THE STORY OF CNA

Civilian Scientists in War and Peace

Don Boroughs

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‘It is hoped that operations research in peacetime fields will be carried on in the next few years to investigate how … this aspect of science can be as valuable in peace as in war.’

Philip Morse and George Kimball
Methods of Operations Research

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1942 – 1945
Bringing Scientists to the Fight

In the first half of 1942, the Atlantic seaboard of North America came under an attack unlike any the coast had seen before. German U-boats prowled shipping lanes from Newfoundland to the Caribbean with impunity. In six months, those submarines sent more than 400 ships to the ocean floor. U-boats cruised so close to the mainland that they could use the lights of New York and Boston to silhouette their targets. Homes along the Outer Banks of North Carolina rattled as torpedoes exploded against American freighters.

A physics professor from the Massachusetts Institute of Technology also felt the U-boat threat up-close. In March of that year, Philip Morse rode the ferry from Delaware to Newport News, Virginia, and was taken aback to see a struggling tanker, its bow torn

open by a German torpedo. He had spent several months trying to use his expertise in acoustics to develop technology for the war effort, but had grown frustrated with the way civilian scientists were pigeonholed by the military. He knew that science could also address tactics, operations and strategy, but officers refused to discuss such secrets with academics. Morse later recalled that as he gazed upon the torpedo victim, "I wondered then who was analyzing the crucial U-boat threat."

Actually, no one in the U.S. government or scientific community had been assigned such an analysis. That would soon change. Just days later, the 38-year-old physicist was summoned to see Capt. Wilder Baker, commander of the newly formed Antisubmarine Warfare Unit of the Atlantic Fleet. The no-nonsense officer was desperate to break with tradition and bring to the fight a team of "outstanding men . . . experienced in utilizing the abstract as well as the material tools of science in solving such problems." It was a meeting that would help change the course of the war. On April 1, 1942, Philip Morse reported to the First Naval District headquarters in Boston and began the task of assembling "Group M."

In the following 75 years, the organization that he founded would grow and evolve into the independent research organization CNA. Through three-quarters of a century, the name on the letterhead would change many times (See box, p. 5),

as would the group's academic sponsors (See box, p. 12). And the range of research topics continually expanded from a pure focus on antisubmarine warfare in 1942 to all elements of Navy and Marine Corps operations and later to such civilian interests as public health, justice, and homeland security. CNA today advises military, federal, state and city leaders from the Pentagon to Pensacola.

Still, after 75 years of evolution, the core elements of CNA research would be immediately recognizable to Morse. Success in solving problems still depends upon analysts getting close to the data — often by gathering it themselves. Researchers still develop theories that must be rigorously tested, with quantitative data whenever possible. And they continue to maintain the independence of their analyses while working side-by-side with those who will benefit from their solutions. The story of CNA is one of both change and constancy. The mission shifts with the needs of the nation. The approach never wavers.

Already, in the formative year of 1942, Morse and his fellow scientists shaped those essential processes that would guide CNA for the next 75 years. When the emerging team of three scientists was shown to a roomful of reports from unsuccessful U-boat hunters — with the expectation that this would keep them busy for weeks — the analysts glanced at just a handful. As physicists and mathematicians,

what they wanted, rather, was a week to think about the problem of antisubmarine warfare and to come up with a theory. The resulting theory of search would be refined into a cornerstone of naval strategy that would be used for decades. They called their science — a new field on this side of the Atlantic — "operations research," and its starting place would always be a theory that could be tested quantitatively against data.

But what data? Returning to the sub-hunters' archive, they saw that the haphazard reports were useless to them. Search theory could maximize the number of U-boat targets found by recommending flight patterns, altitudes and plane spacing, but only if they could be certain of the precise spotting range of planes under a variety of conditions. "We believed our theory, we didn't believe the reports, and we wanted more data," recalled Morse. "We wanted to get as close as possible to the operation we were studying."

Within a month, Morse had assembled seven scientists into the Antisubmarine Warfare Operations Research Group (ASWORG), enough to propose the "heretical" idea of sending several of these civilians to Navy sub-hunting bases. Facing resistance, the headstrong professor held his ground until Capt. Baker relented. The five analysts who headed out into the field by July were the vanguard for future generations of CNA analysts who have ventured out to the source of the data, whether in

the inner cities of America or the deserts of the Middle East. CNA field representatives have stood at the side of military officers in every war and operation since, and dozens continue to serve each year on sea and shore.

Despite the skepticism that greeted the tweedy scientists, the data they were able to gather working with pilots on the ground and in the air refined the theory of search into plans that significantly increased the number of U-boat sightings. The group's mathematical work on search was so valuable to the military that the resulting book, *Search and Screening,* was not declassified until more than a decade after the war.

Search was only step one in the equation; just 2 percent of attacks on U-boats scored a kill in the first half of the year. Although U-boats tried to dive as planes approached, ASWORG analysts questioned the value of dropping depth charges to explode as deep as 75 feet. British depth charges

Expanding Missions, New Names

ASWORG, Anti-Submarine Warfare Operations Research Group	1942
ORG, Operations Research Group	1944
OEG, Operations Evaluation Group	1945
Center for Naval Analyses	1962
CNA Corporation	1990

had been calibrated to explode closer to the surface. Mathematical analysis showed that by the time a sub reached a depth of 75 feet, it was virtually impossible to guess in which direction it had moved. Air-attack doctrine was changed to ban attacks on U-boats submerged for more than 30 seconds. In addition, ASWORG's director of research, physicist William Shockley — who would later go on to win a Nobel Prize for his work on transistors — advised that the depth charges should be set to detonate at just 25 feet. The kill rate for subhunting planes went up by a factor of five.

Such dramatic improvements were not the rare exception for Morse's men. In fact, Morse defined success in operations research as "improvements by factors of 3 or 10 or more." Navy officers recognized those results. Morse's analysts were soon in such demand that he created a policy that allowed them to be sent out to bases by request only, and limited their stays to a maximum of six months.

The hounded U-boats largely retreated from the American coast by August of 1942, but ASWORG followed the effort across the oceans. By repeatedly helping to update technology and tactics, ASWORG researchers, in conjunction with their British counterparts, helped turn the tide of the war at sea. Barely a year after Capt. Baker had warned, "The Battle of the Atlantic is being lost," the Allies were sinking U-boats faster than they were losing freighters.

Morse's war efforts expanded from antisubmarine warfare in the North Atlantic to a variety of Navy operations across the globe. ASWORG became just one part of Morse's Operations Research Group (ORG), based at Navy headquarters in Washington. In Recife, Brazil, for example, a Ph.D. chemist named Jacinto "Jay" Steinhardt brought search theory to a U.S. Navy base that was trying to intercept five German freighters loaded with enough tin and rubber from the Pacific to meet the needs of the Nazi war machine for another 18 months. Despite having to blockade a 1,500-mile swath of the South Atlantic — as wide as the gap between New York and Dallas — with fewer than a dozen search aircraft, Steinhardt's rigorous search plans helped the Navy spot all five blockade runners, sinking three in as many days.

In the Pacific, Morse's analysts worked out flight tactics to avoid flak, and they developed ship maneuvers to foil kamikazes. They evaluated newly developed radars and helped seamen and flyers to make the best use of the technology. By the time Japan surrendered, the group had grown to more than eighty.

In *The Operations Evaluation Group*, Keith Tidman writes that the group had been assembled from "physicists, mathematicians, chemists, biologists, geologists, actuaries, and even a chess champion." Now they were all operations analysts. Rear Adm.

Charles Weakley, who had witnessed the group's work in both the Atlantic and the Pacific, later said, "I have seen it save lives and material for which there is no price."

1945 – 1950
Vital in War, Valued in Peace

With the end of the war in 1945, many scientists like Philip Morse were eager to return to the academic life they had left behind. Since many groups established for the war effort were being shut down, that seemed a likely prospect. But what had started out as a wartime experiment, driven by desperation, was now a critical asset for Navy officers like Adm. Ernest King, Commander in Chief of the U.S. Fleet.

King was famously ill-tempered and sharp-tongued, accumulating enemies as rapidly as he notched up naval victories in the war. But he had a soft spot for the civilian scientists. He argued for "uninterrupted continuation" of ORG in peacetime, because, "The complexity of modern warfare in both methods and means demands exacting analysis."

