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AIRCRAFT CARRIERS

Missions, Survivability, Size, Cost, Numbers

John F. Lehman, with Steven Wills

The aircraft carrier, as employed by the United States and other nations, has been controversial since its operational introduction just over a century ago, with the commissioning of HMS *Argus* into the Royal Navy on 16 September 1918.[1] At that time and ever since, the carrier has faced intense criticism from rival services and political opponents. The arguments have not changed in that whole time. Critics believe carriers to be too expensive and too vulnerable. These arguments are raised anew in times of peace—then in every war the carrier's decisive use in combat ends the discussion for the next decade or so.

In 1949, the Truman administration ordered the decommissioning of all but seven of the Navy's carriers and the dismantling of the first supercarrier, USS *United States,* then under construction. The outraged Secretary of the Navy (SECNAV), John L. Sullivan, who was not even consulted, resigned immediately in protest.[2] In what followed, known as the "Revolt of the Admirals," many admirals and captains lobbied and testified against the administration, and many were fired as a result. Led by the future Chief of Naval Operations (CNO) Admiral Arleigh A. Burke, the Navy fought against efforts by Secretary of Defense (SECDEF) Louis A. Johnson and Air Force Secretary W. Stuart Symington to go even further: giving the Air Force all Navy and Marine aviation. Burke survived an attempt to retire him as a captain, but the Navy's future carrier programs seemed at best to be navigating in shoal water at the end of the 1940s.[3]

However, the Navy's flattops soon got a chance to prove their worth in the emerging Cold War world. Secretary of State Dean G. Acheson provided to Congress a survey of vital American interests in the Pacific that excluded Korea. That exclusion, combined with the dramatic disarmament of the U.S. Navy, provided

an irresistible temptation to the Soviet Union and China, and on 25 June 1950 North Korea attacked South Korea. That, of course, brought about a sudden and complete end to the Truman administration's naval disarmament. Since the invasion captured all air force bases in South Korea, carrier-based aviation, in the form of strike groups from USS *Valley Forge* (CV 45) and its Royal Navy counterpart in the western Pacific, HMS *Triumph*, went into action against North Korean forces on 3 July 1950—providing the only available tactical air support to the fight. Eighty-six U.S. and forty British carrier aircraft provided the primary air component of United Nations forces opposing the North Korean offensive. Carriers quickly proved their worth, and—with no more than four fleet carriers ever deployed to Korea—the Navy flew 276,000 combat sorties (only seven thousand short of its total for World War II) and dropped 177,000 tons of bombs (74,000 tons more than the service had dropped in all of World War II) during the conflict.[4]

President Harry S. Truman sent an emergency bill to Congress trebling the defense budget and canceling the retirement of aircraft carriers, and a few months later he fired Johnson as SECDEF. The House Armed Services Committee and its chairman, Representative Carl Vinson (D-GA), hailed the value of carrier aviation, and the first supercarrier, USS *Forrestal* (CV 59), was authorized in July 1951.[5] The dramatic role that carrier air played in Korea ended criticism of flattops for the next twenty years.

President Truman and his successors often had occasion to utter the words "Where is the nearest carrier?" I myself first heard the question—more like a demand—from President Richard M. Nixon on 15 April 1969, when I worked for Henry A. Kissinger, then the assistant to the president for national security affairs (i.e., national security advisor).[6] That day North Korea shot down a Navy EC-121 reconnaissance plane over international waters, killing thirty-one sailors.[7] There was no carrier in the theater, and we did nothing.

The election of Jimmy Carter to the U.S. presidency in 1976 started a new carrier battle less than two years later—with the same, now sixty-year-old, arguments. President Carter, a former submariner, was opposed to building any more fleet carriers, and he intended to phase them out of the naval order of battle. Congress, however, added another two-billion-dollar *Nimitz*-class carrier to the president's 1978 budget. In an unprecedented move, Carter vetoed the fiscal year 1979 (FY-79) defense bill because it included the carrier. However, the Soviet invasion of Afghanistan and the Iranian takeover of the U.S. embassy soon after settled the issue. With the effort augmented by the presence in the Navy Senate office of Captain (and future U.S. senator) John S. McCain III, the fourth *Nimitz* carrier was authorized by Congress and signed into law by President Carter.[8]

It was not long after the passage of this legislation that I, as the new SECNAV, had the keen pleasure of naming that carrier USS *Theodore Roosevelt* (CVN 71). The contract also became the first that I signed under the new, competitive, fixed-price-procurement philosophy of the Reagan administration. (*Roosevelt* came in early and under budget.)[9]

