Flights From the

By Norman Polmar and Kenneth J. Moore

Attempts to launch aircraft from submarines date to World War I. Between the world wars, Britain used a modified submarine monitor, M2. *By World War II, Japan had taken the lead in sub-launched aircraft capabilities.*

Two revolutionary weapons were introduced early in the 20th century: the airplane and the submarine. Combining the two took some imagination and lots of ingenuity.

The first rudimentary steps toward the combination took place during World War I. The British and German navies used standard submarines that carried floatplanes on the surface that would then submerge just enough to float off the aircraft. After carrying out their mission, the aircraft would return to a land base or put down at sea, where they were scuttled after the pilots were recovered.

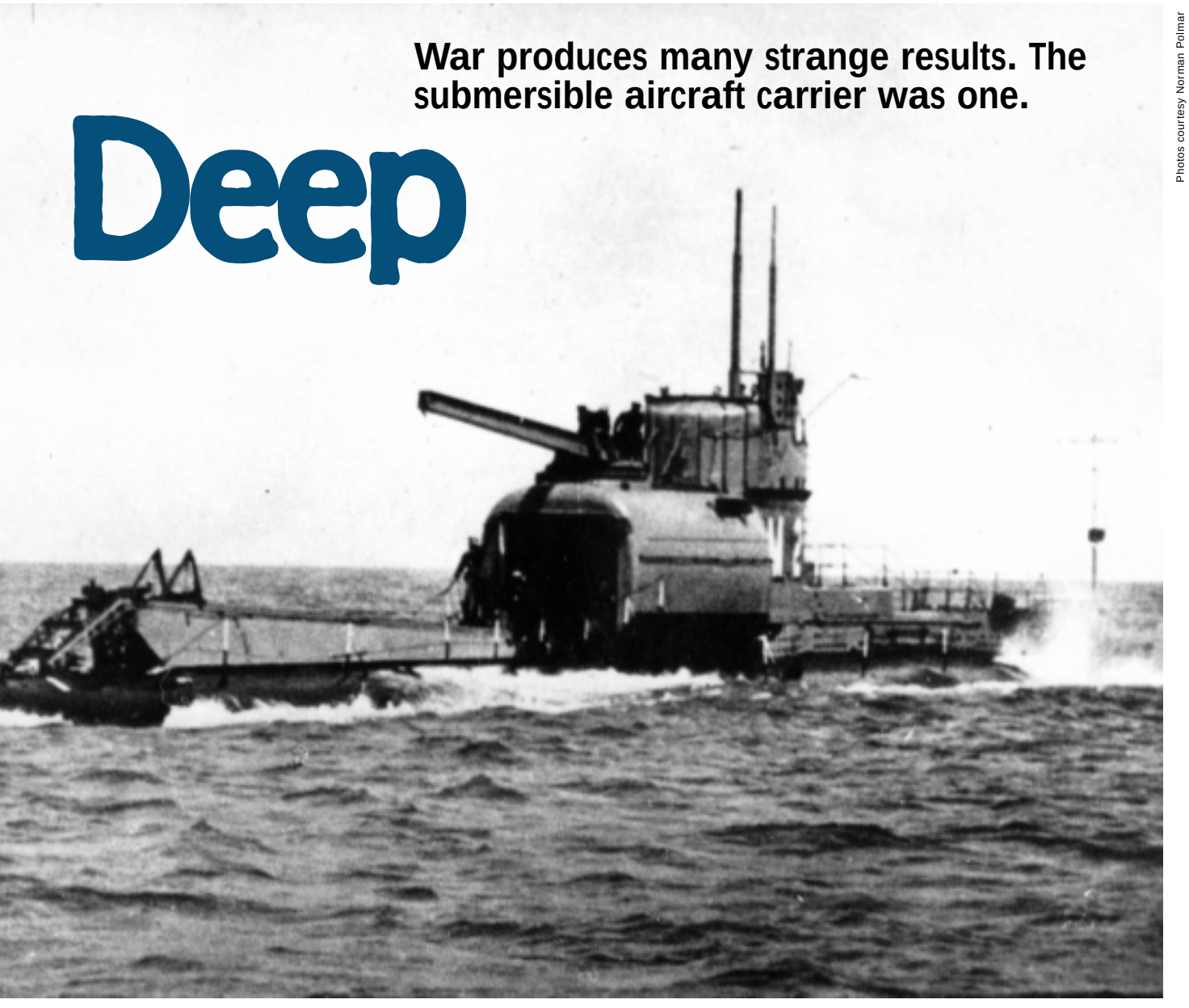
Between the world wars, three other countries began to take an interest in placing aircraft on subs. France, Japan, and the United States experimented with subs and floatplanes. Their approaches varied, and, while most efforts might be described as dilettante, Japan managed to produce a system in World War II that could deliver an aircraft to within striking distance of the US mainland.

