100 YEARS OF NAVAL AVIATION

1911-2011

INSIDE

ABOUT THIS SECTION:
This special supplement was prepared for the Advertising Department of *The Washington Post* by freelance journalist and editor Marcy Gessel in cooperation with the U.S. Navy, U.S. Marine Corps and U.S. Coast Guard and the 100th Anniversary of Naval Aviation Foundation. The production of this supplement did not involve the news or editorial departments of *The Washington Post*.

NAVAL AVIATION

Flying Farther, Faster and into the Future

Since starting as a tool for spotting the enemy navy's ships first, naval aircraft have become one of the nation's leading means for projecting power, hitting targets and moving personnel and supplies to where they are needed most.

"There's the saying that aircraft carriers are 4 1/2 acres of sovereign U.S. territory anywhere in the world," said Hill Goodspeed, historian with the National Museum of Naval Aviation in Pensacola, Fla.

On Sept. 11, 2001, the USS Enterprise demonstrated the versatility of the modern aircraft carrier. The Enterprise had just left the Arabian Gulf and was heading south in the Indian Ocean, beginning the trip back to homeport in Norfolk, Va., when the crew saw the live television coverage of the attacks on the World Trade Center towers and on the Pentagon. Enterprise turned around and headed back to the waters off Southwest Asia.

Enterprise then remained on station in support of Operation Enduring Freedom, launching air attacks against al-Qaeda terrorist training camps and Taliban military installations in Afghanistan. For about three weeks, aircraft from Enterprise flew nearly 700 missions in Afghanistan, dropping hundreds of thousands of pounds of ordnance.

"Operations over Bosnia (in the 1990s), against Saddam Hussein in Operation Northern Watch, in the War on Terror, for counter drug missions, for missions off coastlines to show resolve. These and others are all missions and actions made more efficient by the fact that the Navy has a maritime air presence," said Richard P. Hallion, military aviation historian.

The Navy also has used its aircraft carriers and air strike groups for humanitarian missions. In January 2010, the USS Carl Vinson reached Haiti within 72 hours of its devastating earthquake with water, medicine and supplies, providing medical attention onboard and distilling water.

"The Navy has been in that business for 80 years," said Capt. Richard S. Dann, director of History and Outreach for the Navy's Centennial of Naval Aviation office. "The USS Lexington pulled into Tacoma, Wash., when their dam went dry in late 1929, hooked into the power grid and provided essential services for 30 days. We take our assets and move them to wherever they're needed."

> **"There's the saying that aircraft carriers are 4 ½ acres of sovereign U.S. territory anywhere in the world."**
>
> –Hill Goodspeed, historian with the National Museum of Naval Aviation in Pensacola, Fla.

U.S. NAVY PHOTO BY PHOTOGRAPHER'S MATE 3RD CLASS DAVID PASTORIZA

A U. S. Navy Aviation Machinist's Mate watches a CH-46 "Sea Knight" fly by after delivering supplies during a vertical replenishment operation aboard USS Enterprise.

From Scout to Bomber

Before the advent of the airplane, Naval warfare had not changed fundamentally in centuries, Goodspeed said. Shipboard armament targeted other ships of an enemy fleet. Whichever fleet spotted the other fleet first and maneuvered into position to fire generally would win.

"Although the airplane was not initially used to sink a ship, with it the observer could go higher than the ship's mast—that had been the highest you could go. It enabled you to find the enemy ships at greater distances. When guns started firing, the aircraft could correct the shooting. It extended the range," Goodspeed said.

As early as the First World War, airplanes attacked and sank ships and submarines, by bombing and dropping torpedoes. After the war, American Naval aviators pioneered dive bombing, flying down toward a ship as close as possible and then releasing ordnance, as a kind of guided missile.

At the Battle of the Coral Sea in 1942, all the damage to the American and Japanese fleets

NAVAL AVIATION CONTINUED ON 3

PHOTO COURTESY OF U.S. NAVY

A Vought F4U-4B "Corsair" taxies forward on the flight deck of USS Philippine Sea just before taking off to attack North Korean targets, circa October 1950.

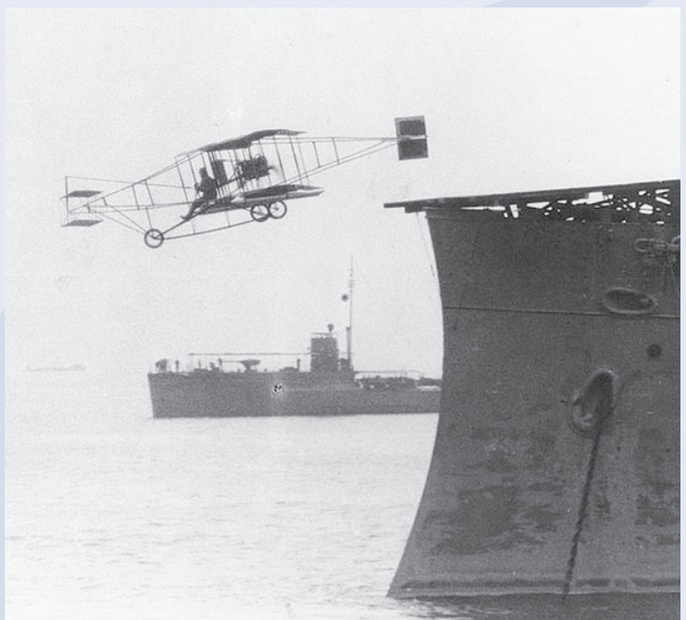
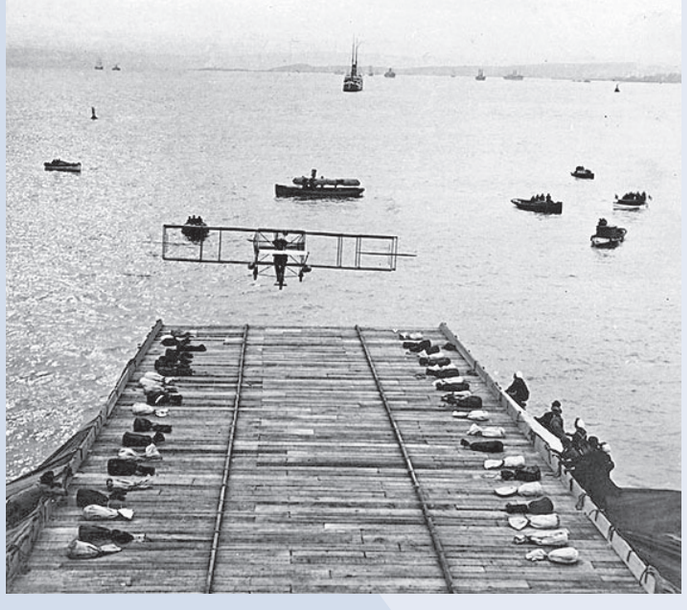


PHOTO COURTESY OF U.S. NAVY

Eugene Ely flies the Curtiss pusher biplane off a platform erected on the USS Birmingham, Nov. 14, 1910, in the first successful take-off from a ship.



Eugene Ely approaches the deck of the USS Pennsylvania just before making the first successful shipboard landing, Jan. 18, 1911.

PIONEERS OF NAVAL AVIATION

Early Naval Aviators Sought Ways to Link Air and Sea

In a test that "came perilously close to being a miserable failure," test pilot Eugene Ely demonstrated that an airplane could take off from a ship, but it took another decade before the U.S. Navy had a practical aircraft carrier in its fleet, said Karl Zingheim, historian at the USS Midway Museum in San Diego, Calif.

> **Test pilot Eugene Ely successfully took off in a Curtiss pusher biplane from a platform built onto the USS Birmingham on Nov. 14, 1910. Ely, who could not swim, wore inflated bicycle inner tubes as a life preserver during the flight.**

Even before the first practical airplane had flown, leaders expressed interest in its military potential. As Assistant Secretary of the Navy in 1898, Theodore Roosevelt recommended that two officers examine plans for a flying machine and investigate the possibilities for naval applications, Zingheim said.

Orville and Wilbur Wright sold their invention to the U.S. Army in 1909, but they determined that trying to use an airplane aboard a ship was too risky. That opened the door for a competitor, Glenn Curtiss, an inventor who had made a name for himself as a motorcycle builder and racer.

In 1910, Navy Capt. Washington Irving Chambers approached a member of the Wright Brothers flying team at a Belmont Park, N.Y., air meet looking for an American flier to do a test launch of an aircraft from a ship. The Wrights were not interested, but word reached Ely, a Curtiss pilot, who offered his services to Chambers.

Ely successfully took off in a Curtiss pusher biplane from a platform built onto the USS Birmingham on Nov. 14, 1910. The plane briefly touched water and damaged its propeller, but Ely successfully landed on nearby Willoughby Spit. Ely, who could not swim, wore inflated bicycle inner tubes as a life preserver during the flight.

Curtiss understood the value of a potential government contract and immediately offered to train a Navy pilot for free, Zingheim said. He scouted for a year-round location with better weather than at his base in Upstate New York and chose North Island, hundreds of acres of flat open land in an inlet near San Diego.

Lt. j.g. Marc Mitscher sits in the pilot seat of a Curtiss type "A" seaplane at Pensacola, Fla., circa 1916. After completing flight school that year, Mitscher became Naval aviator 33. He went on to command the USS Hornet during World War II. After the war, Adm. Mitscher served as Commander in Chief, U.S. Atlantic Fleet.

There, Curtiss trained Lt. Theodore G. Ellyson, who became Naval Aviator Number One.

The Navy secretary remained skeptical and unwilling to purchase an airplane. Then, on Jan. 18, 1911, Ely took off again in the Curtiss pusher, this time landing on a platform built onto the armored cruiser USS Pennsylvania in San Francisco Bay. Ropes held down by sandbags and a tailhook apparatus slowed the plane on landing. It was the first successful shipboard landing of an aircraft.

"Fortunately, Ely was able to land and take off more easily, enough for the Navy and Chambers to commit to the airplane," Zingheim said.

The Secretary became fully convinced in February, when Curtiss demonstrated his "hydroaeroplane," which was fitted with floats, working along with a ship that required no modifications. The Navy's thinking at the time, Zingheim said, was that adding a platform to ships would interfere with a warship's guns.

On Feb. 17, 1911, Curtiss taxied his hydroaeroplane alongside the Pennsylvania at anchor in San Diego Harbor. A crane swung out from the ship and used a hook to pull the plane onto the existing deck of the cruiser. The crew then reversed the process and the plane returned to North Island.

The Navy committed to purchasing its first aircraft on May 8, on what is considered the birthdate of Naval aviation.

Once the Navy embraced the idea of aviation, it pursued three paths to incorporating aircraft into its operations: seaplanes, including what were called "flying boats," lighter-than-air airships, and airplanes landing on shipboard platforms as Ely had done.

PIONEERS CONTINUED ON 4

100 YEARS OF NAVAL AVIATION 1911-2011

NAVY SECRETARY MARKS ANNIVERSARY

Making the Improbable Possible

PHOTO COURTESY OF U.S. NAVY

On a gray and hazy San Francisco morning in January 1911, Eugene Ely brought his Curtiss biplane in for a slow landing on the small raised platform covering the deck of the Navy test ship Pennsylvania anchored in San Francisco harbor—and Naval aviation was born.

When he had begun experimenting with the idea of shipboard landings the year before, few in the country thought flying was safe or practical. Fewer still thought flying from a ship was sane. After his successful landing, Ely likened the deck of the test ship to a wooden plank, an analogy familiar to today's Navy pilots, who routinely land on the "postage-stamp" size pitching decks of our nuclear carriers on station around the world.

Now fast forward 100 years, to a clear April 2010 morning over Southern Maryland—and the test flight of the Navy's Green Hornet, an F/A-18 jet fighter that achieved speeds 1.7 times the speed of sound running on a biofuel/jet fuel mixture. Like Ely's flight, there were those who said it could not be done, that flying on biofuels was impossible. But the plane flew anyway.

For 100 years, Naval aviation has made the improbable possible; change and adaptation have been the only constants. The wood, canvas, and cloth seaplanes of World War I became the flying boats, dive bombers, and Marine squadrons of Midway and the Marianas, which became the supersonic fighters of today.

Naval aviation is central to Navy and Marine Corps operations, and our pilots perform a staggering array of missions—everything the fleet does—from power projection to humanitarian assistance.

They are the helicopters assaulting a beach, rushing to a ship in danger of sinking, or flying to shore to provide food and medical assistance to places like Haiti after the earthquake or Pakistan after the floods. They are the strikers in the sky, attacking enemy targets and providing close air support to Marines and soldiers in contact on the ground. And they are the eyes of the fleet, looking for submarines at sea and terrorist cells ashore. Navy and Marine pilots have flown into space and walked on the moon.

Tomorrow's fleet will continue to evolve to meet the security challenges of an increasingly complex world. We are already taking the first steps, like the Green Hornet and like the unmanned aerial vehicles piloted by Navy and Marine operators that are searching for pirates off Somalia and conducting reconnaissance missions over Afghanistan and Iraq. Within a few years, larger and more powerful UAVs will be capable of integrated carrier flight operations with piloted aircraft and complex aerial combat maneuvers in support of the fleet.

These changes are the natural evolution of Naval aviation, which, since those very first flights, has embodied the American spirit of adventure and tremendous innovation.

And together, these changes will create the fleet of the future. One that will, as the Navy and Marine Corps have done for 235 years, ensure American military dominance and the fleet's ability to operate wherever water touches the earth.

A Navy recruiting poster says it best, depicting a Carrier Strike Group in formation with the caption: "Sometimes we rush in after the storm; sometimes we are the storm." That is what Naval aviation has always been—and what it will always be.

BY RAY MABUS, SECRETARY OF THE NAVY

COMMANDER OF NAVAL AIR FORCES

Aviation Accomplishments Will Continue to Inspire

The headquarters of Naval Air Forces, located on Naval Air Station North Island in San Diego, Calif., is a stone's throw from where Glenn Curtiss first operated a flight school and where Lieutenant Theodore Ellyson, Naval Aviator Number One, learned to fly in 1911. One hundred years later, we celebrate the Centennial of Naval aviation and recognize the tremendous accomplishments achieved by the brave men and women who have crafted a rich history and legacy.

U.S. NAVY PHOTO BY PHOTOGRAPHER'S MATE 3RD CLASS DAVID PASTORIZA

Vice Admiral Allen G. Myers, right, commander of Naval Air Force, U.S. Pacific Fleet, meets Machinist's Mate 3rd Class Taylor Fenton while touring the waste processing room aboard the aircraft carrier USS Carl Vinson during a training exercise in the Pacific Ocean last December.