King got his wish, and the civilian scientists were backed with a three-year contract. Scaled down to a peacetime cohort of 25 scientists, the organization was renamed the Operations Evaluation Group (OEG), to draw a clear distinction between the civilians and the uniformed Office of Naval Research. OEG continues to this day as an important part of CNA's Center for Naval Analyses.

The nonstop pressure of the war was behind them, and the remaining members of Morse's group used their first year or so to recap the lessons of the war in seminal books and reports that would be read for decades. The compilation of such after-action assessments of lessons learned is a role that has continued to distinguish CNA after every conflict since. Morse and George Kimball wrote *Methods of Operations Research*. Bernard Koopman, a Columbia University mathematician both before and after the war, painstakingly drafted and revised *Search and Screening*, writing in pencil, erasing, and rewriting until each page "looked like a patchwork quilt."

Both books were required reading for new analysts even 40 years after publication, recalls Mark Lewellyn, who worked at CNA for more than three decades beginning in 1970. "Those were the foundational documents," says Lewellyn. "The basis of our work is all math and physics, which haven't really changed."

Morse eventually returned to his professorship at MIT, but his approach to science was forever changed by his experiences in the war. Despite resistance, he convinced the university that operations research was an important new field of academic study, and in 1953 he founded MIT's Operations Research Center, which is still active today. Morse saw potential for this field far beyond the military realm and conducted research applying its methods to civilian communications, transportation and city planning.

For his replacement, Morse fingered Jay Steinhardt, who had made his name in Recife, Brazil, as the analyst behind the blockade of German supply ships. By the end of the war, he was leading ORG's division focused on protecting airmen, AirORG. Steinhardt's exacting standards solidified OEG's reputation over the 16 years that he remained as director. But he could be a tough boss. He weeded out weaker members of his staff with scientific regularity, at least 6 percent per year.

Former analysts who worked under him recall that he was also obsessive about the independence of his analysts from the influence of naval officers. "Jay used to beat it into us that we weren't going out to entertain them or to be friendly," says Phil DePoy, who joined in 1959 and eventually rose to lead CNA. He remembers the director saying that an OEG analyst was "'the one person who can stand up to leadership and tell them they're wrong,'" and, "'If

everyone says what a great guy you are, you're not doing a good job.'" In fact, DePoy once told an interviewer, "The one time [Steinhardt] visited me in the field, I warned everyone not to say anything nice about me!"

The Navy didn't seem to mind that Steinhardt's men weren't trying to be chummy. OEG was soon fielding more projects than it could handle. Analysts studied the effects of mine-laying on submarines and the advantages of faster cargo ships. They led the research on the operational requirements for a long-range interceptor aircraft and produced calculations on the maximum effective range of new air-to-air missiles. By 1948 Adm. Jerauld Wright was arguing for OEG's expansion from 25 to 35 scientists, "because the value of the group to the Navy Department is now so well-known as to require no further explanation."

Guardians of Independence
Academic and Institutional Sponsors

Columbia University	1942–1945
Massachusetts Inst. of Technology	1945–1962
Franklin Institute, Philadelphia	1962–1967
University of Rochester	1967–1983
Hudson Institute, Washington	1983–1990
CNA, independent	1990–

Among the new hires, Steinhardt added the group's first economist. He later came to regret that OEG had not engaged economists earlier. He said in a 1962 speech, "If we had had the early tradition of a sophisticated approach to the allocation of economic resources, we would have more often made significant contributions to the formulation of weapon requirements than we actually did."

The group maintained strong linkages to MIT for 17 years following World War II. The university held the Navy contract for OEG's services, one in a series of universities and research institutes that would manage the organization's contract until CNA's independence in 1990. (See box, p. 12) MIT was more than just a paymaster. Professors traveled from Cambridge to Washington annually to give seminars for analysts. Steinhardt himself was a weekly rail commuter, teaching two days a week at MIT during the academic year and devoting three days to OEG.

The three-part structure that is still visible today within OEG became entrenched in this period. Field representatives rotated in and out of commands at sea and on shore. A home staff of analysts worked on studies from OEG's headquarters, which had recently moved to the Pentagon. And Scientific Analysts supported the eight "desks" within Office of the Chief of Naval Operations (OpNav). The goal was to have two analysts embedded with each desk:

Antisubmarine, Submarine, Radar, Guided Missiles, Antiaircraft and Gunnery, Atomic Energy Warfare, and the Tactical and Doctrinal Publications Panel. The Scientific Analysts at that time accounted for about half of OEG's scientific staff.

OEG's headcount continued to creep up with the Navy's needs for analysis, reaching a total staff of 60, including 40 scientists, at the dawn of the 1950s. Still, budgets were tight, and OEG maintained just a skeletal field program, primarily supporting weapons testing at the Operational Development and Evaluation Force. Necessity would soon drive the civilian scientists into the field again.

1950 – 1953
On Land and Sea in Korea

On June 25, 1950, South Koreans awoke to artillery fire as the Korean People's Army of Kim Il-Sung, supported by China and the Soviet Union, crossed the 38th parallel. Within a day, the United Nations passed a resolution calling for members to "repel the armed attack," and Gen. Douglas MacArthur was authorized to fire on North Korean troops. But by August, South Korean, U.S. and other U.N. forces were backed into a corner of the peninsula, holding a mere 10 percent of South Korean territory.

The Operations Evaluation Group responded immediately. All vacation and academic leave was canceled. Analysts were sent to Pearl Harbor to support the Commander in Chief, Pacific Fleet, and to Japan to support the Commanders of Naval Forces in the Far East. They served on combat ships and ashore in Korea with the First Marine

Air Wing. Over the course of the three-year war, OEG would grow by 50 percent.

The analytical needs of the Navy during the Korean War bore little resemblance to those of World War II. The United States and its allies easily dominated the Sea of Japan and Yellow Sea. Submarine warfare was largely irrelevant. But the Navy was called upon to support land forces in ways that led to unfamiliar analytical territory. Battleships rained nearly a half-million artillery shells onto the land, and bombarded analysts with data as they worked to improve the effectiveness of the batteries. Navy and Marine aircraft flew deep inland in close air support. The analytical scrutiny of those flights led to the first and only death of a CNA analyst in combat. (See box, p. 20.)

Despite its naval superiority, suspicions abounded within the U.S. military that the naval blockade around the peninsula was dangerously leaky, that North Korea's troops were being moved and resupplied by sea. The Navy was under growing pressure to devote even more of its precious resources to the blockade. OEG analyst John Pellam, an ASWORG veteran who had led the analysis for a blockade of U-boats at the Strait of Gibraltar, took on this contentious issue. He amassed radar data from Neptune patrol planes and sightings from patrol boats. Even under the most pessimistic assumptions, his mathematical

models revealed that sea routes could supply a mere fraction of the materiel reaching the hundreds of thousands of North Korean troops. Clearly, the interdiction effort needed to be redoubled not at sea, but on land.

Data contradicted instinct again when analysts Douglas Brooks and Origen Bingham studied tactics to minimize the losses of aircraft and their crews. Among the many questions they addressed was the relative risk of planes in different positions within an attack formation. Many pilots assumed that the last plane was the most vulnerable to antiaircraft fire, but the OEG analysts revealed that the opposite was true. Their recommendations led to changes in air tactics to reduce the risks to airmen.

One study had an impact that eventually spread far beyond the military. Congestion at the Korean port of Pusan was a logistical bottleneck for U.S. forces. David Boodman, an analyst who was working with OEG colleagues John Everett and Roger Crane in Pearl Harbor, recalls in *The Spirit of OEG* that a commander visited them with a request. He had a roomful of forms detailing the movements and unloading of ships at the port of Pusan. Could the analysts turn the data into some useful advice that would improve logistics? The challenge became Everett's obsession, as Boodman relates:

> John Everett was a very taciturn fellow. Roger and I ignored the fact that he sought no help from us on this project. It was clear that the shipping problem was fully occupying John's attention, and that he was grimly determined to crack it. It became increasingly difficult to get John's attention on other matters, so wrapped up on this project was he. Then came the Eureka moment. It was on an afternoon when the three of us were at our desks at SubPac Headquarters that John asked whether anyone had a copy of Feller's Probability Theory. You could tell from John's demeanor that he had made a leap toward the solution.