THE REAGAN ADMINISTRATION: HIGH-WATER MARK OF THE CARRIER FORCE

The U.S. Navy reached a high point of fifteen carriers and 594 total ships in 1987, a growth of 74 ships from the end of the Carter administration owing to the 600-Ship Navy initiative spearheaded by President Ronald W. Reagan. Two-carrier block buys—a process in which multiple ships of a single class are purchased in one year, yielding significant cost savings—were executed in the FY-83 and FY-88 budgets.[10] This feat had not been accomplished with fleet carriers since the Second World War. The development of the six-hundred-ship force came directly from the specific requirements to carry out the new Forward Maritime Strategy—the ultimate realization of the Reagan administration's determination to achieve unquestioned command of the seas.[11]

The Navy lost no time in carrying out the new strategy. Seven months after Reagan's inauguration, eighty-three ships, including four carriers (two supercarriers, one vertical and/or short takeoff and landing [i.e., V/STOL] carrier, and one helicopter carrier), hidden by sophisticated cover-and-deception technology, raced north into the Norwegian Sea. The first the Soviets knew they were there was when USS *Dwight D. Eisenhower* (CVN 69) sent four F-14s, four A-6s, and four KA-6 tankers one thousand miles to fly at 550 knots through a Soviet exercise thirteen miles off Murmansk.[12] The Soviets were flabbergasted and never really recovered their previous confidence in their ability to defend their homeland from U.S. naval attack.

Every year thereafter, U.S.-led allied fleets carried out realistic training exercises in those seas—seas where they would fight if the Soviets attacked. Each exercise refined and improved tactics that incorporated the newest technology. By 1985, the carriers were operating in Norwegian fjords and among Norwegian Sea archipelagoes, making enemy targeting next to impossible.[13]

Soviet chief of the General Staff Marshal Sergey F. Akhromeyev visited the United States in July 1988 as part of Soviet leader Mikhail S. Gorbachev's desire to reduce tensions with the West. Akhromeyev flew out to the carrier *Theodore Roosevelt* and observed a demonstration of the carrier air wing's capabilities. During the visit, Akhromeyev presented a global map to U.S. Chairman of the Joint Chiefs of Staff Admiral William J. Crowe Jr. that incorporated symbols detailing a ring of American naval bases and deployed submarines and aircraft

carriers surrounding the Eurasian continent, and specifically the Soviet homeland. Akhromeyev told Crowe, "Your navy and bases surround my country and threaten the security of the Soviet Union."[14] The union of the Forward Maritime Strategy and the six-hundred-ship Navy was the core of the Reagan administration's military and naval rearmament plans that were crucial to deterrence—and ultimately to victory in the Cold War.

The Soviet Navy and Air Force came to realize that they could not cope. In 1986, the Soviet General Staff sent a démarche to the Politburo, urgently requesting a tripling of the budgets for the Northern Fleet and Northern Air Force; otherwise, they believed that in the event of war they could not defend the country's northern flank for more than a week. This hit the Politburo like a thunderclap and was a major factor contributing to the Soviet collapse.[15]

Critics believe carriers to be too expensive and too vulnerable . . . in times of peace—then in every war the carrier's decisive use in combat ends the discussion for the next decade or so.

As occurred after previous conflicts, Cold War victory brought an overreaction in disarmament. The fleet was reduced by one-third, with the number of carriers cut from fifteen to twelve.[16]

CARRIERS: MISSIONS AND COSTS

To build the force of fifteen carriers in the '80s, we froze the design of the *Nimitz* class and built five more of them on fixed-price contracts that varied only in the steady introduction of ever-improving weapons technology.[17] However, passage of the Goldwater-Nichols reforms in 1986 took decisions on new weapons away from the services, transferring them to the significantly enlarged Department of Defense (DoD) bureaucracy.[18] Under this new joint system, it was decided that the Navy should have a new carrier design.[19]

Given the *Ford*'s exorbitant and still-growing price tag, many have advocated a return to smaller carriers. We will examine such options later in this article.