From an austere beginning during the age of a battleship-focused Navy, and with flying machines that were little more than cloth-covered wooden frames, Naval aviation has proven its strategic worth by enhancing the Navy's ability to conduct its missions. The value of a navy is this: to influence coalitions—by building or disrupting them—and to influence the sea lanes of commerce—by opening or closing them. Over the last 100 years, Naval aviation has steadily expanded the area that our naval ships can influence from the line of sight in the crow's nest to hundreds of miles across the sea and inland.

With a modern fleet of nuclear-powered aircraft carriers, each carrying an air wing of some 65 aircraft, and complemented by land-based expeditionary squadrons, Naval aviation is capable of supporting missions across the full spectrum of operations and delivering flexible, agile, immediately responsive and persistent combat power from the sea around the world. From the pitching deck of an aircraft carrier in the North Arabian Sea, Navy and Marine aircrew fly missions hundreds of miles inland to provide 24/7 close air support for coalition forces on the ground in close contact with the enemy in Afghanistan. At the same time, Air Ambulance Detachments operating from unforgiving, dusty, remote forward-operating bases evacuate hundreds of patients, while maritime patrol aircraft provide reliable reconnaissance, maritime security and counter-piracy operations support. Our global presence, including the overseas-based USS George Washington Carrier Strike Group and forward-deployed naval forces constantly on station in the Pacific area of operations, ensures that any time, anywhere we can respond to our nation's call, whether it be to deter aggression or to provide comfort and hope in the wake of disaster.

Throughout 2011, we recognize a century of dedication and service by the men and women who are Naval aviation. We celebrate the heroes of the past who achieved greatness in battles like Coral Sea, Midway, Korea and Operation Linebacker. We acknowledge the brave pilots and air crew, and we especially commemorate the legion of maintainers, ordnancemen, flight deck and other support personnel, military and civilian, who have ensured the aircraft were ready and safe to launch, as well as their steadfast family members, who waited patiently for their loved ones' return. Our shared passion for flight has fueled a century of accomplishment, and it will continue to inspire our proud legacy for the next hundred years.

BY VICE ADMIRAL ALLEN G. MYERS, COMMANDER, NAVAL AIR FORCES/COMMANDER, NAVAL AIR FORCE, U.S. PACIFIC FLEET

100TH ANNIVERSARY OF NAVAL AVIATION FOUNDATION

Group Encourages Participation in Centennial

The Board of Directors of the 100th Anniversary of Naval Aviation Foundation is honored to host the official Kick-Off Gala and help launch the year-long celebration of the Centennial of Naval Aviation in 2011.

The mission of the 100th Anniversary of Naval Aviation Foundation is to raise national awareness of Naval aviation and pay tribute to a century of mission-ready men and women. The Foundation will highlight unique Naval aviation achievements from the past 100 years through regionally based events and educational displays and will provide resources for national involvement in the celebrations.

Events organized by this Board and others will be held across the country and around the world in honor of this historic anniversary. The general public is invited to participate in these events as volunteers and supporters of Naval aviation. For more information on the national schedule of Centennial events, please refer to our Foundation Web site at navalaviation100.org.

The Board would like to extend its sincere appreciation to the many civilian, active and retired military volunteers, as well as the staff of the Foundation, for their tireless efforts to coordinate this commemoration. Members of the Naval aviation family have left an indelible mark on our Nation over the past 100 years. The Board is deeply proud of the contribution of Naval aviation to our country, and we are humbled to serve in recognition of the United States Navy, Marine Corps and Coast Guard's service to America.

United States Navy

United States Marine Corps

United States Coast Guard

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U.S. COAST GUARD

Innovators Adapt Aircraft to Coast Guard's Unique Mission

U.S. Coast Guard aviation history began in 1903 at Kitty Hawk, N.C. It was there that the Keeper of the Kill Devil Hills Life-Saving Station, Capt. Jesse Etheridge Ward, and his crew assisted the Wright Brothers in their quest to become the first to fly a heavier-than-air machine. One of the surfmen under Ward's command even took the famous photograph of that first flight.

The practical start to Coast Guard aviation came in 1915 in the minds of two innovative officers, Elmer "Archie" Stone and Norman Hall, who believed that aircraft could be an efficient way to augment the Coast Guard's small fleet of cutters and shore stations. Working with the Curitss Aeroplane and Motor Company, they conceived the idea of a flying lifeboat. Their commanding officer, Benjamin Chiswell, saw merit in their efforts and approved their request for flight training. They both were ordered to flight school at Pensacola and went on to establish a dynamic Coast Guard aviation program. The Navy even borrowed Stone for most of the next decade during which he piloted the famous NC-4 flying boat on the world's first trans-atlantic flight and participated in the development of early carrier aviation.

Underfunded but innovative, using borrowed aircraft flown from unused airfields, the first few years of Coast Guard aviation were quite a test of the flyers' courage, intelligence and perseverance. But they were the first to practice the tradition of Coast Guard aviators who, with or sometimes without the authorization of higher command, experimented with new or advancing technologies to enhance the Coast Guard's ability to fulfill its large and always changing mission set.

From those early years onward,

PHOTO COURTESY OF U.S. COAST GUARD

These children were among many New Orleans citizens to be rescued from their rooftops after the flooding caused by Hurricane Katrina.

aviation grew to become a vital part of the Coast Guard. Coast Guard aviators served in World War I, commanding air stations in the United States and France, hunting enemy submarines and rescuing shipwrecked survivors at sea. In the period between the wars, the service refined their search-and-rescue techniques, including the always dangerous attempt to land their seaplanes far out at sea to assist mariners in need. For one of these missions, another Coast Guard aviation pioneer, Carl von Paulsen, and his crew earned Gold Lifesaving Medals for a heroic rescue that almost turned disastrous—he landed his seaplane at sea to rescue a boy adrift in small skiff. The landing so damaged his flying boat that Paulsen had to taxi his way back to the beach.

Charged with enforcing Prohibition, the Coast Guard discovered that aircraft made it possible to patrol large areas of coastline more quickly than cutters could and at a lower cost. With the addition of radio and navigation technology improvements, the aircraft came into its own. Coast Guard aviators experimented with arming their aircraft to convince "rummies" to comply with their orders, although the experiment was short-lived and during the coming decades (except the years of World War II) Coast Guard aircraft flew unarmed. The Coast Guard has recently reinstituted armament to some of its aviation fleet in response to changing drug interdiction operations as well as evolving homeland security missions.

During World War II, Coast Guard aviators again hunted for enemy submarines, escorted convoys and rescued survivors from torpedoed vessels, even rescuing a few German

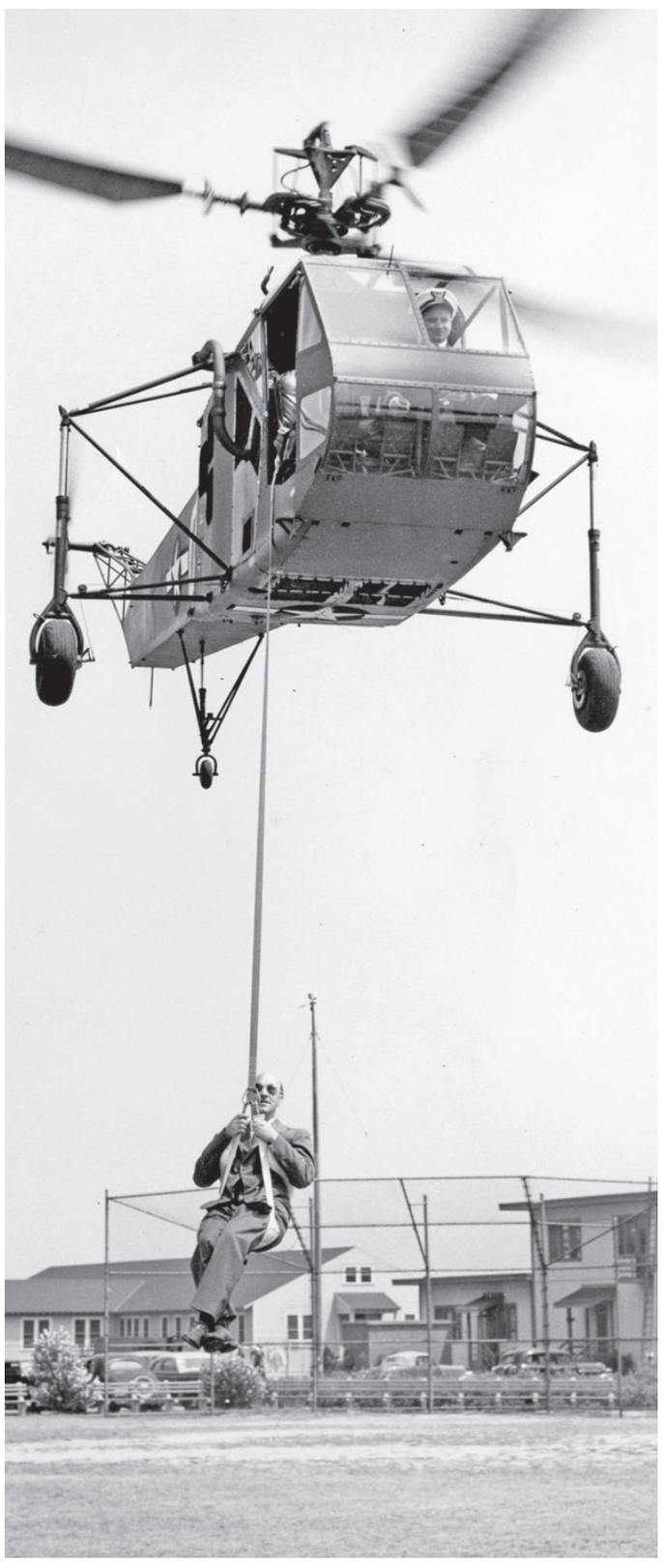
COAST GUARD CONTINUED ON 13

SPECIAL ROLE OF HELICOPTERS

Rotary Aircraft Move People, Supplies Where Needed Most

As a lieutenant with the U.S. Coast Guard, Frank Erickson witnessed the devastation of the Japanese attack on Pearl Harbor from a control tower. He watched helplessly as men lost their lives, trapped in oil-burning waters.

PHOTO COURTESY OF U.S. COAST GUARD



Lt. Stewart R. Graham, USCG helicopter pilot #2, demonstrates the lifting capabilities of the HNS-1 helicopter and its rescue sling by hoisting Dr. Igor Sikorsky, the helicopter's world-famous designer, in 1944.

Erickson remembered an article he had read months before about rotary-propelled aircraft—helicopters—and understood the craft's potential to make rescues against seemingly impossible odds.

With its ability to hover, to travel in conditions that other aircraft cannot, and to land on a relatively small patch of land, the helicopter has evolved into the go-to aircraft for the Marine Corps and the Coast Guard. Helicopters tackle missions from search and rescue to hauling troops and tanks to providing cover for other aircraft. They span the globe aboard not only super carriers but also smaller aircraft carriers and amphibious vessels that offer less room for takeoffs and landings.

Recognizing the Navy's priorities during wartime, then-Commander Erickson emphasized to decision-makers the potential for helicopters to be used against German U-boats and to protect merchant vessels. The Navy relented, acquiring four Sikorsky helicopters in 1943, and Erickson became Coast Guard Helicopter Pilot Number One.

"The early helicopters were little more than canvas-covered frames," Coast Guard deputy historian Scott Price said.

"They were woefully underpowered," explained Benjamin Kristy, aviation curator for the National Museum of the Marine Corps. "Thus, the first generation of military helicopters was limited in what it could carry or how far it could move its cargo." HMX-1, the Marine Corps' first helicopters squadron, formed in 1947, operated helicopters that could carry only a few Marines at a time. In some cases, by removing the canvas skins of the helicopters one or two additional Marines could be accommodated, Kristy said.

> **"The early helicopters were little more than canvas-covered frames [but] helicopters revolutionized search and rescue, and the Coast Guard pioneered that use."**
>
> —Scott Price, deputy historian, U.S. Coast Guard

After World War II, Navy helicopters proved useful in detecting submarines, using radar. They used a process called dipping sonar, in which the hovering helicopter would lower a sonar device into the water, listening for the U-boats. The aircraft could then drop torpedoes onto any submarines they located.

In the United States, the Coast Guard continued to experiment with using helicopters for rescues. In January 1944, Erickson flew the HNS-1 helicopter into blinding snow squalls to carry out the first helicopter life-saving operation. Traveling in conditions that had grounded other aircraft, Erickson delivered 40 units of blood plasma from Manhattan Island, N.Y., to Sandy Hook, N.J., where it was used to help survivors of an explosion on the destroyer USS Turner off New York Harbor.

Over the years, Erickson developed equipment such as the power hoist, rescue slings and baskets, floats that permitted helicopters to land on water, and techniques to land and take off from vessels at sea and hover in all weather and wind conditions.

"Helicopters revolutionized search and rescue, and the Coast Guard pioneered that use," Price said.

Having proved itself as the rescue aircraft Erickson envisioned, the helicopter demonstrated its military capabilities during the Korean War. The helicopter negotiated the rugged terrain of Korea by flying over it, and the ability to make vertical takeoffs and landings enabled the Marines to deliver supplies to troops on the ground and reload with wounded personnel, getting them to hospital facilities quickly.

In Korea, the Marines adopted a doctrine of vertical assault, employing ideas developed at the Marine Corps Schools in Quantico, Va., just after World War II.

After 1945 "You couldn't do a Normandy style of invasion with a mass amphibious assault. That would be a wonderful target for a nuclear bomb," Kristy said. "The helicopter allows you to disperse the fleet with assault and support ships and still bring men ashore."

Even the most powerful helicopter operating in Korea—the Sikorsky HRS-1—could transport only a handful of troops at a time.

"What saved the military helicopter was the adoption of the jet engine," said Karl Zingheim, historian at the USS Midway Museum in San Diego, Calif.

Although jet propulsion engines were being tested on fixed-wing aircraft during World War II, operational jet helicopters were not in general use until the 1960s.

"It was not until midway through the Vietnam War and the CH-46 that the Marines got that helicopter that could really meet our ideal," Kristy said. Jet engines provided the power required for medium-lift helicopters such as the Boeing CH-46 Sea Knight to transport 25 Marines. Heavy-lift helicopters such as the Sikorsky CH-53E Super Stallion can carry a jeep with trailer, a 105mm howitzer or a Hawk missile system. If passengers are carried, 38 combat-equipped troops or 24 litter patients can be accommodated.