Britain continued its earlier work, converting the large submarine monitor, designated *M2*, to carry a floatplane. France built the submarine cruiser *Surcouf* with large guns to attack merchant ships and a floatplane to search out targets. The US Navy modified the submarine *S-1* for experiments with a collapsible floatplane that could be stowed in a hangar on deck.

The more extensive work, however, was begun in 1923 by Japan. It first used two German Caspar–Heinkel U-1 biplanes, fitted with floats, to conduct trials aboard a submarine. It then developed a series of floatplanes for submarine use, beginning with the Watanabe Type 96 (E9W1), which entered service in 1938. This biplane aircraft and the monoplane Yokosuka Type 0 (E14Y1), which entered service in 1941, had far-reaching ser-

War produces many strange results. The submersible aircraft carrier was one.

Deep



Photos courtesy Norman Polmar

vice in the Pacific in the early years of World War II. (The Yokosuka Type 0 was given the Allied codename Glen.)

By the start of World War II, Japan's Navy had 12 large I-series submarines that could each carry a single floatplane. Japan didn't stop there. It had more aircraft-carrying submarines under construction, of which several became operational during the war.

The new subs had hangars for a single, disassembled floatplane, with a catapult built into the deck. The submarine surfaced, the crew extracted the aircraft from the hangar, extended the wings, prepared it for flight, and catapulted the airplane off the sub. After completing their mission, the crew would land the aircraft in the water alongside the submarine, where it would be hoisted aboard by a crane.

These airplanes flew missions throughout the southwest Pacific and Indian Ocean areas, seeking Allied shipping and performing reconnaissance of Allied ports.

To the United States

In 1942, Japan extended operations to the US mainland.

The Japanese submarine *I-25* twice launched a Yokosuka Type 0 monoplane from a position off Cape Blanco, Ore., on incendiary bombing raids against the United States. The goal was to ignite forest fires in the northwestern United States.

On these two missions, both piloted by Warrant Flying Officer Nobuo Fujita, the aircraft flew about 50 miles inland, where Fujita released incendiaries. The missions failed. There were no major fires and no casualties.

These were the only known aircraft attacks mounted against the continental United States during the war. Japan also employed large submarines to refuel seaplanes, including two flying boats that bombed Pearl Harbor on the night of March 3-4, 1942.

Japan continued to pursue the submarine-aircraft combination, building even larger subs intended to carry aircraft to bomb Washington, D.C., and New York City.

In 1942, Japan began construction of the I-400 class—the Sen-Toku (STo) or special submarines. These were the largest non-nuclear submarines ever constructed. They had a surface displacement of 5,223 tons and were 400.25 feet long—a length not exceeded by submarines until the nuclear-propelled submarines of the mid-1960s. The I-400s were propelled on the surface by diesel engines and submerged by electric motors, which obtained their energy from batteries.

While the first I-400s were under construction, the changing course of the Pacific war caused Japan to change the I-400 mission from strikes on Washington and New York City to the Panama Canal. Japan wanted to slow the flow of US warships into the Pacific.

The original 1942 design of the I-400 provided a hangar to accommodate two floatplanes, but it was enlarged to handle three aircraft. The aircraft hangar, beneath the conning tower, opened to an 85.4-foot catapult track forward of the hangar. The aircraft were pre-warmed in the hangar, while the submarine was still submerged, by circulating heavy lubricating oil through their engines. The submarine then surfaced to launch aircraft.