The new administration of President Donald J. Trump called for an increase in the fleet to 355 ships, including twelve aircraft carriers. The FY-17 budget specifically required the Navy to maintain at least eleven aircraft carriers and nine carrier air wings, and the same legislation endorsed the 355-ship, twelve-carrier goals.[20]

Yet challenges to these goals have continued. There was a dip to ten carriers in December 2012 when *Enterprise* was retired, and, surprisingly, the Trump Defense Department requested only five new combatant ships and two tugboats in the FY-21 budget.[21] Presidents now often must be disappointed when in a crisis they ask, "Where are the carriers?"

CARRIER STATISTICS SINCE 1942

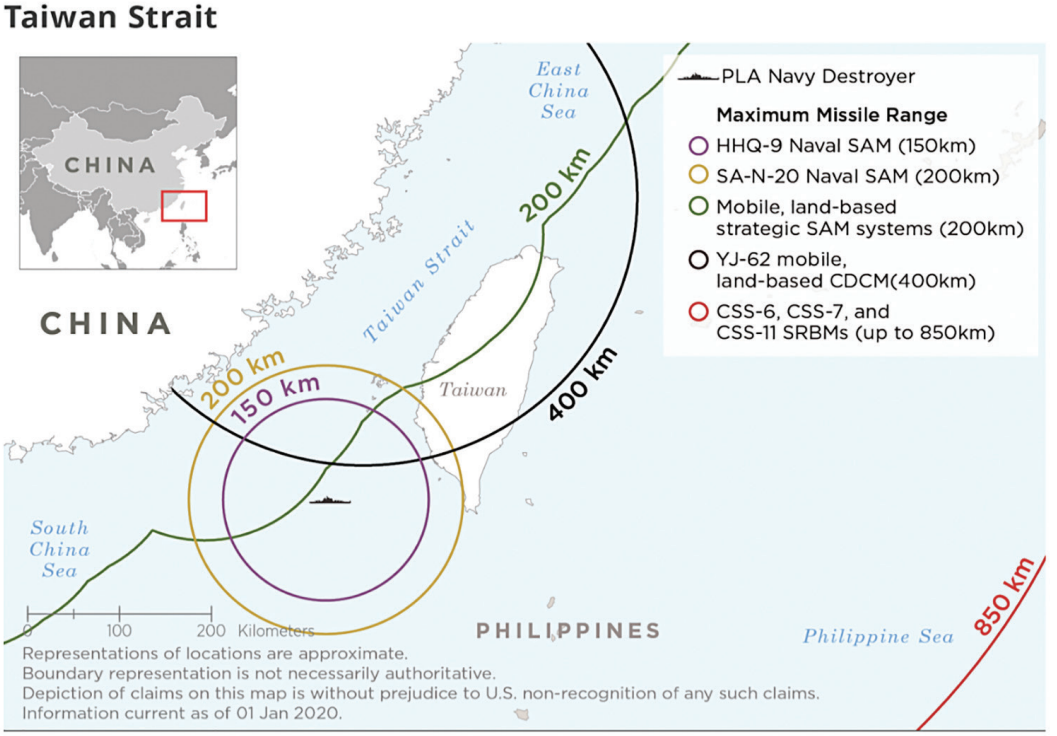
Ship Class	Year Commissioned	Displacement Tonnage (initial)	Length (feet)	Beam (feet)	Crew Size (including air wing)	Cost When Purchased (2019 dollars)
Essex	1942	27,100	872	147	3,170	$68–$78 million ($1 billion)
Midway	1945	45,000	968	136	3,960	$85.6 million in 1945 ($1.2 billion)
Forrestal	1955	60,000	1,039	252	4,100	$217 million in 1952 ($3.13 billion)
Kitty Hawk	1961	64,000	1,072	252	4,600	$400 million in 1961 ($3.4 billion)
Enterprise	1961	75,000	1,125	252	4,600	$451 million in 1960 ($4.11 billion)
Nimitz	1973	80,753	1,092	252	5,244	$1 billion in 1975 ($5 billion)
Theodore Roosevelt	1986	80,753	1,092	252	6,275	$1.9 billion in 1988 ($5.6 billion)
America LHA	2014	44,971	844	108	1,200	$3.4 billion in 2014 dollars
Ford	2017	100,000	1,106	256	4,660	$13.3 billion in 2017 (still rising)

Sources: Lehman, *Aircraft Carriers: The Real Choices,* p. 8; Eric Wertheim, *The Naval Institute Guide to Combat Fleets of the World: Their Ships, Aircraft, and Systems,* 16th–19th eds. (Annapolis, MD: Naval Institute Press, 2013–); Norman Polmar, *Aircraft Carriers: A History of Carrier Aviation and Its Influence on World Events,* vol. 2, *1946–2006,* 2nd ed. (Washington, DC: Potomac Books, 2008).