Additional power also enabled an increase in range, particularly as in-flight air refueling became available to helicopters as well as fixed-wing aircraft.

In November 2001, Marine forces flew more than 400 miles inland by helicopter to set the stage for the attacks on terrorist targets in Afghanistan. Six Sikorsky CH-53E Super Stallion helicopters of the 15th Marine Expeditionary Unit seized an airfield in southern Afghanistan on Nov. 25, 2001, after traveling from the amphibious assault ship USS Peleliu in the North Arabian Sea. The flight required nighttime aerial refueling with the Lockheed KC-130 Hercules aerial refueling and transport aircraft.

Even jet helicopters fly relatively slow and low, rendering them vulnerable to attack. Starting in Iraq in 2007, the Marines have deployed the Bell-Boeing MV-22 Osprey to take advantage of the vertical capability without losing the speed and range of a fixed-wing aircraft. With its engine nacelles and rotors in vertical position, it can take off, land and hover like a helicopter. Once airborne, the transmission nacelle on each wingtip can be rotated to convert the aircraft to a turboprop airplane capable of high-speed, high-altitude flight. Conversion from the helicopter hovering mode to forward airplane flight takes only 12 seconds.

The Osprey can carry 24 combat troops, or up to 20,000 pounds of internal cargo or 15,000 pounds of external cargo, at twice the speed of a helicopter. The Osprey was expensive and complicated to make operational, but the Marines are happy with it now, Kristy said, adding, "It does exactly what we were looking for." ❍

PHOTO COURTESY OF U.S. NAVY

The Bell-Boeing MV-22 Osprey tiltrotor aircraft can haul up to 15,000 pounds of external cargo using dual hooks.

PHOTO COURTESY OF U.S. NAVY

Navy corpsmen help carry a wounded man from a U.S. Marine Corps H03S-1 evacuation helicopter to a hospital in Korea, October 1950.

NAVAL AVIATION CONTINUED FROM 1

came from the air. The ships never came within sight of one another. In June 1942, American Naval aviators flying from three carriers sank four Japanese carriers and one cruiser in the Battle of Midway. It was the most crucial naval battle of the 20th century.

"Since World War II there have not been large-scale sea battles. But there have been numerous Naval campaigns where Naval aviation has played a vital role, from Korea through the Falklands, and on to the War on Terror," Goodspeed said.

After World War I, treaties limited the size of battleships that naval powers could add to their fleet, so the Americans and Japanese focused their efforts on aircraft carriers.

"The British really were ahead of the Americans until immediately following World War I," said Mark Evans, historian with the Navy History and Heritage Command.

> **"It's amazing just to see what efforts go into operating aircraft before the pilot even climbs into the plane. That's just really a hallmark, the team effort that's required to make it all work."**
>
> –Hill Goodspeed, historian with the National Museum of Naval Aviation in Pensacola, Fla.

"They initially designed ships that didn't have the room to handle the aircraft."

The Japanese started with British technology, but improved upon it. Six Japanese carriers conducted an air strike on the U.S. Naval fleet at Pearl Harbor on Dec. 7, 1941, and pulled the United States into World War II.

In the Atlantic, Naval aviation played a crucial role in hunting deadly German U-boats, which had strangled shipping to Europe in the early days of the war. "We wouldn't have won the Battle of the Atlantic without Naval aviation," Evans said.

After the war, the Joint Army–Navy Assessment Committee evaluated the Japanese vessels sunk by Allied forces. The committee determined that 48 percent were sunk by submarines. More than 45 percent were sunk by aircraft alone or in combination with other factors such as mines.

Centuries of surface warfare, Hallion said, "were overturned by two kinds of three-dimensional attackers—submarines and airplanes—that had not existed at the turn of the century."

Despite these successes, the future of Naval aviation came into question after the end of the war. Some military analysts believed conventional wars would never be fought again after the atomic bomb. They were wrong.

In June 1950, Chinese-backed North Korean forces invaded South Korea, starting the first proxy war of the Cold War. Naval aircraft carriers arrived with older, piston-powered planes from World War II and newer jets and helicopters. Navy and Marine aircraft provided close air support for ground troops, aided in the movement of troops and supplies and revolutionized wartime medicine with medical evacuations. Carrier-based aircraft interrupted North Korean supply chains, taking out locomotives and even oxcarts.

PHOTO COURTESY OF U.S. NAVY

Two Grumman F9F Panthers fly above the USS Princeton in 1951, a year after the Panther became the first Navy jet to shoot down enemy aircraft.

The Jet Age

Innovations in jet propulsion and aerodynamic design added to the capabilities of the aircraft, but created challenges to aircraft carrier design, Hallion said.

"The aircraft carrier had always been a vessel with a single straight deck," he said. "You landed on the aft deck and took off over the bow. In World War II, this wasn't much of a problem," with the planes landing at relatively low speeds, less than 100 mph. "But jets approaching at higher speeds and landing up to 140 mph required a safer form of carrier design."

"Traditional hydraulic catapults gave a high initial push to airplanes, but lacked the sustained power, safety, and reliability to meet the needs of the Navy's new jet force. Further, combat operations off Korea indicated they often lacked power to launch heavily loaded jets if winds were weak or nonexistent," Hallion said.

In the 1950s, the Royal Navy pioneered three developments that transformed British and American carrier aviation:

- The angled flight deck slowed down the jets and also enabled them to abort a landing and return to the skies. In addition to greatly increasing safety, the angled deck made simultaneous take-offs and landings possible.
- New steam-powered catapults lacked the initial push of the hydraulic systems, but they provided a constant acceleration needed to reach jet speeds and also had higher overall power.
- The mirror landing system enabled aviators to visually correct their course while landing. Previously, pilots depended on their own sight and paddles and flags waved by landing signal officers on the deck. This system added a concave mirror, lights and a "ball" that represents the plane and its relative position to the landing area that the pilot could then use to help guide the aircraft. Landing signal officers used radios to communicate information to the pilots as well.

The Navy employed these innovations in building the first of its supercarriers, the USS Forrestal, in 1955. The USS Enterprise, the same carrier that later sped toward the Arabian Gulf after 9/11, was the first nuclear-powered supercarrier when it was commissioned in 1962. It is still in use but is scheduled to be replaced by the USS Gerald R. Ford in 2015.

Through the Vietnam War and into the end of the Cold War in 1989, advances in Naval aviation increased its combat capabilities, extended the range of aircraft through air refueling and improved the ability to attack targets in various weather conditions and at night. However, the ability to do more increased the demands on Navy and Marine personnel.

"A study wired pilots during Vietnam to measure their stress level," Goodspeed said. "The stress of landing on a carrier at night was higher than flying into enemy fire. That gives you an idea of how difficult that is."

Since Operation Desert Storm in 1991, the Navy has pursued advanced sensor and weapons technology that has enabled precise air strikes against targets, reducing the risk for U.S. aircraft and crew. In the past, it might have taken 12 planes to knock out the spans of a particular bridge. The aircraft may not have destroyed the bridge and would have had to deliver the bombs in relatively close proximity, risking the lives of the crew, Goodspeed said. Today, one McDonnell Douglas F/A-18 Hornet would deliver a laser-guided bomb right to the target and from a much greater distance.

"In the old days of pre-precision attack, analysts counted the number of sorties required to destroy a target," Hallion said. "Now, in the precision era, they count the number of targets that can be destroyed per sortie."

Naval aviators have been in the forefront of scientific developments that served both defense and society at large. Naval aviators Alan Shepard, Jr., the first American in space, and Neil Armstrong, the first man to walk on the moon, and Marine pilot John Glenn, the first American to orbit the Earth, are just a few of the Navy pilots to serve in the space program over the years. Technology in the development of radar, radio satellites and weather prediction has roots in Naval aviation.

Navy aviators also have been in the forefront of exploration. Rear Admiral Richard Byrd, a Naval aviator, was the first to fly to the North Pole in 1926 and to the South Pole in 1929. Byrd returned to Antarctica in 1934 and 1946 and was followed by exploration missions that continued through the 1990s.

Throughout the 10 decades of Naval aviation, the key to success has been the collaboration of hundreds of crew members working together.

"Look at the flight deck," Goodspeed said. "It is amazing just to see what efforts go into operating aircraft before the pilot even climbs into the plane. It is important to recognize those who support the ones who have fought. That is just really a hallmark, the team effort that's required to make it all work." ❍

100 YEARS OF NAVAL AVIATION 1911-2011

U.S. MARINE CORPS

Marines Rely on Support from the "Flying Leathernecks"

Two factors have continuously set Marine aviation apart in the history of military flight. The first is the close relationship between Marine and Naval aviation, and the second is the unchanging objective of Marine aviation to provide direct support to Marine ground forces in combat.

PHOTO COURTESY OF U.S. NAVY

As Korean Marines move down a trail, three Marine HRS helicopters (one appearing as a dot in the distance), bring in new loads of Marines, April 1952.

PHOTO COURTESY OF THE U.S. MARINE CORPS

U.S. Marines and Afghanistan National Army soldiers exit a CH-53E helicopter during Operation Integrity, in Marjah, Helmand Province, Afghanistan, Jan. 15, 2011.

Marine aviation officially began on May 22, 1912, when 1st Lt. Alfred A. Cunningham reported to Naval Aviation Camp in Annapolis, Md., "for duty in connection with aviation." Already a civilian pilot, he soloed after only two hours and 40 minutes of instruction (in a Wright Bros. Model B-1) and became Naval Aviator No. 5, following four Navy pilots.

In 1915, the Commandant of the Marine Corps authorized the creation of a Marine Corps aviation company consisting of 10 officers and 40 enlisted men. When the United States joined World War I in 1917, the Marines Corps had just five aviators and 30 enlisted men, including Cunningham. At war's end, Marine aviation included 282 officers and 2,180 enlisted men, with two Marine aviators having been awarded the Medal of Honor.

During the 1920s and 1930s, Marine aviation units supported brigades in Haiti, the Dominican Republic, China and Nicaragua. The guerrilla-type warfare of the 1927 Nicaraguan deployment gave Marine aviation its first opportunity to provide a form of close air support to Marines in combat, foreshadowing what was to become the Marine air-ground team standard.

The immersion of the United States in World War II found the Marines on the front lines, defending Wake Island against a better-equipped, more-experienced Japanese force. Marine aviators at Guadalcanal fought valiantly to support the Marines fighting in the jungle in the face of overwhelming Japanese air superiority early in that campaign. Marines ended World War II with 125 aces and eight Medals of Honor. The Marines' F4U Corsair became famous as a symbol of Marine Corps ground support and air superiority in the Pacific.

The Marines continued their close relationship between air and ground forces in Korea, deploying jet aircraft and helicopters for the first time while still making excellent use of the legendary Corsair. The introduction of helicopters in combat increased mobility in rugged terrain and, combined with field hospitals, greatly improved the odds of surviving combat injuries in the field.

The 1960s found Marines fighting in the swamps and jungles of Vietnam while at the same time pioneering America's entry into space. Marine helicopters began operating in Vietnam in 1962, providing air lift support to South Vietnamese forces. The first U.S. combat troops in Vietnam were Marines who landed at Da Nang in 1965, supported by F-4B Phantom IIs and A-4D Skyhawks. From Hue to Chu Lai to Khe Sanh, Marines on the ground depended on their "Flying Leathernecks." Later, Marine helicopters evacuated the American embassy in Saigon in April 1975—the last American military actions in Vietnam.

In 1962, Marine Col. John Glenn became the first American astronaut to orbit the earth, a voyage that lasted less than five hours but would be remembered forever.

One of the first "new looks" of Marine aviation in the early 1970s was the AV-8A British-built Hawker-Siddeley Harrier, with its vertical take-off and landing capability. The second version, the AV-8B Harrier, became the most distinctive signature of Marine Corps aviation in the mid-1980s. On the battlefield, with its advanced capabilities, it opened a whole new approach to operation of higher-powered tactical aircraft from not only small ships in the amphibious force, but also from relatively unprepared and dispersed sites ashore.

PHOTO COURTESY OF U.S. NAVY

A Douglas A-4 "Skyhawk" attack plane is catapulted off the USS Bon Homme Richard in operations off Vietnam, March 1967.

While some aspects of Marine aviation planning have varied, there has never been a departure from the understanding that a Marine aviator's sole reason for existence is to support the Marine infantryman. For decades, Marine air forces and ground forces have worked as equal partners, using communications technology to share information and transmit instructions.

Marine fighter squadrons paid their dues onboard carriers during World War II and even developed the idea of having Marine air groups onboard carriers toward the end of the war. Since 1945, Marine Corps squadrons have routinely deployed on carriers to complement Navy air wings.

More recently, in November 2001, Marine forces were the first front in attacking terrorist targets in Afghanistan. Marines flew helicopters more than 400 miles inland from the Arabian Sea to establish an airstrip for arriving ground troops.

Unique among the military services, the Marine Corps combines personnel from air, ground, command and logistics units with the equipment needed into one organization that can be mobilized quickly. Marine aviation is task organized to support this Marine Air-Ground Task Force (MAGTF) as the aviation combat element, providing six functions: assault support, anti-aircraft warfare, offensive air support, electronic warfare, control of aircraft and missiles and aerial reconnaissance.

Marine AV-8B and helicopter air combat elements of the adaptable Marine Expeditionary Units (MEU), the smallest type of MAGTF, are deployed year-round on amphibious carriers all over the globe. Their locations, along with those of the big deck carriers, often are the subject of the first question asked by the president of the United States when hot spots develop around the world. ❍

PHOTO COURTESY OF U.S. NAVY

Marine Corps F4U-4B "Corsair" fighters are loaded onto the USS Badoeng Strait at Naval Air Station North Island, San Diego, California, for transportation to Korea, July 1950, as part of the initial Marine Corps deployment of the Korean War.

ADAPTED FROM "MARINE AVIATORS: A CENTURY OF SERVICE" BY MARINE AIRCRAFT WING PUBLIC AFFAIRS, 2ND MAW, FEB. 19, 2010, WITH ASSISTANCE FROM BENJAMIN KRISTY, AVIATION CURATOR FOR THE NATIONAL MUSEUM OF THE MARINE CORPS.

PIONEERS CONTINUED FROM 1

Each form had its own advantages and challenges.

Seaplanes

Initially the Navy had great interest in seaplanes, which could float directly on water next to Navy vessels. Some of the aircraft were flying boats, designed to have the hull float directly on the water, and others were floatplanes, with floats mounted on struts taking the place of wheels. Sometimes seaplanes were simply retrofitted fixed-wing aircraft. The Navy's first airplane, the Curtiss A-1 Triad, got its name because it could operate on land and sea and in the air. The A-1 could roll on land or lift its wheels and float as a flying boat.