Everett had remembered that the last chapter of that text described queuing theory, developed for the study of early telephone networks but long-since forgotten. He had recognized the parallels between routing calls and routing ships. Everett's resulting study not only provided guidance to the Navy on easing bottlenecks in ports, it introduced queuing theory into operations research. Fifty years later, CNA analysts are still using queuing theory to solve problems. In the past five years, for example, Neil Carey used queuing theory to analyze the medical treatment of casualties and Annette Matheny published *Using Queuing Theory to Model Ship Refueling Problem*. When Everett's work on queuing theory was made public in 1957, according to Boodman: "Applications to traffic systems, supermarket check stands, and myriad other service systems filled the journals."

In the course the war, the technological and tactical superiority of U.S. forces began to overwhelm the North Koreans, until the insertion of more than a million Chinese troops led to a military stalemate back at the 38th parallel. Three years after the invasion, the warring sides signed an armistice.

A Singular Life

By the age of 28, Irving Shaknov already had more honors than most men could ever hope for: a Bronze Star for Valor in World War II, a Ph.D. in physics from Columbia University, and a paper published in the prestigious *Physical Review*, describing an experiment he and his professor had conducted that would become known as one of the seminal tests of quantum physics. Another honor lay ahead, one that no one could ever wish upon such a promising young man.

Soon after completing his dissertation in 1951, Shaknov joined the Operations Evaluation Group, the organization that would become CNA. By the next year, he was on his way to join other OEG analysts supporting U.S. forces in the Korean War. The civilian scientists had already played a key role by developing mathematical models that disproved the assumption that North Korean troops were largely being resupplied by sea. Now Shaknov and others were collecting and interpreting data on the most effective methods of cutting off supply routes on land.

The OEG analysts had calculated that Marine Corps night-fighters flying at extremely low altitude were very effective at hitting supply trucks, but the squadrons had a difficult time finding enough targets. To gather the data needed to address this problem, the physicist, known to his colleagues as "Spike," flew on a mission deep into North Korea on the night of May 14, 1952. He took the radar operator's position in the two-seater.

As the black Tigercat fighter strafed a North Korean truck convoy, an antiaircraft shell hit one of the plane's engines. The OEG analyst was unable to eject before the plane crashed. Though CNA analysts have served in forward deployment in every major conflict involving U.S. troops since World War II, Irving Shaknov remains the only CNA analyst to be killed in action. He was posthumously awarded the Medal of Freedom, and his family accepted his final honor. Today, his portrait hangs in the Irving Shaknov Conference Center at CNA's headquarters.

1953 – 1963
The Cold War and the Creation of the Center for Naval Analyses

This time, the end of combat did not cause the Navy's analytical organization to shrink. The chill of the Cold War overshadowed the tentative peace in Korea. Over the course of the 1950s, the Soviet Union's stockpile of nuclear weapons would multiply from 5 to more than 1,600 warheads. Busy with the task of assisting the Navy in deterring this threat, OEG would grow steadily through the rest of the decade.

Phil DePoy, who was hired in 1959 with a master's degree in nuclear engineering and partway through his Ph.D., says that in that era, "Navy strike forces were mostly about nuclear delivery, and so any time

they were deployed overseas, it was as if they were in combat. Day and night they were conducting drills and exercises, and there was loads of data to be analyzed."

One reason for the Navy's heightened preparedness was a 1958 OEG study projecting that the balance of nuclear forces in the early 1960s would leave the United States in a weak position to deter a Soviet attack. Keith Tidman describes the response to the study in his definitive 1984 history, *The Operations Evaluation Group*:

> Word of this prediction entered the political and public arenas, causing a considerable stir. The notion of a "missile gap" suddenly bounded onto center stage. … A point easily lost in all of this, especially in light of the alarmist rhetoric that prevailed over the next few years, was that the study had in fact proposed stopgap measures to fill the supposed vacuum.

One of those measures was the increased preparedness of Navy aircraft carriers for a nuclear strike, a contingency that became frighteningly real for DePoy. In the North Pacific on the USS *Kitty Hawk*, the 28-year-old analyst was jolted awake in the middle of a November night in 1963 and summoned to meet with Rear Adm. Thomas South and his three senior officers. The admiral had just received a back-channel message: "President assassinated. Stand by to elevate DEFCON." Given

the possibility that the killing was a Soviet act, South understood that his ship was to prepare to launch a nuclear attack.

The commander told a senior officer to wake the air wing and weapons group to prepare an "exercise" with nuclear weapons loaded. "Think of what we might be missing," the admiral charged DePoy. While pilots were briefed on their targets and the crew scrambled to load the weapons onto jets, DePoy had 15 minutes at his desk to think through everything that could go wrong in the attack.

The image of Jay Steinhardt came to his mind, and DePoy felt chagrined that he had never before addressed the question of how Soviet submarines prowling nearby might react to the two moves that immediately precede a launch — turning the carrier into the wind and accelerating — if they suspected an attack. He approached the admiral on the bridge and was starting to offer his suggestion to conceal the dual maneuver by turning immediately and delaying acceleration until just before launch, when instructions arrived to stand down — the Soviets had not been involved in President Kennedy's assassination.

Some Cold War analyses bore remarkable similarities to analyses performed in the first days of ASWORG. During the Cuban Missile Crisis in 1962, OEG drew on its experience with search theory and blockade planning to help the

Navy devise the blockade of the island. OEG also helped monitor its success, determining that the surveillance had detected 86 percent of merchant ships traveling from Europe to the Caribbean and that land-based patrol aircraft had made more than half of those observations.

But the analysis organization also demonstrated more clearly than ever its ability to flex and adapt to the nation's defense needs. The ad hoc support that OEG had provided to the Marine Corps for years was formalized in 1962 with the creation of the Marine Corps Operations Analysis Group. With its own budget under an amended contract, the group was able to expand support for the Marine Corps. Fifty-five years later, the renamed Marine Corps Program continues to be an important part of CNA.

Similarly, the formation of the Economics Division, more than a decade after Steinhardt hired his first economist, signaled a deeper commitment to the economic effectiveness of the Navy's long-term planning. A raft of economists blown in from the University of Chicago were kept very busy after the appointment in 1961 of Robert McNamara as Secretary of Defense.

McNamara was determined to imprint his stamp of budgetary responsibility and accountability on the military. He had a great appetite for the kinds of cost-benefit and manpower analyses the Economics

Division could produce. On the 20th Anniversary of OEG in 1962, McNamara wrote to Steinhardt, "I am pleased to note that, as the oldest organization of its kind in the country, you have managed to preserve the adventurous spirit of youth in your endeavors." The legacy of the Economics Division lives on in CNA's Resources and Force Readiness division. Today, 15 percent of the analysts working in support of the Department of Defense are economists.

To further support long-term planning needs, the Navy and Steinhardt had cooperated to create the Naval Warfare Analysis Group (NAVWAG) back in 1956. Intentionally somewhat detached from OEG's commitment to address the Navy's immediate needs, NAVWAG focused on plans for a decade or more in the future. For example NAVWAG analysts produced studies on the concept of using tilt-wing aircraft to deliver Marines ashore more than 25 years before the first V-22 tilt-rotor aircraft was built.

Steinhardt also got permission to set up a separate group that would specialize in basic research, ultimately named the Applied Science Division (ASD). Based in Cambridge, Massachusetts, it launched in 1960 with a three-year budget to support 30 scientists in fields such as aeronautics, electronics, space technology, communications and nuclear propulsion.

By 1962, however, the alphabet soup of analysis groups, OEG, NAVWAG and ASD — compounded by another research organization established by the Navy, the Institute for Naval Studies (INS) — had become unwieldy. The solution was to amalgamate them all into one body named the Center for Naval Analyses. For the first time, the initials "CNA" became associated with analysis for the U.S. government.

In time, the various components would become so fully integrated as to become unrecognizable, but the expanded mission endured. The strategic policy emphasis within INS and NAVWAG, for example, was a wholly new direction that saw political scientists rubbing shoulders with the quantitative analysts of OEG for the first time. That legacy can be seen today in CNA's Strategy, Policy, Plans, and Programs division, as well as the China and Indo-Pacific Security Affairs division.

In the gap between two wars in Asia, a much more comprehensive defense analysis organization had been developed under the direction of Steinhardt. Now he decided it was time for him to "retire" to academia. For the Center for Naval Analyses, it was time to gear up.

