfully experimented with as a department head and grew them into a large, Lab-wide family of grants known as Project Catalyst and Janney 2.75. These programs were open to all staff members and served to support ideas that might cross organizational boundaries in novel ways or be too forward-looking to find internal or government financial advocates. The goal of these initiatives was to enable APL's sponsored programs to become even more vibrant and significantly increase the impact of the Lab's contributions. Jerry Krill, in his article in this issue, describes some of these initiatives.

In 2016, as the Lab's culture evolved and the pursuit of highly innovative work blossomed, Semmel led his executive team to develop a centennial vision for the Laboratory, one that included and refined APL's historic core values that have been fundamental to its success: unquestionable integrity, trusted service to the nation, world-class expertise, and game-changing impact. But Semmel also believed in the importance of mixing things up, and he had a knack for knowing when levity enhanced APL's environment. He even formalized this by adding to the Lab's value statement the need for "a highly collaborative, fulfilling (even fun!) environment." A man of his word, Semmel spiced up the Lab's 70th and 75th anniversaries by joining staff member and award-winning music artist Ashley Llorens in original APL-focused raps during surprise segments of Director's All-Hands presentations.

Another fun, some might say raucous, time was the New Horizons spacecraft's flyby of Pluto, one of the most celebrated and watched live NASA events ever, with over 1 billion hits on YouTube. The scientists, celebrants, and press were on hand at APL to watch the success together, a bold move considering the high risk of failure of such a historic event.

In addition to affirming the Lab's core values, Semmel's centennial vision included the goal to "create defining innovations that ensure our nation's preeminence in the 21st century" and APL's envisioned future at its 100th anniversary. Semmel encouraged the Lab to "be bold, do great things, and make the world a better place" and to embrace the risk that is inherent in projects that could become game-changing innovations. He has led the Lab in taking risks that have become great achievements, some in response to the immediate needs of APL's sponsors, such as the Aegis Ashore system, new variants of Standard Missile, the rapidly developed Persistent Ground Surveillance System (PGSS) for protection of forward U.S. bases in Afghanistan, and cyber visualization. Sometimes successes began before a sponsor had made a request, such as with the "space game" evaluating U.S. space investments for high-level DoD and intelligence community officials. Similarly, the Laboratory pushed a focus on neuroscience, in the wake of the successful Modular Prosthetic Limb project, without knowing for sure what the investment might return. Thankfully, it did precipitate a number of new Defense Advanced Research Projects Agency (DARPA) projects as well as Facebook funding for APL to play a leading role in their research and development initiatives in noninvasive brain–computer interfaces.

Not all innovations under Semmel's leadership were in response to sponsor demands. Some stretched out beyond the horizon of APL's sponsors, including the launch of the Intelligent Systems Center, a space where APL and outside researchers in robotics, neuroscience, and artificial intelligence could collaborate and engage analysts and policy makers. That center's development built on the successes of the Central Spark innovation center, developed several years earlier, where staff members could use equipment such as laser cutters and 3-D printers to prototype concepts, employing design thinking and computing tools to collaboratively explore ideas. Similarly, Semmel invested resources to stand up a new mission area addressing national health issues in partnership with Johns Hopkins Medicine and the university, with a major focus on precision medicine and minimizing preventable harms.

Semmel's astute leadership guided APL through major contract renewals during difficult political times, and the Lab rode out the government shutdown of 2013 thanks to good strategic planning, supportive senior stakeholders, and a dedicated executive team that had positioned APL well to weather the storm while avoiding any reductions in force, an act that further energized APL's amazing staff.

As APL advances toward 100 years of enhancing the nation's security and protecting the lives of its citizens, Semmel's centennial vision will provide the most recent of the highly innovative technologies and applications carefully nurtured by all of the Lab's visionary directors. The path has been extraordinarily exciting as new technologies have been developed and new challenges have prompted APL to make new critical contributions, and there is much more to come.

Indeed, all of APL's directors have propelled APL on a bold trajectory to invent the future, and today the Lab seeks to contribute to the next defining innovations of comparable impact to the nine Semmel identified in his article introducing this issue. Will APL's leadership in national programs become key to the United States regaining the advantage in hypersonic missiles and flight? Will DART (Double Asteroid Redirection Test), APL's current NASA mission to impact an asteroid, be the vanguard of a new arsenal of planetary defense? Will NASA proceed to fund Dragonfly, the APL mission concept to explore the Saturn moon Titan with a nuclear powered dual-quadcopter looking for the ingredients for life? Will Johns Hopkins revolutionize national healthcare on a foundation of APL-developed data analytics and technology integration? However the future unfolds, APL will continue to be at the forefront of making defining innovations to ensure the nation's preeminence.

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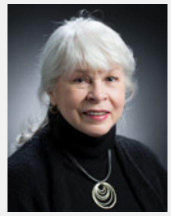

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