The F-18Es and the F-35s are all effective fleet-air-defense fighters. The continuously upgraded Aegis antiair system is now the standard for USN cruisers and destroyers (and soon for the FFG-62 frigate) that serve as the carrier's partners in providing air superiority. While these surface combatants are highly effective in shooting down enemy aircraft and ballistic, supersonic, and hypersonic missiles, they and the Army transports, tankers, merchant ships, and amphibious-warfare vessels they escort cannot survive for long without air cover; they must have fighter cover twenty-four hours a day. The majority of the earth's surface is out of range for land-based fighters, so they cannot provide the around-the-clock coverage needed. Only carrier air wings can provide that capability.

As was the case in the 1970s and '80s with the rise of the Soviet Navy, there is no lack of operational-level-of-war missions for the individual carrier strike group and the multiflattop carrier battle force in the new age of great-power competition. The emergence of a Chinese carrier force—now consisting of three vessels, with the potential for up to six by the 2030s—suggests the potential for carrier duels in blue water that may be reminiscent of the great Pacific War of the 1940s.[22]

MAXIMUM MISSILE RANGES IN THE TAIWAN STRAIT



Source: U.S. Defense Dept., *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2018* (Washington, DC: Office of the Secretary of Defense, 2018).

Like during the Cold War under the 1980s Maritime Strategy, the carrier's first mission might be warfare at sea against enemy surface, subsurface, and aviation units. For example, attriting Chinese surface and air forces could enhance the implementation of *guerre de course* (targeting Chinese global commerce) and could include sea-based aviation strikes against Chinese infrastructure and ports, mining of ports and sea-lanes, and the closing of straits to Chinese merchant and naval shipping. Carrier-based aviation enforcing blockades likely would serve as the backbone of global horizontal-escalation operations against overseas Chinese military and commercial installations. Such a capability greatly strengthens deterrence, as University of Pennsylvania scholar Fiona Cunningham suggests: "[A] blockade would cripple China's economy, deny its leaders access to key resources needed to fight the war, and ultimately compel its leaders to negotiate an end to the conflict. Like deep strikes on the Chinese mainland, the prospect of a blockade could deter China from starting a conflict."[23]

The Russian Federation Navy represents a mere shadow of the former Soviet fleet, but it possesses modern submarines and missiles that can threaten Western targets afloat and ashore.[24] What is similar to the Cold War situation is that the Russian General Staff greatly fears the power of a U.S. "aerospace blitzkrieg," led

in large part by carrier-based aircraft and their weapons.[25] Russia's strategic geography is even worse than that of its Soviet predecessor state. Russian naval forces remain divided by vast geographic distances, often spanning areas that are devoid of useful land bases for aircraft, yet much of Russia's long-range response to sea-based aviation is dependent on land-based systems and relies on significant aerospace control that might not be possible in the presence of U.S. carriers.[26] U.S. naval carrier-based aviation is very useful in bridging and controlling such distances, and it would contribute the largest part of any aerospace campaign against the Russian Northern and Pacific Fleets.

The continuing acquisition of carriers by China—and by Australia, France, Italy, Japan, the United Kingdom, and now South Korea—demonstrates that the flattop remains a vital component of diplomacy, power projection ashore, and operational warfare at sea.[27]

AIRCRAFT CARRIER SURVIVABILITY

While all surface vessels are susceptible to attack, the vulnerability of the carrier to multiple new weapons—including the hypersonic cruise missile, the antiship ballistic missile, and an arsenal of other arms that includes submarine torpedoes, mines, and drones—again is at the center of the debate on the large carrier's continued viability.

Yet consider the examples of carrier survivability provided below.