The First Female Analyst

There was little fuss in 1964 when Erv Kapos hired the first woman analyst. Marjorie Greene just thought the job description looked like a good use for her master's degree in mathematics. And Kapos had wondered, "'Why don't we have any women around here?'" says Greene. "I just happened to be a woman on an OEG team of men."

Still, an ordinary field billet was out of the question in the 1960s Navy. Greene was assigned to The Navy's command-and-control center in the Pentagon, where she analyzed message traffic. Three years later, she had moved to London and began an international career, largely at banking think tanks. Still, she retained such fond memories of her years at CNA that in 2010, more than 40 years later, she returned to a part-time role with her first employer. She marvels at the number of women at CNA today. (Currently, more than a quarter of CNA's analysts are women.) And, perhaps forgetting that she was hired in her mid-20s, adds, "They seem so young now."

1964 – 1970
Protecting Aircrews in Vietnam

Just as OEG had flexed to support the Navy's new nuclear role, the organization adjusted its sights again when the Navy found itself conducting a war of conventional weapons in Vietnam. DePoy and senior analyst Howard Kreiner were deployed with the Seventh Fleet in the war's earliest days, and they flew from carrier to carrier advising weapons planners — steeped in nuclear weaponry — on conventional strike planning. Before long, dozens of CNA analysts were working on problems emanating from Vietnam, many of them in the Southeast Asia Combat Analysis division CNA set up in 1967.

Losses of U.S. planes began to mount quickly, and the effort to reduce those casualties consumed much of CNA's effort throughout the war. In 1964, the Soviet Union began supplying North Vietnam with thousands of SA-2s, its latest surface-to-air missile. "SA-2s when they first appeared were truly frightening, and they were taking out significant numbers of aircraft," says Bruce Powers, who was an analyst of Navy aviation in Vietnam. The recommended solution was to fly below the SA-

2's range, which led to devastating losses from antiaircraft artillery and machine guns.

When pilots began to report that they could outmaneuver SA-2s, however, CNA analysts gathered data to help them refine those tactics. A test site was set up at the China Lake Naval Ordnance Test Station in the Mojave Desert, pitting North Vietnamese radar equipment against U.S. pilots to improve survival rates against SA-2s. The hit rates for those missiles fell by more than two-thirds in three years, from 1 for every 15 missiles launched to 1 for every 48 launched.

Powers devoted much of the war to an analysis of hundreds of search-and-rescue operations for those air crews who were caught by enemy fire. One key element was to identify time sequences and steps in the process that could be sped up. "If you could cut the communications interval from 'mayday' to the alert of the rescue force from 12 minutes to 4 or 5, the rescue rate would increase noticeably," he says. In all, 46 percent of crewmembers who survived the downing of their aircraft in combat or a combat-associated event were rescued. Powers says that his assignments in Vietnam were the most valuable work of his career, "because I actually believe the analysis that I did saved lives."

OEG analysts in Vietnam avoided the fate that met Irving Shaknov in Korea, but danger was never far

away. Nicolai Timenes was sent to a hospital with burns when the USS *Oriskany* caught fire, a tragedy that killed 44 sailors. And a helicopter transporting Jim Wilson and several others from the city of Danang to a carrier crashed into the Gulf of Tonkin. By the time Wilson clawed his way out the door of the sinking helicopter, he was ten feet underwater and had lost his life vest. Years of swimming as a child and the instinct to head for the light kicked in. Wilson made it to the surface and managed to tread water until a boat lowered from a nearby destroyer picked him out of the sea. He lost only his passport and his typewriter. One other passenger went down with the helicopter.

In future years, Wilson became the director of what CNA then called the Strike and Amphibious Warfare Research Department. He recalls that sometimes when flying to or from an exercise or operation, other analysts would ask to ride in the same helicopter with him, "'because Jim's already had his crash.'" As a rational, scientific analyst, he would always dutifully remind his colleague that statistical probabilities offered no such assurance.

Seeing Spots

As always, thinking outside the box was a core competency for CNA analysts during the Vietnam War. When the Navy was troubled to find that its underwater mines were apparently detonating randomly in North Vietnam's Haiphong Harbor, it asked CNA for assistance. Were Chinese minesweepers to blame? The mystery perplexed everyone until analyst Don McGibney noticed the crackling of a radio broadcast signal while driving one day in Hawaii, where he was embedded with the Pacific Fleet. The physicist surmised that if the recent increase in sunspot activity could disturb magnetic fields enough to mess up his radio, it could set off a magnetic mine. His theory and calculations were briefly rejected as outlandish, before the Navy acknowledged that he had solved the riddle. That single epiphany made McGibney a legend among analysts.

1970 – 1990
Seeing through the Cold War

Troop numbers were drawing down in Vietnam as a new decade dawned, but for the Center for Naval Analyses, the 1970s launched with a rocket blast. The rocket's name was Adm. Elmo "Bud" Zumwalt. The new Chief of Naval Operations was a man who, by his own description, liked to take "big bites." On July 1, 1970, Zumwalt was sworn in with a promise to present within 60 days an agenda for transforming the Navy. The resulting Project 60 depended in part on insights from a team of analysts in CNA's Systems Evaluation Group. DePoy, who headed that group, and OEG Director Erv Kapos personally gave a series of briefings on Navy capabilities to Zumwalt in the following weeks. By September, Zumwalt had laid out 52 discrete initiatives to revolutionize the Navy and take on the rising Soviet fleet. In a CNA retrospective study of Project 60's impact, *On His Watch,* analyst Jeffrey Sands called it, "an effort without precedent in U.S. naval history."

When those 60 days were over, the Navy kept CNA busy with many years of work in the development, acquisition and deployment of some of the hardware

influenced by Project 60, which included the Mark III Seahawk helicopter and the Harpoon anti-ship missile. Zumwalt, a former director of the Navy's Systems Analysis Division, had deep experience with CNA and had even set up a cell of active-duty officers within CNA, the Officers Study Group, to improve the Navy's connections to CNA's analytical support. It lasted for more than three decades.

That same year, Zumwalt also turned over to CNA the Navy's Tactical Analysis Group, which had been managed by several contractors since it was established in 1966. In one wave, CNA's field program was nearly doubled by taking on the group's 23 analysts. Their primary role had been antisubmarine warfare, a natural fit for CNA since 1942. The USSR's nuclear-armed submarines were an all-consuming threat to national security at the time. As many as 40 CNA analysts were working on antisubmarine warfare at any one time during the Cold War.

Yet another 1970 assignment for the analysis organization — also backed by Zumwalt — felt much less familiar. The Assistant Chief of Naval Operations in charge of intelligence enlisted OEG to develop a system of analysis applied not to U.S. forces but to the Soviet Navy — "Red-Side" operations analysis. Tidman writes: "There was no tradition of operations analysis of the Soviet navy; much of the group's work therefore had to start from scratch."

By the end of the year, CNA's Red-side Operations Analysis Section consisted of eight civilian scientists and eight naval officers. Within two years, they published "Red ATP-1," a description of Soviet Naval tactics that was distributed throughout the fleet. The director of Naval Intelligence, Rear Adm. E. F. Rectanus observed:

> The reaction to "Red ATP-1" has not only been extremely favorable, but, in more than one case, efforts are being made cooperatively to improve our knowledge of Soviet operating patterns and tactics. This linkup between user and analyst is more desirable and will further the already broad interface between OEG and the fleet, a historic relationship that is unique among the services.

"Red Cells" were soon an expected part of the CNA analysis of any naval exercise. Marvin Pokrant wrote about the experience in his book *Journey to Serendip, Accidental Adventures of a Naval Operations Analyst*.

> The Red Cell gathered all data the Soviets were likely to obtain and tried to think like the Soviets. …One part of the Red Cell estimated the data that would be available to the Soviets and passed that to another, isolated, part of the Red Cell that made the deductions from the information. … The Red Cell also estimated the data the Soviets might gain from their satellites and radio interceptions. Information available from these sources would depend on how the battle group

> operated. If they didn't use radios that could be intercepted, no radio intercept information would be available. … Battle groups learned to do a lot of things without giving information to the Soviets.

Though the threats and potential adversaries have changed, Red-Team analysis remains an essential part of CNA's work today.