Making the seaplane practical was a problem, Zingheim said. "Curtiss discovered quickly that the pontoon design made all the difference in the world. At first it was canoe-shaped, but you couldn't get the aircraft to separate from the water. The engineers kept working at it. They found when you put on a step where you interrupted the bottom of the pontoon like a stairway, there was enough buoyancy not to sink, but the step interrupted the cling to the water when it was getting airborne." English naval Lt. Cmdr. John Cyril Porte was critical in developing the design, which enabled the seaplanes to increase in size and undertake longer flights.

Eight years before Charles Lindbergh's historic non-stop solo flight across the Atlantic Ocean, a Navy flying boat employing this design made the first Atlantic crossing by air. On May 27, 1919, Lt. Cmdr. Albert C. Read and a five-man crew landed the four-engine Curtiss NC-4 in Lisbon Harbor, Portugal. Two other NC flying boats had set out with the NC-4 starting in New York City and on May 16 took off from Trepassey Bay, Newfoundland. The next day, after more than 15 hours in the air, the other two seaplanes lost their bearings in fog near the Azores and could not continue. The NC-4 stayed in the Azores for 10 days before completing the trans-Atlantic journey.

Flying boats served during World War I, patrolling for German submarines and sometimes bombing them. Seaplanes played a similar role in World War II, also assisting in air-sea rescues.

Having outlived its usefulness, the seaplane was phased out by the Navy in 1967, replaced by helicopters and more powerful, more practical aircraft.

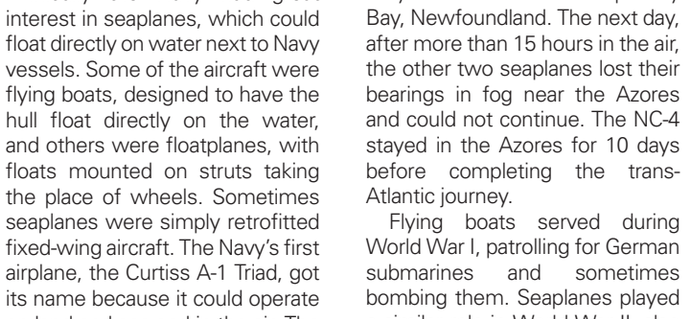
"They could only operate within a limited set of sea and wind conditions," Zingheim explained. "They couldn't launch from a ship, they had to be in water first. In certain conditions, they wouldn't get off the water. The drag interfered with performance.

Because of the limited range, they couldn't work with more than a few sea states."

Airships

Many of the countries that fought in World War I employed lighter-than-air craft for reconnaissance and bombardment, and during the 1920s the United States followed the experience gained during the war by building rigid airships. These airships proved vulnerable, expensive and not very maneuverable; however, they performed valuable reconnaissance and search and rescue flights, said Mark Evans, historian with the Navy History and Heritage Command.

PHOTO COURTESY OF U.S. NAVY



The Curtiss NC-4 seaplane sometime after it completed the first transatlantic flight in 1919.

Based on experiments carried out in the 1920s, rigid airships USS Akron and USS Macon were designed with hooks to hoist Curtiss F9C Sparrowhawk biplanes inside the hull of the airships. This kind of airborne aircraft carrier never came to practical use, Evans said.

Aircraft Carrier Air Wings

While the Americans tried to decide whether to pursue military applications for human-powered flight, innovators in Europe were pushing ahead with the new technology.

"Curtiss and, in particular, the newly minted Navy fliers actively developed catapult designs to launch airplanes from ships in the years before the First World War broke out," Zingheim said. "It turns out a shipboard catapult was the only significant American innovation in Naval aviation at the time. The French, English, Italians were going by leaps and bounds," determining how to best use aircraft from aboard ships.

"By 1918, the airplane was robust enough that the British Admiralty thought of mass attacks from the sea to the air," said military aviation historian Richard P. Hallion. On July 19, seven Sopwith Camels from the retrofitted HMS Furious launched in the North Sea to attack the German airship base at Tondern. The planes destroyed airship sheds in the first carrier airstrike in history.

Important advances in employing aircraft carriers starting in the 1920s were partly the result of treaties intended to slow the rebuilding of navies after World War I. The navies scuttled plans to build more battleships. Instead, in the United States, Great Britain and Japan, some vessels were turned into aircraft carriers.

America's first aircraft carrier was a converted coal hauler called the USS Jupiter that was renamed the USS Langley, CV-1, and commissioned in 1922. The conversion called for a platform with catapults on the forward and after ends of the "flying off" deck. For landings, arresting gear consisted of wires connected to hydraulic brakes.

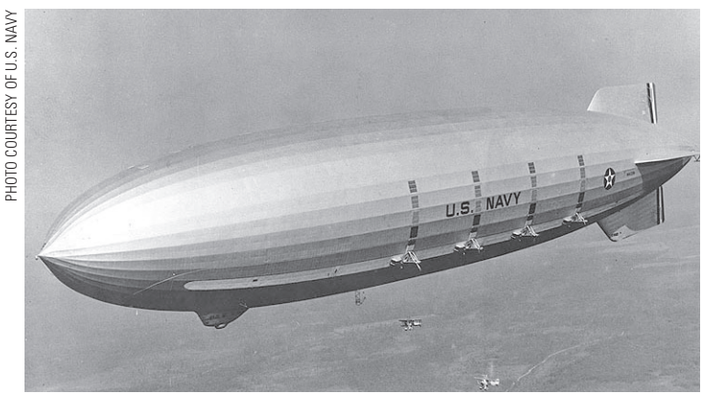
"The Langley was the first American carrier and thus more of an experimental vessel than a combat vessel, though it could have done the job," Hallion said. "The Langley was the ship that America's Naval aviators used to develop their operational skill set."

"On Oct. 26, 1922, a remarkable aviator, Lt. Cmdr. Godfrey Chevalier—they called him Chevy—took off from Norfolk in an Aeromarine 39-B training plane. He flew out to the Langley, which was at sea. As it steamed into the wind he carefully lined up and made his approach, touched down, and the hooks caught the arresting wires. It constituted America's first real trap of a practical naval aircraft at sea" by the U.S. Navy, Hallion said. Tragically, Chevalier died a few weeks later after an airplane crash.

The Navy then converted two unfinished battle cruisers into much larger carriers, the USS Lexington and the USS Saratoga. In 1929 the two vessels conducted exercises near the Panama Canal in which the carriers were integrated into the fleet and equipped with different types of planes for different missions: fighters, dive bombers and torpedo bombers to attack ships and observation planes and fighters to attack land-based targets. These exercises played an important role in preparing Navy strategists for what was to come.

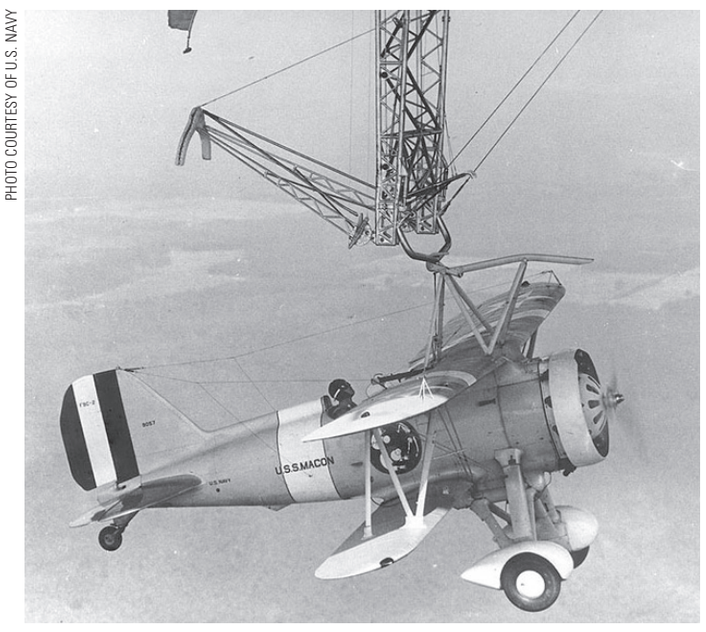
By the time Japanese aircraft attacked Pearl Harbor and the United States entered World War II in 1941, the Navy had seven aircraft carriers, and others in development, including smaller escort carriers. All three aircraft carriers of the Pacific Fleet were away from Pearl Harbor on Dec. 7 and escaped the attack. They provided the Pacific Fleet's primary punch in the opening months of the war that followed. ❍

PHOTO COURTESY OF U.S. NAVY



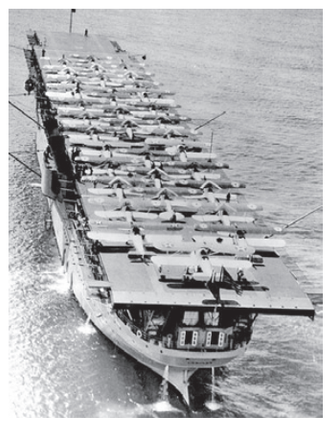
USS Macon airship recovering two F9C aircraft.

PHOTO COURTESY OF U.S. NAVY



Curtiss F9C-2 "Sparrowhawk" hangs from the trapeze of the USS Macon airship, 1933.

PHOTO COURTESY OF U.S. NAVY



USS Langley in Pearl Harbor, May 1928.

> **"Curtiss and, in particular, the newly minted Navy fliers actively developed catapult designs to launch airplanes from ships in the years before the First World War broke out."**
>
> —Karl Zingheim, historian at the USS Midway Museum in San Diego, Calif.

100 YEARS OF NAVAL AVIATION 1911-2011

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How Aircraft Carriers Work

When the U.S. Navy really needs to impress people, it flies them out to one of its super aircraft carriers. Standing 20 stories above the water and stretching 1,092 feet (333 meters) from bow to stern (about as long as the 77-story Chrysler Building is tall), the sheer bulk of these ships is awe-inspiring. But the really amazing thing about a supercarrier is not its size; it is the intense scene on its flight deck. When the crew is in full swing, it can launch or land a plane every 25 seconds—all in a fraction of the space available on a typical landing strip.

At its most basic level, an aircraft carrier is simply a ship outfitted with a flight deck—a runway area for launching and landing airplanes. This concept dates back almost as far as airplanes themselves. Within 10 years of the Wright Brothers' historic 1903 flight, the United States, the United Kingdom and Germany were launching test flights from platforms attached to cruisers. The experiments proved largely successful, and the various naval forces started adapting existing warships for this purpose. The new carriers allowed military forces to transport short-range aircraft all over the world.

Carriers did not play a huge role in World War I, but they were central to the air combat of World War II. For example, the Japanese launched the 1941 attack on Pearl Harbor from aircraft carriers. Today, super aircraft carriers are a crucial part of almost all major U.S. military operations. While the ship itself is not especially useful as a weapon, the air power it transports can make the difference between victory and defeat.

One of the major obstacles of using air power in war is getting the planes to their destination. To maintain an air base in a foreign region, the United States (or any other nation) has to make special arrangements with a host country, and then has to abide by that country's rules, which may change over time. Needless to say, this can be extremely difficult in some parts of the world.

Under international Freedom of Navigation laws, aircraft carriers and other warships are recognized as sovereign territories in almost all of the ocean. As long as a ship does not get too close to any nation's coast, the crew can carry on just like they are back home. So, while the U.S. military would have to make special arrangements with a foreign nation to set up a land military base, it can freely move a carrier battle group (an assembly of an aircraft carrier and six to eight other warships) all over the globe, just as if it were a little piece of the United States. Bombers, fighters and other aircraft can fly a variety of missions into enemy territory, and then return to the relatively safe home base of the carrier group. In most cases, the Navy can continually replenish (resupply) the carrier group, allowing it to maintain its position indefinitely.

Carriers can move in excess of 35 knots (40 mph, 64 kph), which gives them the ability to get anywhere in the ocean in a few weeks. The United States currently has 11 carrier groups stationed around the world, ready to move into action at a moment's notice.

THE PARTS OF AN AIRCRAFT CARRIER

With about a billion individual pieces, the U.S. Nimitz-class supercarriers are among the most complex machines on earth. But on a conceptual level, they are pretty simple. They are designed to do four basic jobs:

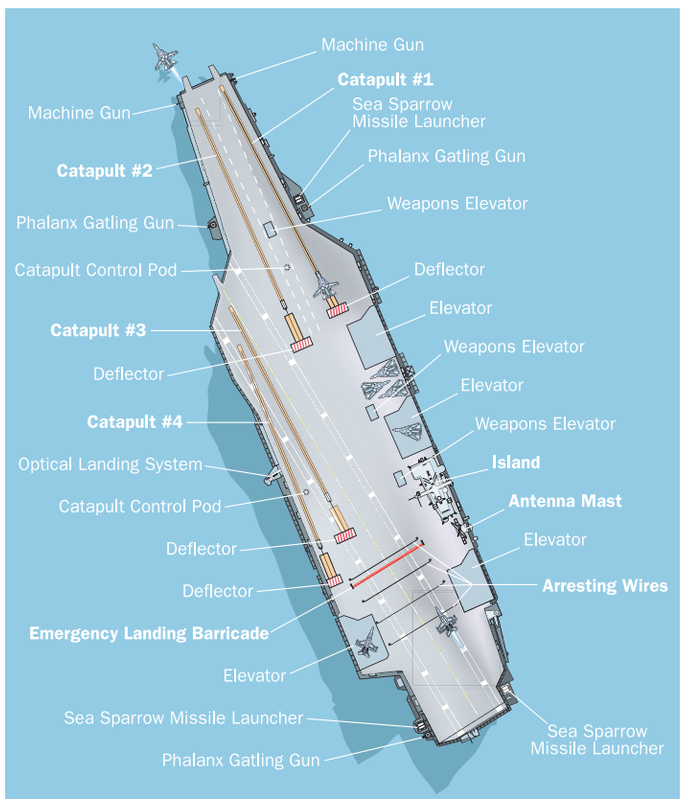
- Transport a variety of aircraft overseas
- Launch and land airplanes
- Serve as a mobile command center for military operations
- House all the people who do these things

To accomplish these tasks, a carrier needs to combine elements of a ship, an air force base and a small city. Among other things, it needs:

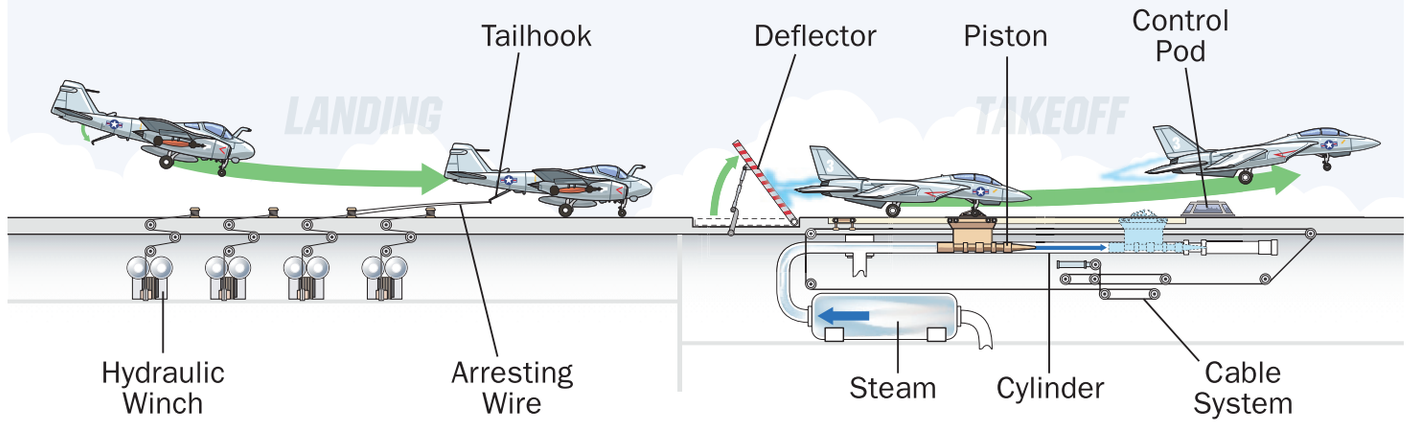
- A flight deck, a flat surface on the top of the ship where aircraft can take off and land
- A hangar deck, an area below deck to stow aircraft when not in use
- An island, a building on top of the flight deck where officers can direct flight and ship operations
- Room for the crew to live and work
- A power plant and propulsion system to move the boat from point to point and to generate electricity for the entire ship
- Various other systems to provide food and fresh water and to handle things that any city has to deal with, like sewage, trash and mail, as well as carrier-based radio and television stations and newspapers
- The hull, the main body of the ship, which floats in water

The hull of the ship is made up of extremely strong steel plates, measuring several inches thick. This heavy body is highly effective protection against fire and battle damage. The ship's structural support largely comes from three horizontal structures extending across the entire hull: the keel (the iron backbone on the bottom of the ship), the flight deck and the hangar deck.

The hull portion below the water line is rounded and relatively narrow, while the section above water flares out to form the wide flight-deck space. The lower section of the ship has a double bottom, which is pretty much what it sounds like—there are two layers of steel plating: the bottom plating of the ship and another layer above it, separated by a gap. The double bottom provides extra protection from torpedos or accidents at sea. If the enemy hits the bottom of the ship, smashing a hole in the outer steel layer, the second layer will prevent a massive leak.



The diagram above shows how these various components fit together. Top View.



The diagram above shows how an aircraft lands and takes off.

TAKING OFF FROM AN AIRCRAFT CARRIER

An aircraft carrier flight deck is one of the most exhilarating and dangerous work environments in the world (not to mention one of the loudest). The deck may look like an ordinary land runway, but it works very differently, due to its smaller size. When the crew is in full swing, planes are landing and taking off at a furious rate in a limited space. One careless moment, and a fighter jet engine could suck somebody in or blast somebody off the edge of the deck into the ocean.

But as dangerous as the flight deck is for the deck crew, they have it pretty easy compared to the pilots. The flight deck is not nearly long enough for most military planes to make ordinary landings or takeoffs, so they have to head out and come in with some extraordinary machine assistance.

An airplane has to get a lot of air moving over its wings to generate lift. To make takeoff a little easier, carriers can get additional airflow over the flight deck by speeding through the ocean, into the wind, in the direction of takeoff. This air moving over the wings lowers the plane's minimum takeoff speed.

Getting air moving over the deck is important, but **the primary takeoff assistance comes from the carrier's four catapults, which get the planes up to high speeds in a very short distance**. Each catapult consists of two pistons that sit inside two parallel cylinders, each about as long as a football field, positioned under the deck. The pistons each have a metal lug on their tip, which protrudes through a narrow gap along the top of each cylinder. The two lugs extend through rubber flanges, which seal the cylinders, and through a gap in the flight deck, where they attach to a small shuttle.

To prepare for a takeoff, the flight deck crew moves the plane into position at the rear of the catapult and attaches the towbar on the plane's nose gear (front wheels) to a slot in the shuttle. The crew positions another bar, the holdback, between the back of the wheel and the shuttle (in F-14 and F/A-18 fighter jets, the holdback is built into the nose gear; in other planes, it is a separate piece).

While all of this is going on, the flight crew raises the jet blast deflector (JBD) behind the plane (aft of the plane, in this case). When the JBD, towbar and holdback are all in position, and all the final checks have been made, the catapult officer (also known as the "shooter") gets the catapults ready from the catapult control pod, a small, encased control station with a transparent dome that protrudes above the flight deck.

When the plane is ready to go, the catapult officer opens valves to fill the catapult cylinders with high-pressure steam from the ship's reactors. This steam provides the necessary force to propel the pistons at high speed, slinging the plane forward to generate the necessary lift for takeoff. Initially, the pistons are locked into place, so the cylinders simply build up pressure. **The catapult officer carefully monitors the pressure level so it is just right for the particular plane and deck conditions**. If the pressure is too low, the plane will not get moving fast enough to take off, and the catapult will throw it into the ocean. If there is too much pressure, the sudden jerk could break the nose gear right off.

When the cylinders are charged to the appropriate pressure level, the pilot blasts the plane's engines. The holdback keeps the plane on the shuttle while the engines generate considerable thrust. **The catapult officer releases the pistons, the force causes the holdbacks to release, and the steam pressure slams the shuttle and plane forward**. At the end of the catapult, the tow bar pops out of the shuttle, releasing the plane. This totally steam-driven system can rocket a 45,000-pound plane from 0 to 165 miles per hour in two seconds!

If everything goes well, the speeding plane has generated enough lift to take off. If not, the pilot (or pilots) activate their ejector seats to escape before the plane goes hurdling into the ocean ahead of the ship (this hardly ever happens, but the risk is always there).

Taking off is extremely difficult, but the real trick is coming back in.

At its most basic level, an aircraft carrier is simply a ship outfitted with a flight deck — a runway area for launching and landing airplanes.

LANDING ON AN AIRCRAFT CARRIER

Landing on a flight deck is one of the most difficult things a Navy pilot will ever do. The flight deck only has about 500 feet (about 150 meters) of runway space for landing planes, which is not nearly enough for the heavy, high-speed jets on U.S. carriers.

To land on the flight deck, each plane needs a tailhook, which is exactly what it sounds like—an extended hook attached to the plane's tail. **The pilot's goal is to snag the tailhook on one of four arresting wires**, sturdy cables woven from high-tensile steel wire.

The arresting wires are stretched across the deck and are attached on both ends to hydraulic cylinders below deck. **If the tailhook snags an arresting wire, it pulls the wire out and the hydraulic cylinder system absorbs the energy to bring the plane to a stop**. The arresting wire system can stop a 54,000-pound aircraft travelling 150 miles per hour in only two seconds, in a 315-foot landing area.

There are four parallel arresting wires, spaced about 50 feet (15 meters) apart, to expand the target area for the pilot. Pilots are aiming for the third wire, as it is the safest and most effective target. They never shoot for the first wire because it is dangerously close to the edge of deck. If they come in too low on the first wire, they could easily crash into the stern of the ship. It is acceptable to snag the second or fourth wire, but for a pilot to move up through the ranks, he or she has to be able to catch the third wire consistently.

To pull off this incredible trick, the pilot needs to approach the deck at exactly the right angle. The landing procedure starts when the various returning planes "stack up" in a huge oval flying pattern near the carrier. The Carrier Air Traffic Control Center below deck decides the landing order of the waiting planes based on their various fuel levels (a plane that is about to run out of fuel comes down before one that can keep flying for a while). When it is time for a plane to land, the pilot breaks free of this landing pattern and heads toward the stern of the ship.

Landing signal officers (LSOs) help guide the plane in, through radio communication as well as a collection of lights on the deck. If the plane is off course, the LSOs can use radio commands or illuminate other lights to correct him or her or "wave him off" (send him around for another attempt).

In addition to the LSOs, pilots look to the Fresnel Lens Optical Landing System, commonly referred to as the lens, for landing guidance. The system consists of a series of lights and Fresnel lenses mounted to a gyroscopically stabilized platform. The lenses focus the light into narrow beams that are directed into the sky at various angles.

The pilot will see different lights depending on the plane's angle of approach. If the plane is right on target, the pilot will see an amber light, dubbed the "meatball," in line with a row of green lights. If the amber light appears above the green lights, the plane is coming in too high; if the amber light appears below the green lights, the plane is coming in too low. If the plane is coming in way too low, the pilot will see red lights.

As soon as the plane hits the deck, the pilot will push the engines to full power, instead of slowing down, to bring the plane to a stop. This may seem counterintuitive, but if the tailhook does not catch any of the arresting wires, the plane needs to be moving fast enough to take off again and come around for another pass. The landing runway is tilted at a 14-degree angle to the rest of the ship, so bolters like this can take off from the side of the ship instead of plowing into the planes on the other end of the deck.

As soon as an aircraft lands, it is pulled out of the landing strip and chained down on the side of the flight deck. Inactive aircraft are always tightly secured to keep them from sliding around as the deck rocks back and forth.

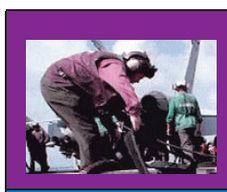
The flight-deck crew has to be prepared for a wide range of unexpected events, including raging aircraft fires. During takeoff or recovery operations, they have plenty of safety equipment at the ready. Among other things, the flight deck has a small fire truck and nozzles leading to water tanks and aqueous film-forming foam, an advanced fire-extinguishing material (there are also nozzles for jet fuel and a number of other useful liquids).

Flight-deck personnel also face the risk of a jet engine blowing them overboard. Safety nets around the side of the flight deck offer some protection, but for extra safety, personnel are also equipped with float coats, self-inflating jackets with flashing distress lights, activated by contact with water. Flight-deck personnel also wear heavy-duty helmets, called cranials, which protect their head and their hearing. ❑

A GUIDE TO THE COLOR-CODED JERSEYS ON AN AIRCRAFT CARRIER

Much goes into flight operations aboard today's modern Navy aircraft carrier. Preparations for a launch very much resemble a well-choreographed ballet. Those involved in the evolution have specific, clearly defined roles, and are easily recognizable by the color of their jerseys.

PURPLE



Aviation Fuels
[nickname: "Grapes"]

BLUE

Plane handlers
Aircraft elevator operators
Tractor drivers
Messengers and phone talkers

GREEN

Catapult and arresting gear crews
Air wing maintenance personnel
Cargo-handling personnel
Ground support equipment (GSE) troubleshooters
Hook runners
Photographer's mates
Helicopter landing signal enlisted personnel (LSE)

YELLOW

Aircraft handling officers
Catapult and arresting gear officers
Plane directors

RED

Ordnancemen
Crash and salvage crews
Explosive ordnance disposal (EOD)

BROWN

Air wing plane captains
Air wing line leading petty officers

WHITE

Air wing quality control personnel
Squadron plane inspectors
Landing signal officer (LSO)
Air transfer officers (ATO)
Liquid oxygen (LOX) crews
Safety observers
Medical personnel

Source: U.S. Navy

AND SUDDENLY FREEDOM HAD A NEW PARTNER.

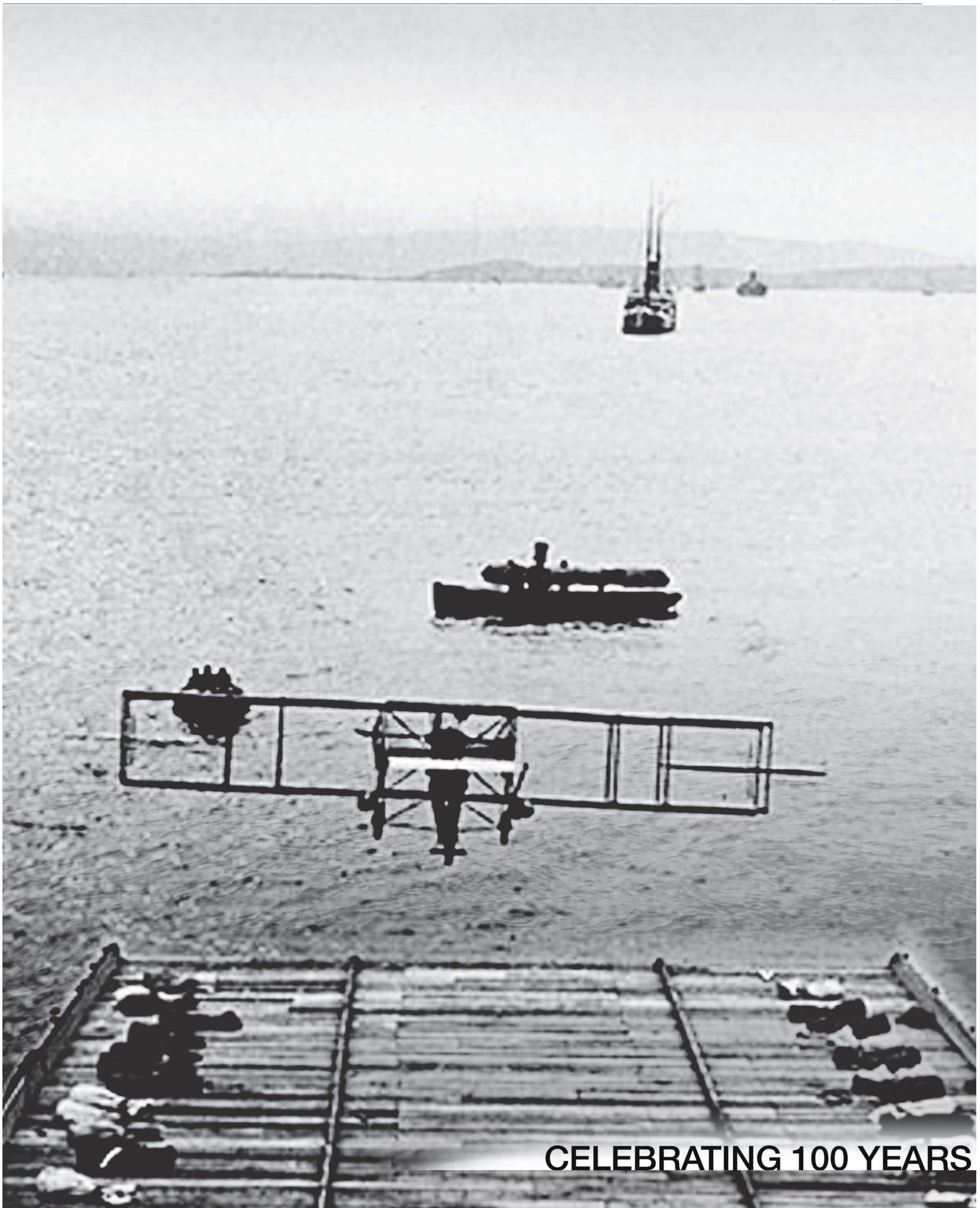


Photo courtesy of Naval History and Heritage Command

DECADE AFTER DECADE, OUR BEST FOR NAVAL AVIATION.