Japan planned 18 of the I-400 class submarines, completing the first in December 1944. The *I-401* and *I-402* followed in 1945. However, the *I-402* was converted to a tanker configuration to carry fuel from the East Indies to Japan. The war ended before the *I-402* undertook a tanker mission. Japan launched a fourth, the *I-404,* but work on the sub stopped in March 1945 when it was 90 percent complete. US carrier-based aircraft sank the *I-404* at Kure, Japan, on July 28, 1945. None of the other 12 I-400s reached the launching stage.

Unique Aircraft

Complications also arose with the aircraft—the high-performance Aichi M6A1 Seiran floatplane—that Japan was building for the I-400 submarines. The Seiran, which translates to "mountain haze," would be the world's only attack aircraft built specifically to operate from submarines. (The Allies did not learn of the aircraft until after the war, so it had no Allied codename.)

The single-engine Seiran was 38 feet long and 15 feet high, with a wingspan of just more than 40 feet. It weighed 7,277 pounds empty. It had to fit inside an 11.5-foot cylinder-shaped hangar, so a ground crew rotated the wings, then folded them to lie flat alongside the fuselage. They could also fold each side of the horizontal stabilizer and the vertical stabilizer part way.

The aircraft's initial specifications called for no undercarriage. There were provisions for support pylons with floats that would enable the aircraft to land on the water but limited its payload to one 551-pound bomb. The Seiran could be launched without the pylon-attached floats, but then the pilot would have to ditch at sea. Without the large pylons and floats, the aircraft could carry one torpedo or 1,760-pound bomb or two 551-pound bombs.

During practice, the time to unfold the aircraft's wings and tail surfaces and ready it for launching—in darkness—was less than seven minutes. The three aircraft could be readied for flight and launched within 30 minutes of the submarine coming to the surface. Although, even at night, this was a long time for the submarine to be exposed, it was a remarkable achievement.

The giant submarine had a magazine that could hold four aerial torpedoes, three 1,760-pound bombs, and 12 550-pound bombs. Beyond its aircraft weapons, each I-400 was armed with eight 21-inch torpedo tubes forward and carried 20 torpedoes. Each sub also had one 5.5-inch deck gun and 10 smaller anti-aircraft guns.

Japan also modified two slightly smaller AM-class submarines, the *I-13* and *I-14,* to embark two M6A1 aircraft. The *I-13* and *I-14* were intended to operate with the I-400s in long-range air strikes.

Finally, on July 26, 1945, the *I-400* and *I-401*—with their six attack aircraft—sortied from the Inland Sea to strike the US naval anchorage at Ulithi Atoll in the Caroline Islands in an operation called Hikari. The *I-13*

Photos courtesy Norman Polmar

One of Japan's large I-series submarines twice used submarine-launched aircraft to mount attacks against the US mainland. These were the only manned attacks against any part of the 48 contiguous states during World War II.

Warrant Flying Officer Nobuo Fujita was the pilot for both of Japan's 1942 incendiary attacks on the US.

and *I-14* preceded them, each with two aircraft to fly from Truk Island to scout the lagoon at Ulithi before the attack. (The *I-13* was sunk before reaching the area.)

However, the war in the Pacific ended on Aug. 15, two days before the planned strike. The submarines returned to Japan to be surrendered, along with their sister ships, to US forces.

Japanese plans for these underwater aircraft carriers—had the war continued—included replacing their Seiran aircraft with Baka rocket-propelled suicide aircraft. There were unconfirmed reports of proposals to use the submarines to launch aircraft carrying biological agents against the United States.

US naval officers studied the I-400 submarines after the war. One idea was to convert one or more of these giants to transport submarines. However, to meet US Navy safety standards and rehabilitate the ships would take six months of yard work and would cost some $750,000 per submarine. This did not include later modifications that would be needed to use US electric batteries for underwater propulsion. In the end, the work was not undertaken, and all three I-400s were sunk or scrapped.