For the parts of CNA that were focused on long-term strategy, the role of aircraft carriers in the Cold War was a dominant theme in the 1970s and 1980s. Retired NAVWAG analyst David Perin discussed this work in an interview with StoryCorps. The prevalent concept of a war with the Soviet Union at the time was a conflict on land. Perin says: "One of the central features of that conflict would be major armies clashing in Central Europe, so what was the Navy doing? What would the carriers do?"

But new intelligence about Soviet plans suggested that the oceans might actually be at the center of such a war.

> In a surprise attack, the Soviets would seize Iceland, and it created a whole bunch of problems for us. We needed to go back and take back Iceland. In order to do that, you had to achieve air and sea superiorities, and lo and behold, you needed the carriers and eventually the Marines to do that.

Elements of this strategic analysis would one day

emerge in the book that Tom Clancy wrote with former CNA analyst Larry Bond, *Red Storm Rising,* which envisions a superpower war over Iceland. President Ronald Reagan once recommended the novel to British Prime Minister Margaret Thatcher as a window on Soviet strategy.

There were many other aspects to CNA's aircraft-carrier work. When Congress requested an analysis of future carrier roles, Adm. Carlisle Trost relied heavily on CNA analysis for his 1978 Sea Based Air Platform Study. The next year, Congress authorized a new nuclear-powered carrier.

The 1970s also marked the dramatic birth of a CNA specialty that has endured through today: open-source analysis or "literary intelligence." CNA Sovietologist James McConnell, assisted by analysts Robert Weinland and Bradford Dismukes, perused Soviet naval journals and other Russian-language publications and gleaned remarkable insights by reading between the lines. McConnell explained the process in a CNA annual report:

> Because of its obliqueness, [Soviet open literature] is not easy to read and interpret. To be successful, the analyst has to constantly bear in mind certain Soviet communications techniques: the tendency to imply rather than state; the use of elliptical logic and expression; the avoidance of sustained arguments; the failure to highlight noteworthy items or new points.

What those writings implied was that the Soviets had changed their naval warfighting plans in the 1970s in a way that the U.S. Navy had not anticipated. The Americans were preparing to fight a version of the U-boat war — though vastly more sophisticated and destructive. They naturally expected their adversary to try to cut sea lanes across the open oceans. But CNA analysts argued that Moscow was actually planning to devote its Navy to protecting its decisive assets, ballistic-missile submarines, in "bastions" close to home.

"Though some of these studies clearly proved remarkably prescient, their authors were for some time prophets without honor in their own country," former Navy officer and CNA analyst Peter Swartz later wrote. In fact, Dismukes recalls being told that one admiral had asked, "What are those guys smoking over there?" Both the suggested naval strategy and the analytical process that CNA used to uncover it were too radical at that time for the Navy to accept.

That all changed when the Navy's own secret intelligence effort yielded intercepts confirming the Soviet Union's bastions strategy. Plans to counter these bastions became a foundation of the U.S. Maritime Strategy of the 1980s — a development that required still more work from CNA analysts. The Department of Defense has made use of CNA's open-source insights in subsequent decades.

But CNA's role was also expanding beyond military strategy, tactics and hardware. Developments in manpower made new demands on analytical expertise. President Nixon had established the Gates Commission in 1969 to study whether the military could effectively operate as an all-volunteer force. CNA was one of the commission's three consulting organizations, and David Kassing, then the head of CNA's personnel research program, was a commission research director. Their 1970 report led to the end of the draft.

It was the implementation of this all-volunteer force that would truly absorb CNA's attention. In an interview with StoryCorps, retired analyst Bill Sims recalled what it was like doing manpower research in that era:

> It was what in the military we would call a "target-rich environment." The draft had just ended. And the recruiters were having a really hard time making it, because now they actually had to go out and find people, and they didn't know how to do it.

Sims devoted five years in the 1970s to solving a mystery presented to him by a Marine Corps commanding general in charge of recruit training. Aptitude-test results reported that the latest intakes had been the brightest ever, but training results suggested otherwise. Through analysis, Sims not only identified calibration problems with the test, but he also used

internal consistency indices to pinpoint recruiters who had been padding their results by teaching the test to potential recruits. He was even asked to represent the Corps on a joint service working group responsible for the test. In time, the quality of recruits improved dramatically.

> We were able to fix that through the incredible cooperation we had with the Marine Corps. It was a real team effort. Neither of us could have done it by ourselves, but together we got it done. … It's one thing to write a study report and ship it out and say, "Hey, there's an answer, boys. Take it." And it's another thing to actually be there where you can make things happen. And because the Marine Corps was willing to put us in a position like that, we could do that.

CNA had its own manpower problems in that era — and a womanpower solution. Phil DePoy, who became the head of OEG in the 1980s, explains:

> After Vietnam, it was a tough time to recruit. There was a lot of anti-military sentiment among young people. But there also were very well-qualified women who were very interested. We hadn't hired women as analysts because they were not able to live on board Navy ships or even to visit ships for more than a day or so, and hence were unable to gain the experience they needed. We finally reached an agreement among the OEG management that we had to

> hire some women and hope that the Navy and Marines would accept them. It turned out to be the correct decision at the right time. The first group of women we hired did amazingly well.

Many of the women hired in the 1970s and 1980s indeed went on to very distinguished careers. Christine Fox eventually led OEG and even became acting deputy secretary of defense in 2013 and 2014. Nancy Spruill earned her master's and doctoral degrees while working at the Center for Naval Analyses and went on to become the director of Acquisition Resources and Analysis at the Pentagon. And Katherine McGrady is today the president and CEO of CNA.

They sometimes had to fight for equal treatment by the Navy, however. Spruill still keeps a copy of the naval message sent to CNA in 1979 after she was proposed as member of a team to collect logistics data on the USS *Nimitz*. It ended with the words: "…ANTICIPATE MALE MEMBER WILL BE ADDED TO WORKING GROUP TO REPLACE MS SPRUILL." The analyst just stared at it for a while. She recalls thinking, "'I can either sit down and color within the lines, or I can at least try to do something.'"

So Spruill picked up the phone and called the Navy Judge Advocate General's (JAG) Corps to challenge the decision. She phoned day after day. Two days before the team's departure, the JAG Corps left a different message for Spruill: "Be prepared to be a

member of the team."

In six days, as the *Nimitz* crossed the Mediterranean Sea, Spruill attracted shocked stares from the all-male crew. But she received full cooperation as she gathered data and briefed officers on a range of issues, including the sharing of spare parts among flight squadrons. The resulting research helped the Navy successfully supply evidence against a proposal to consolidate squadrons. And Spruill made her mark as the first female analyst to collect data on an aircraft carrier.

Obstacles remained in place for years, however. In the early 1980s, standard procedures allowed women on Navy ships for a maximum of one night, but DePoy was campaigning for his female analysts to observe longer exercises. In 1983 his persistence particularly irritated one senior admiral. "He told me that as long as he lived we would not put women aboard Navy ships for more than overnight," DePoy says. When Fox phoned DePoy soon afterward to say that another admiral had asked her to evaluate a week-long exercise at sea, he said nothing to her about that resistance. Fox recalls, "He just said, 'That's a great opportunity. You should go.'" And so she did.

At the pier, the analyst with a graduate degree in applied mathematics found herself ushered to a roped-off area where sailors' wives stood to watch the departure. Eventually she was found and

taken aboard. Every night for the following week, Fox would brief the commanding officers on her analysis of countertargeting efforts to protect the carrier against Soviet bombers.

Back at headquarters, DePoy was fretting. The admiral who had so recently lectured him about women on Navy ships was on his way to the carrier for an evaluation of the exercise. And Fox would be delivering a presentation to him. DePoy still remembers that his office phone rang at 5:50 that Friday evening. "It was the admiral. After a barrage of bad names that he was calling me, he settled down. But that really broke the barrier, and from then on we were able to get women aboard." In 1993 Congress repealed prohibitions against women sailors on combatant ships, and that year, CNA's Linda Kelsey become the first female analyst to serve a full deployment of several months on a carrier.

Fox became the field representative to the Navy's "Top Gun" aviation school, a coveted field billet that CNA has "manned" for about four decades. She evaluated risky tactics for the "outer air battle," in which fighters would engage Soviet bombers before they could close within firing range of a carrier group. "This was a time that is hard to imagine now. We were sure the next time we deployed, the balloon would go up, and we would be at war," she says. "Fear drove creativity, and CNA analysts were an integral partner with DOD on a lot of technically

rigorous work."