SBD Dauntless

A-1 Skyraider
A-2 Savage
A2D Skyshark
A-3 Skywarrior
A-4 Skyhawk
AV-8B Harrier II


F-4B Phantom II

B-314
BD Havoc
BTD Destroyer
BT2D Destroyer II
C-9B Skytrain II


F/A-18 Super Hornet

C-40 Clipper
CH-46 Sea Knight
DT-1
E-6 Mercury
EA-18G Growler
EC-24A
FH-1 Phantom


P-8A Poseidon

F-4 Phantom II
F-10
F/A-18 Hornet
F/A-18 Super Hornet
F2B
F3B
F4B
F4D Skyray
F5D Skylancer
F2H Banshee
F3H Demon
FJ Fury
FLB
H-46 Sea Knight
HCH
HUP Retriever
JD Invader
KDH Katydid
Model C/C-1F
NB
N2B
N2S Kaydet
OB
O2B
OD
O2D
OJ
OV-10 Bronco
PB-1
PB Flying Fortress
P2B Superfortress
PD-1
P2D
P3D
P-8A Poseidon
PB2B Catalina
PB2B-2 Canso
PBJ Mitchell
PB2S Catalina
PJ-1/-2
RA-5C Vigilante
R4D-8
R5D
R6D Liftmaster
RD Dolphin

R2D
R3D
SBD Dauntless


A-1H Skyraider

ScanEagle UAS
SNJ Texan
T-2 Buckeye


CH-46E Sea Knight

T-28B Trojan
T2D
T3D
T-39D Sabreliner


EA-18G Growler

T-45 Goshawk
TBD Devastator
TB2D Skypirate
TC-18F


MV-22 Osprey

HV-22 Osprey
MV-22 Osprey
XHJD-1 Whirlaway

BOEING

WWII TURNING POINT

Midway: Battle to Adapt to New Form of Naval Warfare

Midway was one of the most decisive naval battles of all time. During the six months of war preceding Midway, the Japanese carrier fleet rampaged unchecked throughout the Pacific, destroying the U.S. battle line at Pearl Harbor and enabling Japan to seize the Philippines, capture Singapore and overrun the Dutch East Indies. Then came Midway—a battle in which a supposedly weaker American force won a spectacular victory that blunted the Japanese advance in the Pacific. It was the turning point in the war against the Japanese empire—the point at which the U.S. Navy took over the strategic initiative.

PHOTO COURTESY OF U.S. NAVY

Torpedo Squadron Six TBD-1 aircraft are prepared for launching on the USS Enterprise on June 4, 1942, just hours before the battle began.

More broadly, the Battle of Midway—like the Battle of the Coral Sea that preceded it—marked a turning point in naval operations in which the aircraft carrier supplanted the battleship as the absolute determinant of naval supremacy. It was the culmination of a technical revolution in which carrier airpower displaced gunnery as the primary means of delivering naval ordnance. The Americans prevailed at Midway because the doctrine they adopted to operate within the new world of Naval aviation was better than that of the Imperial Japanese Navy.

For the Navy, doctrine is the foundation upon which tactics, techniques and procedures are built—a shared way of thinking that must be uniformly known and understood to be useful and effective. Because doctrine articulates the operational concepts that govern the employment of armed forces, it is critical for the success of any military operation—thus its importance in evaluating the actions of the forces engaged at the Battle of Midway.

The outcome of the Battle of Midway was decided at precisely 10:22 a.m. on June 4, 1942, when the first of three squadrons of American dive-bombers from the USS Yorktown and USS Enterprise attacked the Japanese First Air Fleet as it was preparing to launch its own planes against the U.S. carriers. The American planes struck the Kaga, Akagi and Soryu in quick succession, setting all three ablaze within three minutes. The surviving Japanese carrier, Hiryu, quickly retaliated. After an exchange of air strikes that afternoon, Hiryu was burning from stem to stern, while its opponent, Yorktown, was dead in the water, without power. Hiryu sank the next day. Yorktown survived long enough to be taken under tow, but then it was torpedoed by a Japanese submarine.

Different paths of carrier development taken by the Japanese and American navies following World War I led to differences in carrier doctrine—differences that had a tremendous impact once the two forces were engaged.

First and foremost of these was the American airmen's obsession with locating the enemy's carriers first and then striking first. This principle became sacrosanct in U.S. carrier doctrine as soon as commanders realized that the best way to achieve air supremacy was to attack the opposing carrier before it had a chance to get its own planes in the air. Once launched, such a strike would be almost impossible to fend off.

Although the Japanese understood this principle, they devoted their carrier forces entirely to the attack mission, relegating the search mission to the less capable floatplane of the cruiser escorts. This fatal flaw in doctrine caused the Japanese to be caught while their hangar decks were packed with aircraft being fueled and armed.

The second doctrine-based difference was the predominance of the scout/dive-bomber on the American side. This type was unique to the U.S. Navy and could both locate and attack an enemy carrier. The effectiveness of the scout/dive-bomber (particularly the superb SBD, which outflew, outdove and outbombed the Japanese Val) was proved beyond the shadow of a doubt at Midway.

Last, but certainly not least, was the adoption of the deck park and the associated handling procedures devised by American airmen to maximize the number of aircraft that could be operated at one time from an aircraft carrier. This system of keeping aircraft on the deck enabled the U.S. Navy to operate more aircraft per carrier than its Japanese counterparts and thus to fly almost as many aircraft as the Japanese at Midway, with one less carrier.

The deck park allowed a second dive-bombing squadron to be added to each carrier's air group, in the combined role of scout and bomber. It was one of these squadrons, VS-6 from the Enterprise, that made up for the lost planes from the Hornet that failed to locate the enemy carriers. The extra squadron allowed the U.S. to strike three carriers at once, leaving just one.

The outcome at Midway would have been very different had VS-6 not been present.

On the downside, the U.S. Navy's reliance on the deck park meant that the entire air strike group had to be launched at one time. This system worked well during short-range simulated engagements conducted during the 1930s, when the various squadron types could circle the carrier while the air group formed up. At Midway, differences in aircraft range, cruising speed and the takeoff run for each type (fighter, bomber, torpedo), combined with the extreme distance to the target, played havoc with the air group's ability to conduct a coordinated attack. The piecemeal commitment of forces that resulted from this approach and the lack of satisfactory air cover had disastrous consequences for the torpedo squadrons, which were all but annihilated.

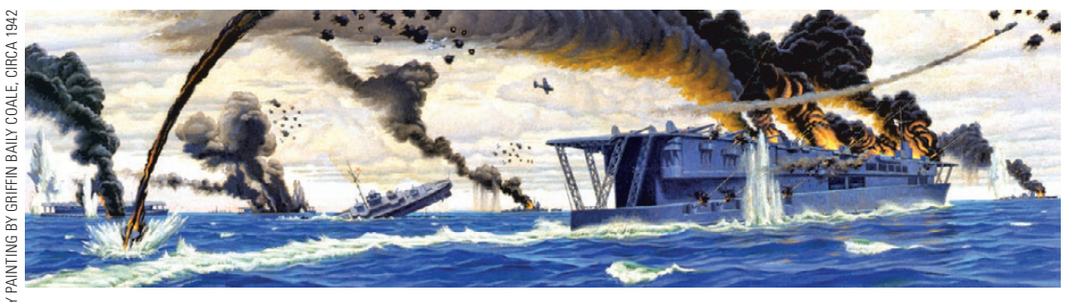
In terms of launching aircraft, the Japanese had devised a workable doctrine that was in some ways superior to the U.S. technique. They developed the concept of the "deckload spot," wherein each carrier contributed one of its attack units (bomber or torpedo) and then some number of escort fighters. Not only was this technique better suited to the smaller flight decks of the Hiryu and the Soryu, but it was highly advantageous when it came to coordinating air strikes from multiple carriers. The latter enabled the Japanese to conduct the massive air strikes that were the hallmark of the First Air Fleet.

The lack of coordination among the American carriers was a major deficiency that could have cost them the battle. Instead of assembling for a coordinated strike, individual flights from different carriers—both torpedo and dive-bombing—arrived over the target independently of each other and attacked separately. This resulted in the ineffective torpedo plane attacks that preceded the arrival of the two flights of dive-bombers, whose simultaneous appearance at this critical juncture of the battle was extremely fortuitous—many would say "sheer luck."

The example of Midway illustrates the critical role of doctrine as a partner with technical innovation. In its development, different paths lead to different technical solutions. Further, what happened at Midway shows that chance and circumstances often play major roles in the evolutionary path taken by a military establishment as it attempts to adapt to new technologies and the changes they bring to the character of warfare. ❍

BY THOMAS WILDENBERG

ADAPTED FROM "MIDWAY: SHEER LUCK OR BETTER DOCTRINE," WHICH APPEARED IN THE WINTER 2005 ISSUE OF NAVAL WAR COLLEGE REVIEW.



U.S. NAVY PAINTING BY GRIFFIN BAILY COALE, CIRCA 1942

Dive Bombing Japanese Carriers Because the two opposing fleets never came face to face, many significant incidents of the Battle of Midway were unrecorded. Artists used eyewitness accounts and official photographs to visualize this historic encounter.

This oil painting is based on the recollections of Ensign George Gay of Torpedo 8, who watched the battle from the ocean after his plane was shot down in the first wave against the Japanese.

The Americans prevailed at Midway because the doctrine they adopted to operate within the new world of naval aviation was better than that of the Imperial Japanese Navy.

NAVY WOMEN

Increasingly, Naval Aviation Is Women's Work, Too

Although civilian women have been flying airplanes since before 1911, women have only recently taken flight as Navy combat aviators.

The first women permitted to report to Navy flight training earned their "wings of gold" in 1974. Barbara Allen became the first, followed by five more women that year. The women mostly trained with their male counterparts, but they were not allowed to fly jet aircraft or board an aircraft carrier.

As opportunities have increased, the number of female pilots has increased, though women still make up only about 4 percent of Navy pilots, 317 in all as of June 2010. About 7 percent of naval flight officers (onboard crew) are women, while nearly 16 percent of active duty enlisted Navy personnel are women.

Increasingly, women have punched large holes through what has been called the "armor-plated ceiling," especially since 1993, when Congress repealed the law excluding women from combat.

"For almost the past 20 years now since the law has changed, women and men come into the Navy together, go to training together, go to ships together, go to squadrons together. It's a vastly different world than when I got into the Navy" in 1979, said Rear Admiral Nora Tyson, the first woman to command a carrier strike group.

PHOTO COURTESY OF U.S. NAVY

Rear Admiral Nora W. Tyson, Commander of Carrier Strike Group Two, is the first woman to command a carrier strike group.

During World War II, women served as Women Accepted for Volunteer Emergency Services (WAVES), freeing men to fight in the war. Unlike the Women Airforce Service Pilots (WASPs), the Navy women did not fly planes. But they paved the way for today's female pilots because more than 20 percent served in aviation support roles such as air traffic controllers and trainers, and they received pay equal to that of their male counterparts, said Regina Akers, historian with the Navy History and Heritage Command.

After the war, Congress passed the Women's Armed Services Integration Act, which created a place for women in the peacetime military but restricted their opportunities and excluded women from combat roles.

At the end of the Vietnam War, the services were facing the end of the military draft. At the same time, a progressive chief of naval operations, Admiral Elmo Zumwalt, set out to modernize the Navy, issuing Navy policy directives he called "Z-grams." Z-gram #116 in Aug. 1972 declared that women would have equal rights and opportunities in the Navy. As a result, the Navy invited women to apply for flight training, and was the first U.S. service branch to do so, Akers said.

Capt. Rosemary Mariner was one of the first to answer the call. Already a pilot by the time she graduated from Purdue University, she was encouraged to apply by a dean who had herself been in the Navy during World War II. Mariner became the sixth woman to earn her Navy wings and was the last of the original six female pilots to retire, in 1997, having served for 24 years.

What the women wanted most was to qualify aboard aircraft carriers, the true test of a Navy pilot's mettle and a requirement for men to earn their flying wings—but women were not allowed to fly onto the carriers, Mariner said.

PHOTO COURTESY OF U.S. NAVY

WAVES aircraft mechanics work on the port outboard engine of a Naval Air Transport Service R5D, circa mid-1945.

Lucy Young became the 14th woman to earn her wings in 1977 but left active duty in 1983. She said many women like her left the Navy within a few years because they were frustrated with the lack of opportunity. While her male counterparts were serving on aircraft carriers, Young was "playing the bad guy" in mock missions to train combat pilots. Young, now a pilot for US Airways, piloted cargo missions as a reservist during the first Gulf War.

Mariner persisted in the Navy. "I'd always been interested in history and it was the injustice of it" that Mariner said she wanted to change. "It was not just that. I enjoyed the leadership part of the Navy, the airplane part of it. There was no other place you could fly those kinds of planes."

In the mid-1970s, Mariner qualified to fly a tactical jet aircraft, the A-4E Skyhawk, and became the first woman to qualify as an A-7E Corsair II pilot.

"I went through a back doorway," Mariner explained. "I went to a squadron that had some old propeller airplanes, but predominately A-4s from the Vietnam Era. My officer was one of a handful of African-American pilots. With him and the support of several others, I was able to go through jet qualification with my fellow pilots."

The officer, Capt. Ray Lambert, shared his experiences as an African-American pilot in the Navy with the young Mariner. "It really helps to have someone tell you what the ropes are like, what the culture is like, how to set a goal and obtain it," she said.

In 1990 Mariner became the first woman to command an operational squadron, Tactical Electronic Warfare Squadron 34, a training squadron for combat aircraft.