Photos courtesy Norman Polmar

Pictured is a Japanese I-400 submarine, surrendered to the US at the end of World War II. Note the large metal hangar below the submarine's island. It was used to house the Aichi M6A1 Seiran attack aircraft.

Shortly after World War II, the United States showed little interest in pursuing some form of aircraft-carrying submarine. A 1946 submarine officers conference noted, "No design studies should be made on this type of submarine at this time unless the Chief of Naval Operations believes that the need for such a type submarine may be required in the near future."

The Soviet Union, however, took an initial step. In 1948, the Soviets developed a draft design for Project 621—a large landing ship-transport submarine—that, in addition to a battalion of troops, tanks, and vehicles, was to carry three La-5 fighter aircraft in a hangar built into the conning tower. The aircraft would be launched by catapult. Project 621 was the only known Soviet aircraft-carrying submarine to reach that stage of design.

Although, as it turns out, the Soviets never took the project beyond design, in the early 1950s, US intelligence agencies did give credence to the possibility of a submarine-launched nuclear air attack against Strategic Air Command bomber bases.

Wiping Out SAC?

In 1953, a secret Project RAND study—sponsored by the US Air Force—concluded, "Using the submarine-launched or low-altitude Tu-4 [land-based bomber] surprise attack, *the enemy can destroy a major part of SAC potential at relatively small cost in A-bombs and aircraft.* With no more than 50 aircraft and bombs,

Photo by Paul Kennedy

The last Aichi Seiran ever built now sits in the National Air and Space Museum's Udvar–Hazy Center. At right is a Japanese manned suicide flying bomb.

The Aichi Seiran Today

The Smithsonian's new Steven F. Udvar–Hazy Center, near Dulles Airport outside Washington, D.C., has the only existing Seiran. It was the last M6A1 airframe Japan built. Allied forces found it in the remains of the Aichi aircraft factory.

The US transported the Seiran to NAS Alameda, Calif., where it was periodically displayed. The Navy transferred the aircraft to NASM's Paul E. Garber Facility in Silver Hill, Md. It remained in storage there for 12 years. The facility began restoration of the aircraft in 1989 and finished in 2000. No production drawings had survived.

Projected Destruction of SAC Bombers, Circa 1950s

The RAND estimate of damage to the US strategic bomber force by Soviet submarine-launched aircraft and land-based Tu-4 Bull strategic bombers.

Type	No Warning		With One Hour Warning	
	Heavy Bombers	Medium Bombers	Heavy Bombers	Medium Bombers
Sub-launched	100%	76%	100%	73%
Tu-4 low altitude	100%	82%	100%	72%
Tu-4 high altitude	90%	64%	43%	42%

Source: Project RAND, "Vulnerability of US Strategic Airpower to a Surprise Enemy Attack in 1956," Special Memorandum SM-15 (April 15, 1953).

two-thirds or more of SAC bomber and reconnaissance aircraft could be destroyed." (Italics in original.)

The RAND study postulated that Soviet submarines each would carry one aircraft with performance similar to the North American F-86 Sabre, a Mach 1 fighter aircraft that in its F-86H variant would be able to carry a nuclear weapon. In a submarine-launched attack, each Soviet aircraft, armed with a 40-kiloton bomb (i.e., more than twice the explosive power of the Hiroshima A-bomb), could strike all occupied SAC bomber bases in the US and overseas within about 800 miles of the coast. Most bases in the continental United States and 15 overseas SAC bases could be targets of the proposed submarine attack. Only eight of 39 US strategic bomber bases were beyond the 800-mile range.

Further, the RAND study estimated that Soviet aircraft, with only a slight increase in size over the US F-86, would provide a range of about 1,380 miles, enabling attacks on the remaining eight continental SAC bases.

The study estimated that, if the attack against Stateside bases came without warning, the Soviets would be able to destroy all heavy bombers (B-36) and 76 percent of the medium bombers (B-47). If the US had warning—defined as about one hour—the submarine-launched strike would still destroy 100 percent of the heavy bombers as well as 73 percent of the medium bombers. Overseas SAC bases would fare slightly better because their larger size would make aircraft on them less vulnerable to 40-kiloton bombs.