For much of that time, Fox was devising mathematical models for flight plans on Top Gun's Wang computer.

> While the results were getting plotted — kerchunk, kerchunk, kerchunk — out of the old printer, pilots would hear it and come running. They would huddle around the Wang, rip it off the printer and run away saying, 'let's plan flights,' before I could check it. I'd say, 'No! I haven't checked it.' They couldn't do the modeling, but I couldn't do it without their insight.

Around that time, producers and screenwriters were milling about the Top Gun base, refining ideas for a film. Both the lead actress, Kelly McGillis, and the commanding officer had rejected the first couple of ideas for the female lead's career. They needed to come up with a plausible job that would bring her in contact with a Navy pilot. Then someone spotted Fox, and a famous Hollywood romance between a Navy aviator nicknamed "Maverick" (Tom Cruise) and his operations analyst was hatched. Fox coached McGillis a little, and the film *Top Gun* went on to be the box-office hit of 1986. Moviegoers never heard or saw a mention of CNA, however. DePoy had insisted to the producer that the organization's name should not appear, a demand he now calls, "one of the worst marketing decisions in the Free

World."

In 1983, CNA's sponsor had changed from the University of Rochester to the Hudson Institute, the fourth sponsor to supervise the organization in just over 30 years. (See box, p.12) The original intention of keeping the organization under academic and institutional sponsors was in part to solidify the organization's stability, independence and integrity. But in the 1980s, the reality sank in that outside sponsorship was actually becoming a source of instability. DePoy negotiated with the Navy to secure permission to establish CNA in 1990 as an independent nonprofit under a board of trustees. Jamil Nakhleh, OEG's director at the time, says that through this "traumatic" period, "the primary factor that guaranteed the continuing existence of CNA was the integrity of Phil DePoy."

You don't want your analyses from that place

The independence of CNA's analysis remained a top priority in the post-Steinhardt era. Larry Cohan proves that in an anecdote recounted in *The Spirit of OEG*. Deployed with Sixth Fleet in the Mediterranean Sea in the mid-1970s, the analyst was at the side of the gruff Adm. Isaac "Ike" Kidd aboard a carrier when Sen. Gary Hart visited. The senator — known to be skeptical of the utility of carriers — asked Kidd about the potential for Soviet missiles to hit the carrier they were standing on. Kidd began describing a hypothetical attack by 40 missiles and then turned to Cohan, asking, "'Larry, how many of them would hit the carrier?'" Cohan said he would need time to come up with a figure. That afternoon the analyst was summoned to the admiral's quarters.

> Ike was in a rage. With a very red face, he yelled, "Don't you EVER do that to me again. Do you UNDERSTAND? When I ask you for a number, you GIVE me a number. … I don't care if the number has come from one of your ANALYSES or out of your ASSHOLE. You give me a NUMBER."

Cohan stood his ground. "'You're paying me for high quality analyses. I WON'T give you a number from my ASSHOLE.'"

The story ends a few months later — after both Kidd and Cohan had moved on from the Sixth Fleet — in the offices of Charles DiBona, the Center for Naval Analyses president at the time. DiBona told Cohan that he had received "a strange call from Bud Zumwalt" requesting that Cohan be assigned as the Scientific Analyst to Adm. Kidd in his new role at the Pentagon. DiBona went on: "Ike had specifically requested you because, quote, you won't give him anything out of your asshole, unquote."

1990 – 2000
The Era of Independence Begins

The Berlin Wall fell as the 1980s came to a close. The Cold War was over, and the United States was the world's singular military superpower in a time of relative peace. CNA's move to independence was to be DePoy's swan song, conveniently timed in history so that he could depart quietly. Saddam Hussein had other ideas.

CNA analysts had already begun deploying with the U.S. troops to the border of occupied Kuwait by October 1990, when CNA Corporation was established as an independent nonprofit under a board of trustees. It was a time of great change internally. Robert Murray took charge as president

and CEO, after a long career in academia and the Defense and State Departments — including two years as the Under Secretary of the Navy. CNA's offices in Alexandria, Virginia, had to be resupplied from scratch. "Before that, we used to be given everything, from couches to pencils, through Defense Supply," recalls Murray.

Externally, CNA had scrambled dozens of analysts to support the preparatory phase of the war against Iraq, Desert Shield. "CNA turned itself inside out," says Swartz, a historical analyst of the Navy who was then a naval officer. "It was a huge effort." DePoy would stay on as a senior fellow at least until the after-action reports from the Iraq War were complete.

Desert Shield and the subsequent Desert Storm also provided a chance to analyze the combat performance of equipment and tactics that CNA had helped develop and evaluate in simulations. A prime example was the Maritime Prepositioning Force, or MPF. An alternative to delivering Marines to the battle on amphibious ships, the MPF had occupied a generation of analysts. CNA had helped develop the experimental concept and produced more than 50 studies on prepositioning over nearly four decades.

In its first combat test, the 7th Marine Expeditionary Brigade flew from California to Saudi Arabia to meet up with shiploads of equipment and supplies that had been prepositioned in the Indian Ocean

for years, ready for an emergency like this. Just 12 days later, more than 15,000 Marines, their tanks, helicopters and artillery, were in position and ready for combat. They were the first American brigade ready to defend Saudi Arabia from the Iraqi troops massed on the border. The Marines who traveled in traditional amphibious ships, by contrast, took five weeks to arrive.

One analyst embedded with the Marines in Saudi Arabia was a young woman who would one day succeed Robert Murray to lead CNA. Katherine McGrady had already learned how to think like an operations analyst in the two years since she had earned her Ph.D. in chemistry. In one logistics meeting about plans for accommodating enemy prisoners of war, she wondered why the Marines were only preparing for small numbers of prisoners. "One of the things CNA analysts are trained to do is to think about what's not being planned for," she explains. "What are the assumptions that really need to be questioned?"

So McGrady raised her hand to ask about alternative plans for a large number of prisoners, in case masses surrendered. Officers around the table, trained to plan for stiff opposition on battlefield, dismissed her notion. But one colonel pulled her aside after the meeting. "You need to pull that plan together," he told her. "Fold it, and keep it in your pocket."

Later, when a flood of surrendered prisoners did indeed materialize, he was back. "Where's that plan?" he asked. McGrady pulled it from one of the many pockets on her camouflage utility pants. The colonel unfolded it on the table, and said, "OK, here's what we're gonna do."

Some of CNA's most notable contributions took place well after the 20 field representatives had returned from the Persian Gulf. Analysis led by Robin Holliday caused some consternation in the military ranks for its conclusion that far fewer Tomahawk missiles had hit their targets than the U.S. had originally announced. But the Vice Chief of Naval Operations, Adm. Stanley Arthur, responded by commissioning detailed studies from CNA on Tomahawk performance. Holliday followed up with studies through the 1990s on improving Tomahawk performance in the Balkans and Iraq. In 2005, the Navy honored her with its Superior Public Service Award.

As the Navy's lead agency for Desert Shield and Desert Storm data collection and analysis, CNA was buzzing with analysts and officers for many months after the war. The resulting classified study, 14 volumes for the Navy and four for the Marine Corps, "became the primary source material for the Navy's official history and lessons learned from the war, and was used throughout the fleet as the basis for learning from the war's searing experience," according to Swartz.

The end of the Cold War affected CNA on several fronts. As the Navy adjusted to downsizing through the 1990s, the Center for Naval Analyses contributed to projects and studies to minimize the impact on military effectiveness. Manpower and personnel policy analysts were particularly busy with this work. CNA also fielded an analytical support team for the 1993 Navy and Marine base-closing effort.

The Chief of Naval Operations spoke frankly with Murray about the fact that the Navy's budget for analyses would also come under pressure. So the choice for CNA was clear, as Murray saw it, shrink or diversify. Says Murray, "I couldn't think of a reason why smaller would be better."

He began an effort to leverage CNA's expertise in manpower, training and operations analysis for other government agencies. It wouldn't be the very first time that CNA had ventured beyond the military realm. For example in the 1970s, CNA economists had performed significant work for the Department of Labor by request. A name was even created for a non-defense division: the Public Research Institute, or PRI. But each contract had to go through the Navy, since CNA as a whole had a special relationship with the Navy and Marine Corps as a Federally Funded Research and Development Corporation (FFRDC). None of the non-defense work from that time would carry on through the 1990s.