Tyson, too, progressed with the encouragement of fellow officers. She did not enter the Navy planning to fly, but soon took that path "because I worked for aviators who said, 'Hey, you need to apply for flight school.'" Slightly less than perfect eyesight kept her out of the pilot seat, but Tyson trained to become a naval flight officer. She has served in both air and sea roles, including as commander of the amphibious assault ship USS Bataan, leading the Navy's disaster relief efforts after Hurricane Katrina and deploying twice to the Persian Gulf during the Iraq War.

They say the definition of a radical feminist is a father who has a daughter at the Naval Academy.

— Capt. Rosemary Mariner, USN (ret.)

In the 1980s, Vice Admiral William Lawrence aided the transition for women as chief of naval personnel. "They say the definition of a radical feminist is a father who has a daughter at the Naval Academy—that was Lawrence," Mariner said. Lawrence was the Academy superintendent when his daughter Wendy graduated in 1981, among only the second class that included women. She became a Navy pilot and served on four space shuttle missions for NASA. Today, 20 percent of the U.S. Naval Academy midshipmen are women.

Mariner, now a resident scholar at the Center for the Study of War and Society at the University of Tennessee, said history shows that after a war, a brief window opens during which Congress might make significant changes.

For women, she said, "The window was the first Gulf War. That's when a number of women from all the services, men from all the services and a lot of civilians who had followed these issues were able to convince Congress to change" the combat exclusion law in 1993.

In 1991 about 2,600 Navy women participated in Operations Desert Shield and Desert Storm in non-combat roles. Last year about 11,600 Navy officers and enlisted personnel who were serving on combatant vessels were women.

Currently, all Navy aviation operations are open to women. Female pilots take aircraft into battle zones in all weather and at night, on missions to drop ordnance, gather information and support ground troops. In January, personnel assigned to the aircraft carrier USS Abraham Lincoln participated in an all-female catapult crew event, as Lt. Cmdr. Jessica Parker launched an F/A-18F Super Hornet during flight operations supporting Operation Enduring Freedom in the Arabian Sea.

Experience in combat and humanitarian roles has increased the ability of women to rise through the ranks in the services. Capt. Sara Joyner, a 1989 USNA grad and a fighter pilot, was recently selected as the first woman to command a carrier air wing. She will be responsible for all aircraft, pilots and support personnel in Carrier Air Wing-3, now attached to aircraft carrier USS Harry S. Truman. In November, Lt. Col. Alison J. Thompson became the first woman Marine pilot to command a squadron, Marine Heavy Helicopter Squadron 464.

A year ago, Secretary of Defense Robert Gates announced that women would serve on submarines, one of the last positions still closed after 1993. Special forces remain the only assignment closed to women.

"We will have made progress when this is not a newsworthy event," Mariner said. "When the first gals go aboard the submarines, there will be some attention around that. Is this news anymore, really? Not like it would have been in 1975." ❍

PHOTO COURTESY OF U.S. NAVY

Photographed in her A-7E (Corsair II) cockpit during 1991, then–Commander Rosemary Mariner was the first Navy woman to command an aviation squadron.

100 YEARS OF NAVAL AVIATION 1911-2011

HOW TO BECOME A NAVY PILOT

Do You Want To Earn Your Wings of Gold?

It is an arduous process, taking up to four years. Young men and women, all college graduates, report from three recruiting sources: Just under 40 percent come from the U.S. Naval Academy, just over 40 percent come from Naval Reserve Officer Training Corps (NROTC) units, and about 20 percent from Officer Candidate School (OCS). A small number of "flying chief warrant officers" have come from the enlisted ranks.

Candidates must first take an aptitude test and a battery of physical, psychological and background tests. Pilots need to pass an eye test, though naval flight officers have much less stringent sight requirements.

Introductory Flight Screening (IFS)

All students who do not already have a private pilot certificate first enroll in a civilian flight school for 15 hours of flight training in small general aviation aircraft. The training includes a solo flight by the student.

Aviation Preflight Indoctrination (API)

Flight training begins at Naval Air Station Pensacola, Fla., the "Cradle of Naval Aviation."

To qualify for flight training, students start with Aviation Preflight Indoctrination (API) at the Naval Aviation Schools Command, Pensacola, Fla. Navy, Marine Corps, Air Force and Coast Guard flight students spend about six weeks at API. There they are challenged both academically and physically. Classes include engineering, aerodynamics, air navigation, aviation physiology and water survival.

Upon completion of API, student pilots, also known as Student Naval Aviators (SNA), and student navigators, known as Student Naval Flight Officers (SNFO), proceed to their separate primary training pipelines. Time for primary, intermediate and advanced training varies by designator (Naval Aviator or Naval Flight Officer) and pipeline (Jet, Rotary and Multi-Engine).

Navy Flight Training

For the student aviators, primary training is about 22 weeks. It includes ground-based academics, simulators and flight training. Primary training consists of six stages: Familiarization (FAM), Basic Instruments, Precision Aerobatics, Formation, Night FAM, and Radio Instruments.

Pipeline selections occur upon completion of primary training. This is based on the current and projected needs of the services, the student's performance and preferences. At that point, the students progress to intermediate and advanced training.

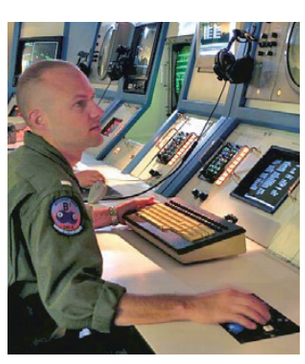
Flight Officer Training

All Student Naval Flight Officers (SNFO) initially train together under the Navy syllabus. After completing API, all SNFOs report for primary NFO training. SNFOs fly the T-6 Texan II in an abridged primary training syllabus. Pipeline/aircraft selection is made several times as training progresses and the student begins to specialize. The type of aircraft affects the flight officer's function. Some will train to be weapons officers, while others learn to operate the complex Aviation Tactical Data System (ATDS), which helps commanders make decisions based on a variety of information sources. ❍

PHOTOS COURTESY OF NAVAL AIR SYSTEMS COMMAND

F/A-18 Hornet cockpit simulator.

P-3C Orion cockpit flight simulator.



P-3C Orion crew station training device.

E-6B Mercury full motion cockpit simulator.

For more information, see cnatra.navy.mil

THE NEWEST CARRIER

George H. W. Bush

The Navy's newest aircraft carrier, named after the 41st president, is scheduled to leave Norfolk, Va., for its maiden deployment in May.

PHOTO COURTESY OF U.S. NAVY

The aircraft carrier USS George H.W. Bush at sea.

The aircraft carrier George H.W. Bush (CV-77) is the 10th and last of the Nimitz class of nuclear-powered supercarriers. The vessel is powered by two nuclear reactors that can operate for more than 20 years without refueling. The $6.2 billion carrier is expected to serve as a Navy warship for about 50 years.

The George H.W. Bush towers 20 stories above the waterline with a four and one-half-acre flight deck. It is 1,092 feet long—nearly as long as the Empire State Building is tall. More than 80 combat aircraft will travel aboard the carrier. About 6,000 Navy personnel will live and work on the carrier during the deployment to the Fifth and Sixth Fleets in the Mediterranean Sea and the Arabian Gulf.

Bush was himself a Navy aviator, earning his wings at 18, the youngest pilot in the Navy at the time. During his service during World War II, he flew torpedo bombers off the USS San Jacinto.

This spring's deployment also will be the first for Rear Admiral Nora Tyson as commander of Carrier Strike Group Two, which includes the George H. W. Bush, two cruisers, destroyers, a frigate and an air wing.

"I have a phenomenal team on the George H. W. Bush and the George H. W. Bush Strike Group," Tyson said. "One of the unique things is we do have a living namesake and everybody is aware of that and they really want to make him proud. They are giving him everything they have got." ❍

Former President George H. W. Bush meets with the crew of the aircraft carrier George H.W. Bush during a July 2010 training exercise.

2011 CENTENNIAL EVENTS

FEBRUARY 10-13
Centennial Kickoff Celebration & Aerial Review
Naval Air Station North Island, San Diego, Calif.

DECEMBER 3
Centennial Closing Gala
Washington, D.C.

MARCH 19-27
Jackson Navy Week
Naval Air Station Meridian & Keesler Air Force Base, Miss.

APRIL 9-10
NAS Corpus Christi Salute to 100 Years of Naval Aviation
Corpus Christi, Tex.

APRIL 15-17
NAS Ft. Worth Joint Reserve Base Air Power
Naval Air Station JRB, Ft. Worth, Tex.

APRIL 30-MAY 1
MCAS Beaufort Air Show
Marine Corps Air Station Beaufort, S.C.

MAY 3-9
Centennial of Naval Aviation Week Pensacola
Naval Air Station Pensacola, Fla.

MAY 5-11
New Orleans Navy Week & 'Nawlins Air Show
Joint Reserve Base, New Orleans, La.

MAY 13-15
MCAS New River Air Show
Marine Corps Air Station New River, Jacksonville, N.C.

MAY 20-22
DoD Joint Services Open House
Andrews Air Force Base, Md.

MAY 22-JUNE 2
NY Fleet Week & Jones Beach Air Show
Jones Beach State Park, New York, N.Y.

MAY 23-29
Philadelphia Navy Week & Millville Army Air Field Show
Millville Airport, N.J.

JUNE 4-5
Rockford AirFest 2011
RFD International Airport, Chicago, Ill.

JUNE 11-12
Evansville Freedom Festival
Downtown Evansville Riverfront Esplanade, Ind.

JUNE 16-22
Davenport Navy Week & Quad Cities Air Show
Davenport Municipal Airport, Eldridge, Iowa

JUNE 20-26
Marine Week St. Louis
St. Louis city-wide event, Mo.

JUNE 25-26
National Guard Association of Rhode Island Open House & Air Show
OQU State Airport, North Kingston, R.I.

JULY 11-17
Rochester Navy Week & ESL International Air Show
ROC International Airport, N.Y.

JULY 18-24
Detroit Navy Week & Thunder Over Michigan Air Show
Willow Run Airport, Ypsilanti, Mich.

JULY 25-AUG. 1
EAA AirVenture Oshkosh
EAA Aviation Center, Oshkosh, Wis.

JULY 31-AUG. 8
Seattle Fleet Week & SeaFair
South Lake Washington, Seattle, Wash.

AUG. 8-14
Fargo Navy Week and Air Show
Hector International Airport, Fargo, N.D.

AUG. 26-27
The Great State of Maine Air Show
Naval Air Station Brunswick, Maine

SEPT. 3-4
NAS Pax River Air Expo '11
Naval Air Station Pax River, Md.

SEPT. 6-11
Omaha Navy Week & Guardians of Freedom Air Show
Lincoln Airport, Neb.

SEPT. 14-18
National Championship Air Races
Reno-Stead Airport, Nev.

SEPT. 17-18
Memphis AirFest
Millington Regional Jetport, Tenn.

SEPT. 19-OCT. 2
San Diego Fleet Week & MCAS Miramar Air Show
Marine Corps Air Station Miramar, Calif.

SEPT. 20-25
NAS Oceana Air Show & AIAA Centennial Convention
Naval Air Station Oceana, Virginia Beach, Va.

OCT. 8-9
San Francisco Fleet Week
San Francisco city-wide event, Calif.

OCT. 15-16
Lemoore Air Show
Naval Air Station Lemoore, Calif.

OCT. 17-23
El Paso Navy Week & Amigo Air Show
Fort Bliss, Tex.

NOV. 5-6
NAS Jax, Birthplace of the Blue Angels Air Show
Naval Air Station Jacksonville, Fla.

NOV. 11-12
Pensacola Homecoming
Naval Air Station Pensacola, Fla.

MUSEUMS

Within a short drive of Washington, D.C., learn about Naval aviation at these attractions:

U.S. Navy Memorial Foundation and Naval Heritage Center
Washington, D.C.
navymemorial.org

National Air & Space Museum and Steven F. Udvar-Hazy Center
Washington, D.C., and Chantilly, Va.,
nasm.si.edu

National Museum of the Marine Corps
Quantico, Va.
usmcmuseum.org

Patuxent River Naval Air Museum
Lexington Park, Md.
paxmuseum.com

Hampton Roads Naval Museum
Norfolk, Va.
hrnm.navy.mil

Military Aviation Museum
Virginia Beach, Va.
militaryaviationmuseum.org

Tours of the Naval Station Norfolk
Norfolk, Va.
cnic.navy.mil/NorfolkSTA/Programs/FleetFamilySupportProgram/ShipBaseTours

Museums worth traveling to:

National Naval Aviation Museum
Pensacola, Fla.
navalaviationmuseum.org

Intrepid Sea, Air & Space Museum
New York, N.Y.
intrepidmuseum.org

USS Hornet Museum
Alameda, Calif.
uss-hornet.org

USS Lexington Museum
Corpus Christi, Tex.
usslexington.com

Glenn H. Curtiss Museum
Hammondsport, N.Y.
glennhcurtissmuseum.org

In San Diego, Calif.:

USS Midway Museum
midway.org

Flying Leatherneck Historical Foundation & Aviation Museum
flyingleathernecks.org

San Diego Air & Space Museum
sandiegoairandspace.org

RESOURCES

Web sites:

100th Anniversary of Naval Aviation Foundation
navalaviation100.org

How Stuff Works
HowStuffWorks.com

U.S. Navy's Aviation Centennial
public.navy.mil/airfor/centennial

Navy History and Heritage Command
history.navy.mil

The Smithsonian's Air & Space magazine: 100 Ways to Celebrate the Naval Aviation Centennial
airspacemag.com/specialsections/Celebrate-Naval-Aviation.html

Books:

U.S. Naval Aviation
by Hill Goodspeed, updated reissue forthcoming in April 2011.

Destined for Glory: Dive Bombing, Midway and the Evolution of Carrier Air Power
by Thomas Wildenberg, 1998.

Ship Killer: A History of the American Torpedo
by Thomas Wildenberg and Norman Polmar, 2010.

The Naval Air War in Korea
by Richard P. Hallion, 1986, with reissue forthcoming in April 2011.

FOR MORE INFORMATION

ABOUT THIS SECTION:
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PBS DOCUMENTARY

ANGLE OF ATTACK: How Naval Aviation Changed the Face of War

A **two-part documentary** series co-produced by *The Washington Post* will bring to life the largely untold story of one of the pillars in our national defense structure.