Such a Soviet submarine-launched aircraft strike existed only in the deliberations of the RAND study group.

Meanwhile, in the US, the development of nuclear propulsion sparked some interest in aircraft-carrying submarines, prompting the Office of Naval Research to issue a solicitation for proposals. In response, Edward H. Heinemann, an aircraft designer who preferred to be called an innovator, developed a series of design sketches for a fighter aircraft that could be carried aboard the nuclear-powered submarine *Halibut* that had been specifically designed to carry and launch guided ballistic missiles. *Halibut* was commissioned in January 1960 and could carry four Regulus II missiles in a massive bow hangar.

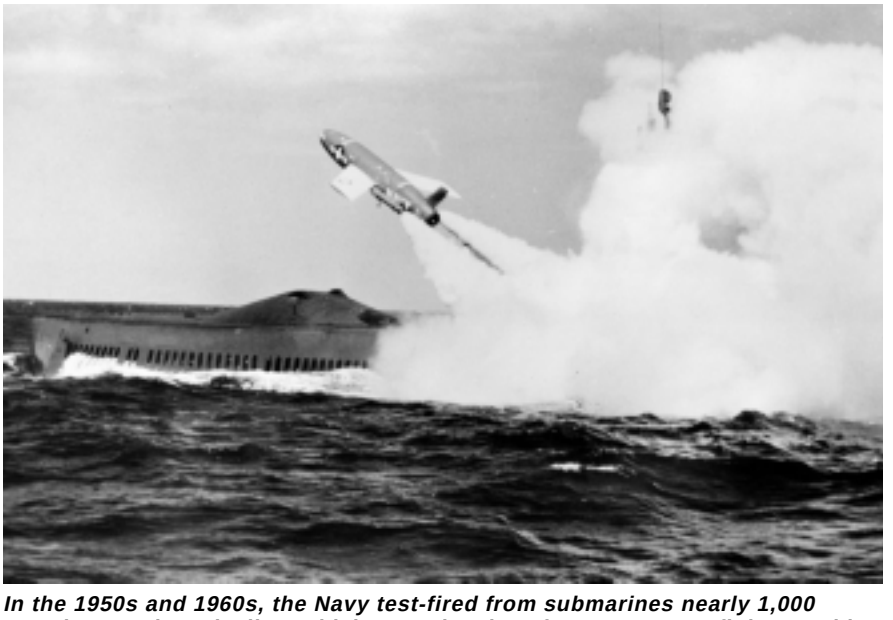
Heinemann's sketches indicated how a new-design aircraft or his versatile Douglas A4D Skyhawk could fit into the submarine's hangar with minimum modification. The basic *Halibut* hangar was 80 feet long. The new-design aircraft was the Douglas model 640, a turbojet attack aircraft with a flying boat hull. It would be catapulted from the surfaced submarine, would come down at sea, and would be recovered aboard the submarine by a telescoping crane. Depending upon modifications to the hangar, the aircraft's wings, tail fin, or nose section would fold for shipboard stowage.

Flying Carpet

The Navy did not pursue Heinemann's proposals, but there were several other proposals for nuclear-propelled, aircraft-carrying submarines. The Navy's aircraft development office—the Bureau of Aeronautics—sponsored the most ambitious one, called Project Flying Carpet.

Boeing Aircraft Co. undertook the extensive feasibility study of aircraft-carrying submarines for the project. The secret study employed, initially, hangar configuration and hull lines based on the *Halibut* design and the S5W propulsion plant used for the *Thresher*-type submarine.

The Boeing study proposed a near-term submarine carrier configuration—designated AN-1—that would carry eight high-performance aircraft in two large hangars, built into the forward hull. The nuclear-propelled submarine would be some 500 feet



***In the 1950s and 1960s, the Navy test-fired from submarines nearly 1,000 Regulus I cruise missiles, which were the size of contemporary fighters. This was the first shot from USS* Halibut.**

long and displace 9,260 tons on the surface—larger than any US submarine then planned, including the 380-foot-plus Polaris ballistic missile submarines.