Under the new structure, the independent CNA could keep its FFRDC, the Center for Naval Analyses, while developing separate lines of work without involving the Navy. "I sent out reconnaissance patrols to the domestic side to see where our skills and abilities were pertinent to the problems of domestic agencies," says Murray. For example: "The FAA deals with operational problems; well, we're good at operational analysis."

The Federal Aviation Administration agreed, and in 1991, analyst Igor Mikolic-Torreira, who had been analyzing the airspace above carriers in the Mediterranean, began to analyze the airspace over the entire United States. Congress had asked the FAA to determine the upper limits of the nation's capacity for commercial flights. CNA had to find the data and develop the mathematical models to quantify the obstacles to growth.

Unlike Navy officers, agency officials had no experience with the blunt independence of CNA analysis, which concluded that air-traffic controllers and airline managers were among the obstacles. But FAA administrators gradually came to appreciate the frank analysis. Referring to the Director of Traffic Management David Hurley, Mikolic-Torreira says, "Hurley threw me out of his office more than once, but he didn't throw me out of the building."

In fact, the FAA has continued to request more work from CNA to this day. In his next project, Mikolic-Torreira discovered that a gold mine of detailed air-traffic data was collected and then routinely discarded if it wasn't needed in order to examine a safety incident. "We orchestrated an effort to save the data and knit it together across regions," he says. "Nobody had tried gluing that together before." Using big data before the Age of Big Data was not easy. Transmitting 30 or 40 terabytes of FAA data meant hauling magnetic storage devices by truck to the computers at Oak Ridge National Laboratory.

The FAA support team grew into CNA's Enterprise Systems and Data Analysis (ESDA) division, which today has offices just down the road from FAA headquarters and has supported multiple directorates with the seamless integration of people, processes, data and technology. The leader of ESDA for more than two decades, Brad Ng, started supporting the FAA in 1993, fresh off a Navy cruiser that had been tracking the flights of drug shipments out of South America. "The Navy was easier," Ng quips. "There were fewer assets to track."

In February of 1993, CNA's management held a retreat at the Wye Woods Conference Center on Maryland's Eastern Shore. There, they decided to stand up a formal entity under CNA that would handle all non-

defense work. It would be called the Institute for Public Research (IPR). Today about a quarter of CNA analysts work for IPR, which, in addition to ESDA, has the Safety and Security Division.

Just past its 50th anniversary, CNA had ventured far beyond the U-boat war. But it's a fair assumption that Philip Morse would have approved. In his 1977 memoir *In at the Beginnings*, CNA's original founder wrote: "Business and government policymakers would have to be shown that the combination of scientific measurement and theoretical extrapolation called [operations research] could help them control the operations they administered."

The end of the Cold War brought many other new developments to CNA. One of the most unusual was an effort to support cooperation between the U.S. and Russian navies. CNA's Russia Program organized 16 seminars and many visits and speaking engagements in both directions. It lasted throughout Boris Yeltsin's two terms as Russian president, and the first few years of Vladimir Putin's presidency. CNA's Russia specialists took steps toward cooperation on important issues such as the safe retirement of nuclear-powered submarines.

CNA's Linton Brooks and Michael McDevitt, both former Navy officers, found discussions with their former adversary strangely wistful. Brooks recalls wearing a coat and gloves inside the office of the

commander of the Russian Pacific Fleet; the navy could not afford to heat its offices. Ships rusted at the piers. "You could see the old Soviet navy more or less disintegrating before your very eyes," McDevitt told StoryCorps.

Murray was also looking even farther east. "We wanted the capability to understand political-military problems, especially in China," he says. In 1998 CNA hired David Finkelstein, an Army officer with a Ph.D. in Chinese History from Princeton with on-the-ground experience in China. At CNA, Finkelstein built the largest research group studying Chinese military and security affairs in Washington, outside of the government. "We wanted sufficient numbers to dig deep, a talented set of folks who could speak the language," says Murray. "I was trying to jump in feet-first to make a big splash."

McDevitt, hired at about the same time to help manage Asia projects at CNA, looks back on this as a prescient move. "Twenty years ago, nobody foresaw what China would become," he told StoryCorps. "You have to remember that in the '90s we were still in the period of euphoria," adds Brooks. "The Cold War was over, and we were all going to hold hands and sing Kumbaya."

This China expertise would be rounded out with strategic analysts who specialized in the Middle East, Africa, Latin America and North Korea — and who were fluent. "They can read in the

language," notes McDevitt. "The Russia specialists can go to the Russian websites, talk to the Russians. The China department is not dependent upon translators. The Iran team speaks Farsi, reads Farsi." Together, these international policy analysts form the two "pol-mil" divisions at the Center for Naval Analyses today: China and Indo-Pacific Security Affairs and Strategy, Policy, Plans, and Programs. "CNA was already well established as a scientific organization, doing operational work," says Murray. "I also wanted us to be able to do strategic work, international work, because it was important to the future of the country."

As the millennium turned, IPR was still a mere fraction of CNA, and managers were happy to take on small non-defense projects. When the Federal Emergency Management Agency (FEMA) and the Department of Justice launched their first major terrorism exercise, CNA sent two analysts to work on an after-action report about one city. James "CHIPS" Stewart, one of the two analysts to go to the Top Officials (TOPOFF) 2000 exercise, knew that CNA could contribute far more, but he was thinking, "If they just try us, they'll like us."

In May 2000, Stewart and Kathleen Ward traveled to Aurora, Colorado, one of the three exercise locations, where local, state and federal officials would have to react to a staged bioterrorism attack — without prior warning. Their report made an

impact. "We got noticed," says Stewart. "Literally, when they tried us, they did like us." By the time TOPOFF 2 was in planning, CNA was the analytical lead contractor, contributing 21 analysts in multiple locations. CNA has worked on a continuous stream of projects for both the Department of Justice and FEMA ever since.

Related work saw Neil Carey and Monica Giovachino developing a bioterrorism plan for a city agency, the Washington, D.C., Department of Health. CNA's work in safety and security had started, if only modestly. The organization had the expertise to contribute more in this area, but whether the segment would grow was still uncertain at the time. Terrorism was not the top issue in the nation. That would soon change.

2000 – 2017
A New CNA for a New Century

After the World Trade Center and Pentagon came under terrorist attack on September 11, 2001, the impact of that day would touch — or even transform — every corner of the organization. Giovachino, the managing director of CNA's Safety and Security division, explained to StoryCorps:

> After 9/11, I think everyone felt like we could contribute to making our nation safer and better prepared, and it was an exciting time to be working with government. I mean everyone in government — whether it was federal, state or local — was motivated. People were just trying to make a difference. And I think 9/11 was surely a turning point for us as we started to grow the non-DOD business, and a lot of us started working in new areas.

Both the Office of the Secretary of Defense and the Joint Forces Command contacted CNA immediately for assistance. Several analysts reconstructed the Navy's response to the terrorist attack. Others in IPR were evaluating crisis-response command and control by FEMA and local agencies in New York and Washington. CNA employees even created temporary office space in headquarters conference rooms to temporarily accommodate staffers from the office of the Chief of Naval Operations, forced out of the Pentagon by the destruction.

That week, the D.C. Department of Health asked CNA if analysts could drop their weekend plans and come back to help. The Centers for Disease Control had put in place an emergency stockpile of medical supplies in case the city should come under a bioterrorism attack. It begged the question, "What are we supposed to do with this stuff?" says Giovachino. On Saturday, September 15, Neil Carey, Rosemary Spears and Giovachino plunged into developing an emergency distribution plan with the D.C. officials.

Giovachino was eight-and-a-half months pregnant at the time, and working through a weekend to prepare distribution plans for such a hypothetical bioterrorist attack may have seemed paranoid. It was not. On September 18, letters infected with anthrax spores began arriving in offices near the Capitol, leading to five deaths. The freshly written plan

was put into action, and CNA's Neil Carey directly supported the D.C. government's responders to set up the distribution of medicine from the stockpile to those who had been exposed.

By December, the nation was at war in Afghanistan. Combat of varying levels of intensity in Afghanistan and Iraq would outlast the decade that had just begun. As ever, the nation's forces had to adapt to new adversarial tactics, and the Center for Naval Analyses would flex with them, building up expertise in counterinsurgency and low-intensity conflict, for example. In all, some 85 analysts deployed to the combat zone in the first years of those two wars.