World War II–Era Kamikaze Attacks

In an unexpected attack by a Japanese kamikaze (i.e., suicide-attack) plane on 30 October 1944, USS *Franklin* (CV 13) was hit with a 550-pound bomb. It penetrated the ship's unarmored flight deck and exploded, igniting dozens of other weapons on the aircraft parked on the ship's hangar deck.[28] Less than six months later, on 19 March 1945, *Franklin* was hit again, this time by two five-hundred-pound bombs from Japanese attackers. *Franklin* suffered almost eight hundred dead out of 2,600 personnel aboard at the time of the attack.[29] The *Franklin* battle-damage report later stated, "The conflagration in *Franklin* resulting from the action of 19 March was the most severe survived by any U.S. warship during the course of World War II. It is pertinent, however, to point out that the resulting damage would not in itself have caused the loss of the ship since the principal strength structure, watertight integrity and vital machinery below the hangar deck remained intact."[30]

The official USN damage report highlights the robust design and survivability of the large flattop in action. The report does acknowledge that the "major damage sustained in each of the actions of 30 October 1944 and 19 March 1945 demonstrates the effectiveness of bomb hits when received by aircraft carriers during the extremely vulnerable period just prior to and during periods of launching

strikes." However, the *Franklin* report then goes on to state, "The latter two cases of damage to *Franklin* illustrate thoroughly the ability of modern U.S. aircraft carriers to survive extensive damage from plane crashes, fire, and heavy bombs." Large carriers can survive heavy damage and remain afloat, if not operational. When *Franklin*'s fires finally were brought under control, the ship resumed steaming under its own power.[31] The damage to *Franklin* was important, in that it helped set new design parameters for post–World War II flattops (beginning with USS *Midway* [CV 41]) that emphasized armor and other forms of improved protection for the carrier.[32]

During the Okinawa campaign, the Japanese launched an estimated 1,900 kamikaze sorties against the Allied fleet.[33] Of the 793 kamikazes that actually found targets, 181 hit ships and another ninety-five crashed close enough to cause damage. Most of these aircraft were very agile fighters using very effective tactics, often making them superior in performance to modern anti-ship missiles. During 1945, six large carriers were hit by these kamikazes, and another six by bombers using kamikaze tactics. None of the ships were sunk or damaged beyond repair.[34]

Army transports, tankers, merchant ships, and amphibious-warfare vessels . . . cannot survive for long without air cover. . . . The majority of the earth's surface is out of range for land-based fighters, so [o]nly carrier air wings can provide that capability.

***Vietnam-Era Accidents:* Oriskany, Forrestal, *and* Enterprise**

The lessons learned from *Franklin* and other World War II carriers influenced the design of subsequent Cold War flattops, with positive results. Three cases in particular emphasize the survivability of the big carrier across the Cold War.

USS *Oriskany* (CV 34), USS *Forrestal* (CV 59), and USS *Enterprise* (CVN 65) all experienced exploding bombs and severe fires that killed many sailors. Yet all returned to port for repairs under their own power. *Enterprise* later was assessed to have survived the equivalent of six heavyweight Soviet cruise-missile strikes in the course of its accident, but could have resumed air operations in several hours had repair capacity not been immediately available.[35]

USS* America *Testing

The former *Kitty Hawk*–class flattop USS *America* (CV 66) was the subject of four weeks of extensive survivability testing (referred to as a SINKEX) in May 2005.[36] The tests were designed to support the development of the future large nuclear carriers.[37] *America,* with its double hull and more than a thousand watertight compartments, stubbornly resisted sinking; in the end, sending it to the bottom required deliberately opening the scuttles.[38] Granted, a controlled SINKEX is not

a combat test, but it does suggest that the current *Nimitz*- and *Ford*-class carriers—which were built as *improved* versions of *America*—incorporate superior survivability.

Bonhomme Richard *Fire*

USS *Bonhomme Richard* (LHD 6) was a large amphibious-warfare ship much like an aircraft carrier. In July 2020, it was moored at Naval Station San Diego, California. The ship was undergoing upgrades to allow it to operate F-35B Lightning aircraft, as one of the so-called Lightning carriers, such as the most recent USS *America* (LHA 6), a similar large, amphibious warship that recently deployed with thirteen F-35B Marine Corps Lightning aircraft.[39]

Bonhomme Richard then underwent an unintended test of aviation-ship survivability. On 12 July 2020, the ship suffered a fire that resulted in severe damage. It affected eleven of the ship's fourteen decks, buckled segments of the flight deck, damaged the vehicle storage area, and gutted the command-and-control spaces located in the ship's island. The damage was so severe that *Bonhomme Richard* was declared beyond economical repair.[40]

The blaze demonstrates the vulnerability of large amphibious ships that act as light carriers. While ships such as *Bonhomme Richard* and *America* look like aircraft carriers, and in fact are larger than World War II–era flattops such as *Franklin,* they are not built to the same survivability standard as are full-size carriers.[41] They have little armor; more important, they incorporate little compartmentation, having large, open spaces that include well decks for landing craft and large storage parks for vehicles as key components of their mission to transport and land Marines. These characteristics add to the overall vulnerability of amphibious ships compared with purpose-built aircraft carriers.