PHOTO COURTESY OF U.S. NAVY

Eugene Ely sits in the pilot seat of the Curtiss pusher biplane aboard the USS Pennsylvania on Jan. 18, 1911. Note the inflated bicycle inner tubes Ely wore to keep him afloat in case the plane crashed at sea.

"Angle of Attack: How Naval Aviation Changed the Face of War" is set to appear later this year on public television stations nationwide. The two-hour program will tell the story of a hundred years of Naval aviation, from wobbly gliders to supersonic jets. The broadcast, produced by The Documentary Group, a New York production company, will chart how technological innovations shaped strategic choices and, conversely, how strategic imperatives propelled Naval aviation toward innovation and reinvention.

While chronicling the technological and strategic advances of Naval aviation, the program also will focus on the aviators, the heart and soul of Naval aviation.

"Every new technology requires visionaries, pioneers, and risk-takers, and Naval aviation has had more than its share," said Chana Gazit, one of the program's two writer-producers. "You're talking about larger-than-life figures who risked their own lives to push Naval aviation forward. They really are kind of a breed apart."

The first hour of the program will follow young men and women on their way to earning their "Wings." In a rigorous course of instruction they will learn how to lift off and land a supersonic aircraft on the deck of an aircraft carrier in the middle of the ocean—still one of the most difficult and hazardous tasks undertaken by man and machine.

The program will then take viewers back to the very first shipboard landing, by Eugene Ely in 1911. Viewers will learn how the act of landing a fragile biplane on a make-shift wooden deck would eventually lead to a weapon of unprecedented power and influence.

The first hour will conclude with World War II and the U.S. victory in the Pacific, when carrier aviation proved itself beyond measure. But just as Naval aviation reigned supreme, it faced a threat to its very existence—not from an enemy source, but from a competing technology: the nuclear bomb.

The second hour will open with the potential demise of Naval aviation, as many in the military establishment promoted nuclear weapons as the wave of the future and pronounced carrier aviation as obsolete. Then, suddenly, the war in Korea changed everything. Korea, and later Vietnam, offered a startling reminder of the usefulness of Naval aviation and shook the notion that all wars would be fought with nuclear weapons.

Nevertheless, the specter of nuclear war did not diminish. As the Cold War raged on, the installation of Soviet ballistic missiles in Cuba brought the nation's alert system to DEFCON 2—just short of nuclear war. By then, Navy aircraft had become fully capable of delivering nuclear bombs, but it was another important function of Naval aviation—reconnaissance—that rallied world opinion and helped diffuse the crisis. Photographs of the Soviet missiles taken by low-flying Naval aviators were shown to the world at the United Nations, providing incontrovertible evidence that the Soviet Union had been lying.

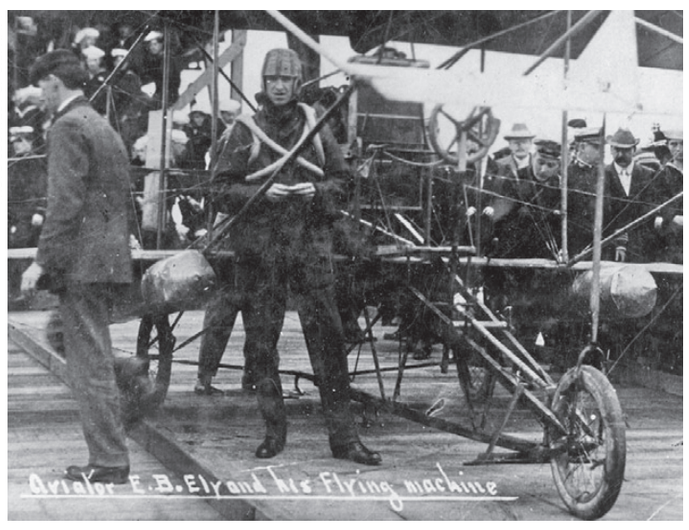
The broadcast will travel through a rich history that includes racial integration and the presence of women in combat. The program will progress from the age of nuclear terror to a new kind of terror: asymmetrical warfare. On Sept. 11, 2001, aviator Bill Lind had gone jogging on the deck of the USS Enterprise—a no-fly day, a welcome day of quiet. The ship was on the way home, and Lind was walking back to his quarters, when he heard a correspondent on TV report a possible accident in downtown Manhattan. By the time he was out of the shower, the Enterprise was on a sharp tilt, carving a high-speed U-turn back to the Persian Gulf. Thus began the first feverish weeks of Operation Enduring Freedom, when carriers were, as one interviewee put it, "the only game in town." Viewers will also learn how Naval aviators have struggled to remain relevant throughout the long, difficult ground wars in Afghanistan and Iraq. The cost of carrier aviation, combined with the dazzling pace of technological progress, means that once again the strategic ground is shifting. The rise of unmanned aerial vehicles poses new unsettling questions: how does war change when we take the man or woman out of the cockpit?

The film will close where it began, with the next generation of pilots working to hone their skills, in all kinds of weather, day or night, to operate a jet safely from an aircraft carrier in the middle of the ocean. Viewers will be with them during the two-day trial on the aircraft carrier George H.W. Bush for which they had been preparing nearly two years.

If change is coming to their craft, these pilots are unworried by it, indeed welcome it.

"Americans as a whole may be unfamiliar with this history, but these students really get it," producer Thomas Lennon said. "Naval aviation has a big place in American history, and these young men and women want to add to it. They want to make a little history of their own." ❍

PHOTO COURTESY OF U.S. NAVY



Eugene Ely poses with the Curtiss pusher biplane aboard the USS Pennsylvania on Jan. 18, 1911.

> **"Every new technology requires visionaries, pioneers, and risk-takers, and Naval aviation has had more than its share."**
> —Chana Gazit, co-writer-producer of "Angle of Attack: How Naval Aviation Changed the Face of War"

DOCUMENTARY GROUP

The Washington Post

COAST GUARD CONTINUED FROM 2

submariners who had found themselves adrift off the American coast when their U-boat was sunk by an Army bomber. In Greenland they hunted for German weather stations placed along the coast and for downed U.S. aircraft and aviators lost on ferry flights. Coast Guard aircraft participated in the construction and maintenance of radio-based navigation stations, called LORAN, around the globe. Coast Guard aircraft participated in the construction and maintenance of radio-based navigation stations, called Long Range Navigation (LORAN) around the globe.

In one of its most important aviation missions of the war, the Coast Guard began experimenting with rotary-winged aircraft. In fact, they led the nation in the development of helicopters and oversaw the training of new helicopter pilots for the Allies. As in the early years of Coast Guard aviation, far-sighted officers saw the potential of new technology and made the effort to experiment with and promote that technology.

William Kossler and Frank Erickson led the service's efforts to develop the helicopter first as an anti-submarine and convoy escort aircraft and then as a search-and-rescue platform. Erickson witnessed the Japanese attack on Pearl Harbor first-hand as the duty officer on Ford Island that morning, and the event profoundly influenced his thoughts on aviation and rescue capabilities. Erickson experimented, and he perfected the helicopter's capabilities, including using hoists to recover persons in the water and techniques to land and take off from ships underway at sea, the latter pioneered by another famous Coast Guard aviator, Stewart R. Graham. As a direct result of their efforts, the helicopter—what was then an ungainly and dangerous air machine like the first Wright Flyer—ultimately became what it is today—the versatile workhorse of today's Coast Guard aviation fleet.

The helicopter continually proved its worth as an excellent search and rescue platform over land as well. Coast Guard helicopters responded to dozens of domestic floods and hurricanes, pulling survivors in imminent danger off rooftops and out of trees from flooded land. Surface forces also responded to these events but the helicopter proved more versatile in its ability to arrive on scene as a storm moved inland or the flooding crested and to instantly begin pulling survivors to safety.

Indeed, the Coast Guard's most shining moment came during just such an incident in 2005. Literally minutes after Hurricane Katrina screamed ashore along the Gulf coast in 2005, a host of orange helicopters strategically placed prior to the storm swarmed over the ravaged areas and began rescuing survivors as the hurricane winds moved inland. Over the coming days, Coast Guard helicopters, HH-65 Dolphins and HH-60 Jayhawks, pulled from peril thousands of victims, while fixed-wing aircraft surveyed damaged areas, looked for spills and sunken vessels and helped coordinate the busy air traffic over New Orleans.

USCG PHOTO BY PETTY OFFICER RUSS TIPPETS

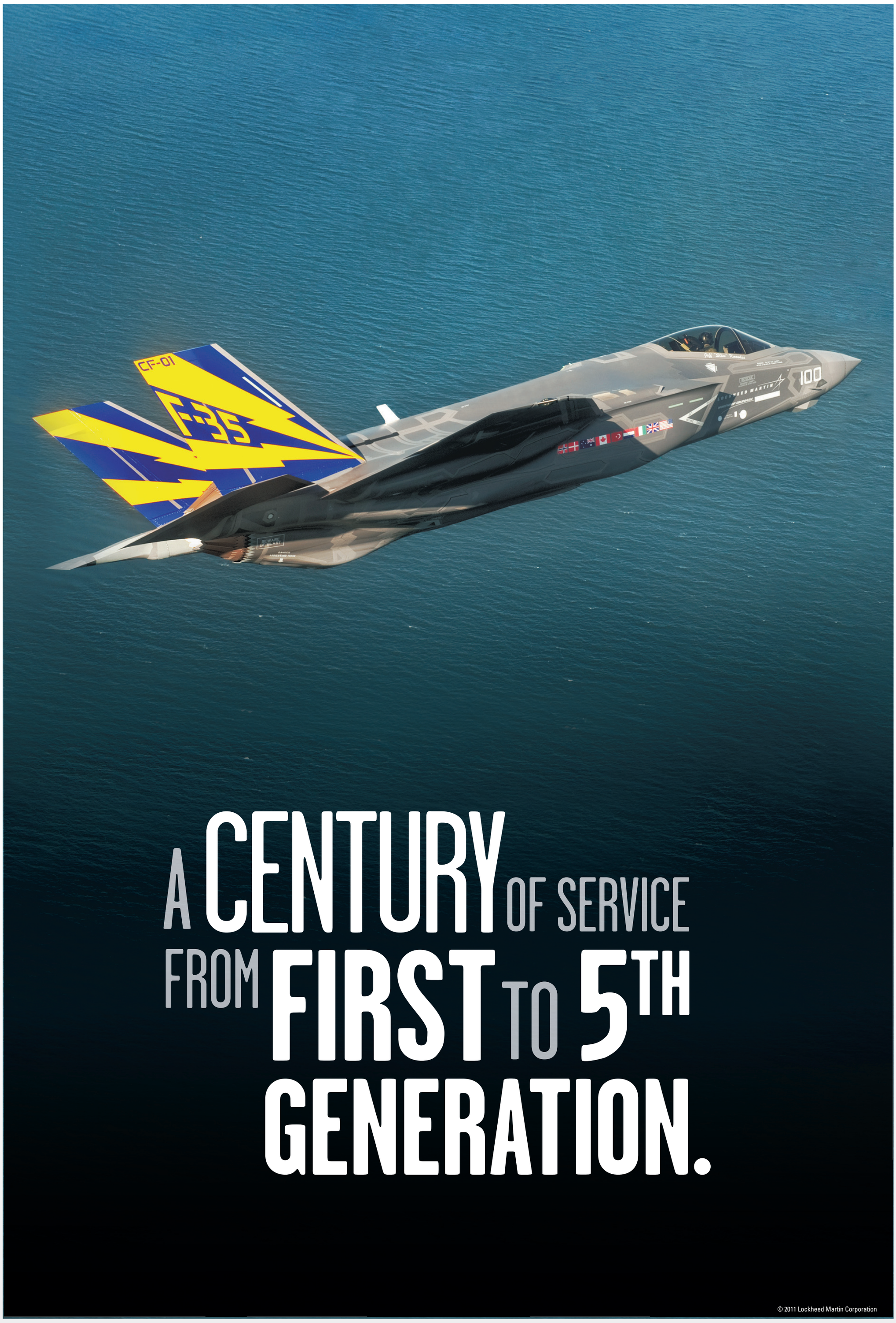
An HH-65 Dolphin helicopter lands on the Coast Guard cutter Spencer, September 5, 2005. After refueling, the crew resumed search and rescue operations in New Orleans following Hurricane Katrina.

> **Underfunded but innovative, using borrowed aircraft flown from unused airfields, the first few years of Coast Guard aviation were quite a test of the flyers' courage, intelligence and perseverance.**

The Coast Guard and its aviation branch have long been involved with operating in polar regions and over Alaska. Helicopters flew from each of the service's icebreakers (the Coast Guard from 1965 has been charged with operating the nation's icebreaking fleet) that resupplied bases in the Arctic and Antarctica every winter and explored the world's ice-crusted seas. Coast Guard aviation also scours the North Atlantic for errant icebergs for the International Ice Patrol, first established after the loss of the HMS Titanic. Now the venerable but updated HC-130 carries on the almost century-old task of safeguarding international shipping.

The spirit of innovation still pervades the service as it did in the beginning years of Coast Guard aviation. Whether preparing to aid hurricane survivors, surveying oil spills, flying helicopters off of ships far out to sea to hunt for smugglers, rescuing mariners in distress, developing a rescue-swimmer program on a shoe-string, safeguarding the nation's coasts, flying over the North Pole or developing a logistic system that became the model for current Coast Guard logistics modernization efforts, the service's aviation program leads the way. Powered flight has never been entirely without danger though, something understood by all who fly, and such daring has had a cost. But to the women and men of the Coast Guard, those who take to the air or sail on the sea, "service before self" is a way of life, and they willingly accept that cost and the challenge. ❍

BY SCOTT PRICE, DEPUTY COAST GUARD HISTORIAN



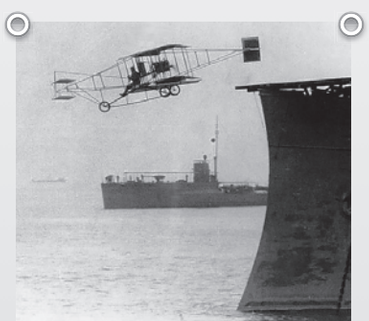


Photo courtesy U.S. Navy

For one hundred years, Naval Aviation has played a major role in the defense of freedom. And pushed the envelope of aviation technology. From the Curtiss biplane that performed the first takeoff and arrested landing aboard a ship to today's state-of-the-art fixed- and rotary-wing aircraft, Naval Aviators and support personnel have been at the tip of the spear. The men and women of Lockheed Martin are extraordinarily proud to be a part of the Naval Aviation team. As we celebrate the 100th anniversary of Naval Aviation, we offer our heartfelt thanks and a resounding Bravo Zulu.

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