As full-scale combat bled into insurgency, CNA broke new ground. In the first half of 2004, improvised explosive devices (IEDs) had killed 145 coalition forces. That summer, three CNA analysts were visiting a base when, Ed Michlovich recalls, a Marine "practically grabbed us by the collar." His fellow Marines were getting blown up every day in Iraq, and he pleaded for analysis to demonstrate whether a new counter-IED effort that was about to be cancelled was actually saving lives.

"I thought to myself, 'This is why I joined CNA. This is it,'" recalls Michlovich. Within weeks, the analyst was briefing the commander of U.S. forces in the Middle East, Gen. John Abizaid. Michlovich recalls:

> The room was dimly lit, so that it was hard to see their faces from the podium where I stood. Mostly what I saw from there was the glistening of all the stars on all the shoulders, reflecting the dim lights above them. The general asked no questions. Finally, after I finished presenting the results and the recommendations, he sat up in his chair, looked around the room and said: "Why hasn't anyone shown me this before? This is what I've been waiting for."

Instead of being canceled, that counter-IED strategy was tripled. And a major CNA program was created. The complexity of the counter-IED fight would test the outer limits of both data collection and mathematical analysis. It would bring together field representatives in Afghanistan and Iraq and headquarters analysts, linked in real-time by a classified network. Each analysis was driven by the urgency of knowing that lives were on the line. "Days meant lives. This weighed constantly on our minds," says Michlovich, who led the analysis from the Alexandria, Virginia, headquarters. "We would sometimes be here past midnight and overlap with Dave Broyles starting his work in the morning in Iraq."

The first decade of the millennium was also a time of explosive growth for CNA's non-defense work. In its first decade, IPR had been hampered by the fact that each project had to borrow defense analysts from the Center for Naval Analyses. They were analysts who

had other bosses and other priorities. In 2003, Lee Gunn, took over the management of the unit on the condition that IPR would have its own analytical staff. "We went from 5 to 70, virtually overnight," says Gunn.

Gunn would need those analysts to address the nation's growing antiterrorism needs. "9/11 set the stage here," says Gunn. For example, CNA assisted the Office of Emergency Preparedness at the Department of Health and Human Services to run a disaster-response war game. CNA already had deep experience in setting up and evaluating war games for the Navy, but this was the organization's first non-defense war game. "We used our stars from Navy war games," says Stewart, including Peter Perla, author of *The Art of Wargaming*. Vice President Dick Cheney and two other cabinet members observed the game, which "worked out pretty damn well," according to Stewart. CNA support for preparedness at Health and Human Services expanded rapidly and continues to this day.

The decade was also marked by natural disasters that demanded analysis. When Hurricane Katrina devastated the Gulf Coast in 2005, CNA moved into FEMA's Washington operations center to support the planning section 24/7 for six weeks. Eric Trabert flew toward the storm to help deploy and monitor the prototype Federal Medical Station for the Department of Health and Human Services. Trabert followed every step as this tented hospital

was unpacked from 18-wheelers and set up in Louisiana. And since there were no hotel rooms available, he slept on the floor of the medical captain's room.

Trabert's analysis of patient needs and medical-station capabilities led to a recommendation that the station shift its emphasis toward treating chronic conditions. "They had underappreciated the number of people who live in communities day-to-day but are sick," he explains. "They're not hospitalized, but when they get cut off from services like clinics and pharmacies due to a storm, an earthquake, a terrorist attack, this is a whole population that can get very sick, very fast." In the aftermath of Katrina, the Federal Medical Station concept of operations was rewritten, with a formulary of supplies and equipment to match those needs that Trabert had observed by getting close to problem.

CNA's growing expertise in disaster relief and humanitarian assistance within both IPR and the Center for Naval Analyses would be repeatedly put to use in the coming years for Hurrican Rita, the earthquate in Haiti, the Japanese tsunami and Superstorm Sandy.

A survey of the historical highlights of the first years of the 21st century could easily give the impression that the majority of CNA's work is performed on short notice, in emergencies. In fact, the majority of

studies take many months. Some take years. This is when skills are honed and knowledge is deepened in a way that makes emergency response possible.

That was the case in 2005, when the office of the Deputy Secretary of Defense contacted CNA. Preparations for the Quadrennial Defense Review had been under way for several months, but the important chapter on maritime acquisitions was not going well. The Pentagon asked "Could CNA step in and complete the project in one month?" Mark Lewellyn remembers the weeks that followed as a series of analyses and briefings that lasted 18 to 20 hours a day, seven days a week. Fortunately, in the Advanced Technology and Systems Analysis division he led, he could pull together twenty analysts with experience in the systems being developed for the Navy, Marine Corps and Coast Guard. "It was based on work we had already done," Lewellyn says. "We could pull it off the shelf, add some analysis, brief it, take their adjustments, and rework it."

Lewellyn remembers the Quadrennial Defense Review as the most important work of his CNA career, and the day he briefed Deputy Secretary of Defense Gordon England on the final results as his most memorable day. "It had an impact at the highest levels of government," he says, influencing decisions on the Littoral Combat Ship, aircraft carriers and Zumwalt-class destroyers.

The link between CNA's history of military operations research and policing was a natural one. In the language of the field, one term is used to describe soldiers and nurses, pilots and police. They are all operators. So in 2009, Stewart and Steve Rickman published a white paper on the process of bringing data and analysis to domestic law enforcement. They called their concept "SMART Policing." It was no ivory-tower essay. Stewart had been a beat cop in Oakland, California, who rose to be chief detective and then director of the National Institute of Justice. SMART Policing would bring local researchers and police departments together to focus on key local issues, isolate relevant data and measure results.

The Department of Justice embraced the concept, and in the eight years that have followed, the department and CNA have worked with more than 35 police departments to implement it. In Boston, for example, one crime-ridden precinct discovered that just 4 percent of addresses accounted for 50 percent of incidents. The most surprising result was that when concentrated preventative policing stabilized those hotspots, data showed that crime did not shift to other nearby areas, as police had predicted. "Circles of benefit" grew around them. "We're bringing a whole different discipline to policing," says Stewart, CNA's Director of Public Safety, and a senior advisor to the Department of Justice's Smart Policing Initiative.

By 2015, Bob Murray had steered CNA through more than a third of its history as the organization had vastly broadened its mission. The time had come for a new generation to take the helm. No one seemed surprised when that task was handed to Katherine McGrady. Yes, she would be the first woman to lead the organization, but in many ways she was a traditional choice, in the spirit of the founders. The new president and CEO was a scientist who had made her mark in a time of war, an operations analyst to lead CNA to its 75th year and beyond.

The Long and the Short of It

CNA has lived and grown through 75 years of world-changing events. The organization has been shaped by a tumultuous period in history. And at times, the people of CNA have played a role in shaping that history, too.

Yet for all that has taken place in those 75 years, it's worth noting that it is also brief enough that the threads of the first work performed in 1942 still carry through to 2017. In fact, salt spray from the oceans seems to preserve operations analysts for so many decades that some current CNA'ers still recall working alongside those who served with Philip Morse in World War II.

After Harvey Spivack joined the organization in 1977, his projects were reviewed by the 10th employee to join ASWORG in 1942, Jim Tyson.

(Spivack still cringes at the memory of Tyson finding a mistake that had been throwing off his results by a factor of two.) In those years, Spivack learned the equations of search that the founders had developed for the U-boat war. Today, as the leader of CNA's antisubmarine warfare team, Spivack still teaches those fundamental equations to new analysts. "The deep connection is that the modeling techniques developed by ASWORG are still as relevant today as when they were developed in World War II," says Spivack. "The sensors change; the targets change; but this is mathematics."

Perhaps it all points toward CNA's own Theory of Search: When facing a problem, seek the undiscovered path forward, but remember the path behind.

$$p = 1 - e^{-SR\,t/A}$$

One of the 75-year-old search equations Harvey Spivack teaches to new analysts.

About the Author

Don Boroughs wrote for magazines for more than thirty years before joining CNA. He has been a senior editor for the weekly newsmagazine *U.S. News & World Report*, a roving editor for I*nternational Wildlife,* and a contributing editor at *Prism*, the magazine of the American Society for Engineering Education. Since 2016, he has been the executive writer at CNA. He lives in Washington, D.C.

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