OPTIONS FOR CARRIER SIZE

There are infinite varieties of potential carrier designs. For purposes of this article, it is useful to reduce that variety to three general sizes for consideration.

The Ford*-Class CVN*

The current *Ford*-class carrier is in serial production, with a planning goal of at least six ships. This was the first carrier designed under the post-Goldwater-Nichols joint-bureaucratic process. While *Ford* has essentially the same hull as USS *Nimitz* (CVN 68), changes from *Nimitz* to *Ford* originated with Navy participation but without the Navy having final decision authority. Many of those twenty-three changes were based on undeveloped technologies and have been the source of billions of dollars in cost overruns and years of delay.[42] They include engineering challenges with the electromagnetic catapults (EMALS), advanced arrestor gear, and elevators.

Ford also has been unable, so far, to meet the contracted rate of 160 sorties per day.[43] The *Ford* catapult system in particular has not been able yet to match the *Nimitz* sortie-generation capability, which approached 130 sorties per day during the initial part of the 2003 Iraq war. But that raises a more fundamental question: Is there any need for a higher number of sorties than *Nimitz* flattops can provide? The requirement for a higher number came from a joint requirement committee that based it on the old Vietnam War–era Alpha strike, or "aluminum cloud," operation—which no longer is conducted.[44]

A more serious, as yet unsolved problem that goes beyond mere reliability is that if one electromagnetic catapult goes down, all go down. The FY-20 Director of Operational Test and Evaluation annual report stated, "[T]he crew cannot readily electrically isolate EMALS components during flight operations due to the shared nature of the Energy Storage Groups and Power Conversion Subsystem inverters on board CVN 78 [*Ford*]. The process for electrically isolating equipment is time-consuming; spinning down the EMALS motor/generators takes 1.5 hours by itself. This inability precludes EMALS high power maintenance during flight operations."[45]

These new, unproven technologies mandated by the joint bureaucracy have caused delays that have increased the cost of the first unit to $13.3 billion so far. This represents an increase of over $3.3 billion from original estimates—to *double* the cost of the last *Nimitz*.[46]

The *Ford* class, like the *Nimitz,* can be built in only one shipyard, effectively making Newport News Shipbuilding a monopoly. This makes it difficult to obtain innovation or cost savings in construction.

A New Midway*-Size CVM*

The *Midway*-class carriers of the immediate post–World War II era were developed to incorporate all the lessons from the Pacific War. *Midway* went on to serve a forty-six-year career, from 1945 through the 1991 Gulf War. *Midway* was roughly two-thirds the size of *Nimitz*. While a new *Midway*-size carrier would operate fewer aircraft than *Nimitz/Ford* vessels, its catapult and arrested-landing configuration would allow it to operate all current and planned U.S. naval aircraft.

Changes in the oil-supply situation, including the U.S. transition from net oil importer to exporter, as well as lower prices, would make a new, conventionally powered, 65,000-ton carrier much less costly to build and operate than a *Ford*-class flattop. There are several options for proven, low-risk, conventional propulsion systems, ranging from diesels through gas turbines to combined diesel and gas-turbine (CODAG) systems. Nuclear power also is an option, especially using existing, proven submarine power plants. A modern *Midway*-size carrier would offer 368,000 square feet of weapons storage and 1.48 million gallons of aviation

fuel—not as much as a *Nimitz/Ford* platform, but enough to support more than eighty sorties per day and at least a week of sustained operations.[47]

A future *Midway*-size carrier would incorporate all the survivability features of the CVNs. These would include extensive watertight compartmentation and lighter-weight yet much more effective side protection than heavy belt armor, and would incorporate advanced firefighting capability employing the latest technology.

LHD/LHA Lightning Carrier

Other platforms often mentioned as candidates to serve as light carriers, or to augment the current carrier force, are the ships of the U.S. "big deck" amphibious force. It consists of *Wasp*-class landing helicopter docks (LHDs) and the new *America*-class landing helicopter assault ships (LHAs).