The starting point for AN-1 aircraft would be a modified Grumman F11F Tiger turbojet fighter. The aircraft's standard folding wings (for carrier use) would be supplemented by a folding tail fin, and it would employ a large rocket booster for launch from a "zero length" catapult. The catapult would be elevated to the vertical (90 degrees) to launch aircraft. The pilot would climb into the aircraft while it was still in the hangar, then an automated system would move the aircraft onto the catapult.

The aeronautics bureau conducted a feasibility study to investigate the submarine weight, stability, and equilibrium using an F11F conventional aircraft stowed in the Regulus missile hangar of USS *Grayback*. *Grayback* could carry two Regulus II missiles, one in each of two hangars faired into her forward superstructure.

The plan was, eventually, to replace the Mach 1+ F11F fighter with a Mach 3 aircraft. The aircraft would land aboard the submarine through the use of an innovative hook-and-cable arresting system. An aircraft that had to set down at sea could be brought back aboard the submarine by crane.

Initially, designers expected each aircraft-carrying sub to be able to haul aircraft fuel, weapons, and other stores for 10 missions per aircraft—a total of 80 missions per submarine. That estimate grew during the preliminary design process to at least 160 missions, with only minor changes in the submarine design.

Designers developed a subsequent AN-2 variant aircraft-carrying submarine with similar hull lines to the AN-1, but the AN-2 would operate vertical takeoff and landing aircraft. The sub would carry these VTOL aircraft in eight vertical hangars built into the hull forward of the sail structure. The below-deck configuration of the AN-2's forward hull would differ considerably from the AN-1, while the after section of the submarine—containing crew quarters, control spaces, propulsion, and reactor plant—would be similar.

The Navy for some years investigated ideas for aircraft-carrying submarines. Pictured is a 1957 Navy concept for a 346-foot, nuclear-powered submarine capable of launching large Regulus II cruise missiles from the deck.

The Boeing study noted that "flight deck operations in the conventional meaning of the word do not exist." It estimated a ground crew could launch four VTOL aircraft within 5.5 minutes of surfacing and eight aircraft in just over nine minutes. If the aircraft engine start used self-contained starters rather than shipboard power, those times could be cut. The study further concluded that, under even the most adverse sea conditions, the time to launch all eight aircraft would be 18 minutes. To compensate for the adverse conditions, the ground crew would move the aircraft, via deck tracks, to the amidship launchers closest to the ship's center of buoyancy.

The Boeing study calculated that the AN-1 submarine would cost about half again as much as a Polaris missile submarine.

However, the Navy did not pursue the aircraft-carrying submarine. Defense analysts have offered a number of reasons: a questionable operational requirement for submarine-based aircraft; bureaucratic opposition to a ship concept developed by the Navy's Bureau of Aeronautics, not the Navy's Bureau of Ships; and a shortage of submarine construction capability since the Navy was accelerating the construction of both torpedo-attack submarines and Polaris missile submarines.

Despite the Navy's ultimate lack of interest in aircraft-carrying subs, proposals continued to surface from a variety of sources.

Over the years, the US Patent and Trademark Office routinely received such proposals. One dated 1930 shows a submarine with a hangar built into the superstructure, carrying two floatplanes that were to be launched on rollers. A post-World War II patent shows a conventional submarine with a large hangar within the pressure hull and an elevator to lift floatplanes to the main deck. That proposal had the submarine recovering the floatplanes, after they landed at sea, at the sub's stern.

The patent office has issued patents on numerous other designs. Although few of the proposals were feasible from an engineering or operational viewpoint, they were interesting and demonstrated the continued interest in this type of weapon system.

Today's long-range bombers, cruise missiles, satellites, and unmanned aerial vehicles have eliminated any practical reason for aircraft-carrying submarines. Still, the idea was ingenious for its time. ■

Norman Polmar is the author of numerous books about submarines and aircraft. He and Kenneth J. Moore are leading analysts of submarine technology and programs. This article is adapted from their book Cold War Submarines *(Brassey's, 2004).*