The eight ships of the *Wasp* (LHD 1) class and the current three *America*s are amphibious-warfare ships designed for helicopter assault and well-deck-based landing operations with embarked U.S. Marines or other ground forces. Weighing in at over 45,000 tons and stretching almost 850 feet in length, they are nearly the size of the original *Midway* when it commissioned in 1945.[48]

These ships' size and aircraft carrier–like flight decks have allowed them to operate the AV-8B Harrier II ground-attack aircraft for decades—in a secondary role, as an air/ground-attack element of Marine Corps amphibious, and later expeditionary, forces. An earlier LHA-class ship, *Nassau* (LHA 4), acted as a carrier during Operation DESERT STORM in 1991, and later the small force of six Harriers aboard *Kearsarge* (LHD 3) played an outsize role in 2011's Operation ODYSSEY DAWN against Muʿammar Gadhafi's Libyan forces. As noted earlier, *America* recently deployed with thirteen F-35Bs embarked to test the Lightning carrier concept.[49]

Yet while these ships are large and carrier-like in many ways, they are built to a much lower standard of survivability than conventional flattops and are much slower, with a best speed of twenty-four knots. The fire on and subsequent decision to scrap *Bonhomme Richard* further suggest that the big-deck amphibious ship is not a viable carrier design.

NUCLEAR VERSUS CONVENTIONAL PROPULSION: COST AND RELATED FACTORS

The U.S. Navy has not built a nonnuclear-powered aircraft carrier since the first USS *John F. Kennedy* (CV 67) was commissioned in 1968. The last conventionally powered carrier, USS *Kitty Hawk* (CV 63), was decommissioned in 2009.

However, Congress has dropped earlier legislation mandating that all carriers be nuclear propelled.[50] Another issue that was not appreciated fully in the late 1970s is that of nuclear carrier defueling and ultimate disposal.

Nonetheless, the U.S. Navy has been committed to nuclear propulsion for aircraft carriers. Yet apart from the operational advantages of nuclear power, there are significant cost differentials compared with conventional options. Some quick illustrations follow:

- Acquisition: The current estimated cost of a nuclear plant producing 280,000 shaft horsepower is $9.7 billion.[51] The Navy has not analyzed the current estimated cost of a conventional plant producing the same horsepower using the latest technology, but it likely would be significantly less than that of the nuclear plant.
- Refueling (as part of a regular refueling complex overhaul [RCOH]): The cost for a nuclear carrier is $678 million.[52]
- Defueling: Current cost estimates for defueling and recycling a nuclear carrier at retirement range from $750 million to $1.5 billion (depending on whether a military or commercial shipyard is used).[53]
- Fueling: The Navy has not calculated the current estimated annual cost of fueling a conventional carrier with modern diesel, gas-turbine, or CODAG propulsion at today's fuel prices.
- Lost availability: An RCOH takes two years, whereas conventional flattops have no comparable loss of operational availability.

A General Accounting Office study in 1998 put the operating cost differential at about 10 percent in favor of conventional propulsion. The Navy believed that nuclear propulsion offered 10 percent more in terms of operational advantages, most notably in terms of fossil fuel costs.[54]

Since those studies were conducted, two things have changed. First, technology has increased vastly the availability of fossil fuel in the United States; its effective average cost today is a small fraction of what it was in the 1990s. Another significant difference is that now there is only one (monopoly) shipbuilder for supercarriers, leading to the runaway costs of the *Ford*-class carrier. In the words of a 2017 RAND study, "[C]ontinuing the *Ford*-class carrier program imposes high acquisition cost and might unduly affect the whole of the Navy shipbuilding budget."[55]

Other problems, with *Ford*'s electromagnetic catapults and arresting gear and new radar systems, have delayed the ship's first deployment further. The follow-on units to *Ford* also have continued to see cost increases. Cost estimates for Newport News Shipbuilding to design and construct *John F. Kennedy* have increased by $3.58 billion so far.[56]

The aircraft carrier has been the single most expensive platform in the U.S. military ever since World War II, but the cost of the *Ford* class is out of proportion to that of any of its predecessors. There are several reasons for this. It is the first

carrier procurement managed by the joint Pentagon bureaucracy established by the Goldwater-Nichols reforms of the 1980s, rather than by the Navy itself. Joint Requirements Oversight Committee inputs added twelve undeveloped technologies to the design, including electromagnetic catapults, arresting gear, and elevators, along with new radars and other fundamental elements of the ship's infrastructure—none of which existed at the time of the contract, and some of which have not been completed or tested successfully even at this writing.[57] Some skeptics have described the *Ford* carrier as a seagoing camel (*camel:* a horse designed by a committee). The ship was authorized in FY-08. Now, thirteen years later, the cost so far, in 2008 dollars, is over $14 billion—and still climbing, since not all of its systems have been fully certified.[58] By contrast, the first ship of the *Nimitz* class (roughly the same size as *Ford*) took nine years from contract (1967) to deployment (1976) and cost $4 billion in 2008 dollars, adjusted for inflation. (*Nimitz* cost about $1 billion in 1975 dollars.)[59]

COCOMs—not surprisingly—prefer to hold on to naval forces for as long as they can. These regional demands are being met at the cost of grinding down the ships and sailors.

Required maintenance also restricts carrier availability. Even a dozen supercarriers cannot meet the demands from the regional combatant commanders (COCOMs). The Goldwater-Nichols Act of 1986 gave COCOMs the authority to issue demand signals for forces, and in effect force the Navy to provide more carriers for their operations, even when it means the ships forgo required maintenance and their crews' required training.[60]

REQUIRED NUMBERS

The Korean War demonstrated a calculus that has remained consistent to the present day. For every deployed flattop, the Navy must possess three: the first carrier on station; the second in the shipyard undergoing refit; and the third in the training cycle, preparing to deploy.

Since the 1970s, carrier deployments have been concentrated in three hubs: the Mediterranean Sea, the western Pacific Ocean, and the Arabian Sea. The force requirements to maintain combat-credible power in those regions have played a prominent role in determining both the numbers of carriers needed and the size of the rest of the fleet.

When the Soviet Union collapsed and the Cold War ended, the number of flattops required declined to twelve. The hope was that a dozen carriers could provide the appropriate global deterrent, perform Middle East war-fighting missions, and conduct presence operations in at least one other deployment region, as stipulated in the 1993 Bottom-Up Review document.[61]

The Navy has tried to stretch the eleven-carrier force to cover the demands of the COCOMS; however, the Navy has learned—and relearned the hard way—that the service cannot do more with less. The tried-and-true system of three carriers in rotation, intended to keep one forward-deployed, was able—in the emergency circumstances of wartime—to provide instead two out of the three; but that cannot be maintained in peacetime without severe damage to retention, maintenance, and readiness. That is where we are today. The Navy needs more ships.

Recent deployment lengths suggest this shortage is not going away. In January 2020, the carrier *Abraham Lincoln* (CVN 72) set a dubious record in making a yearlong deployment—the longest of any flattop since the Vietnam War.[62] *Dwight D. Eisenhower* and *Theodore Roosevelt* made nine-month deployments in 2020.[63] *George H. W. Bush* (CVN 77) has completed a nine-month deployment, *Carl Vinson* (CVN 70) completed a 9.5-month deployment, and *Theodore Roosevelt* will complete an 8.5-month deployment in 2021.[64] Despite strenuous efforts by a succession of SECNAVs and CNOs to reduce the length of carrier deployments, they have failed. Since the Goldwater-Nichols reforms of 1987, the CNO has no authority over the ships once they deploy in response to a request from a COCOM, and COCOMs—not surprisingly—prefer to hold on to naval forces for as long as they can. These regional demands are being met at the cost of grinding down the ships and sailors. Again: The Navy does not have enough ships.

The last Trump administration SECDEF, Mark T. Esper, did not support adding carriers to the fleet. He suggested that as few as eight carriers and no more than eleven were needed. He called for replacing them with alternative force structures, including unmanned surface and subsurface units.[65] These hopes are naive; many of the notional low-end platforms suggested as carrier replacements, and the logistics needed to support a large number of such units in a distributed deployment, simply do not exist.

The Navy cannot afford the time needed to travel—again—down the road of troubled joint ship classes when a rapid expansion of fleet capability is sorely needed now.

AN ELEVEN-CARRIER NAVY IN A FIFTEEN-CARRIER WORLD

The immediate post–World War II U.S. Navy and its Cold War successor embodied a mix of capabilities in both high- and low-end units. Both navies, however, were built around carriers, as combat from the 1940s to the 1980s Falklands War proved that surface combatants cannot operate in the absence of sea-based air superiority. The carrier is not the only USN offensive platform that can strike targets ashore; other surface ships and submarines provide significant capability in terms of missile firepower. However, the carrier is the only platform that can

provide a mobile dome of 24/7 air superiority over the 71 percent of the earth's surface covered by seawater. Carriers exist to protect the missile shooters as much as to conduct strikes themselves. Even distributed, low-end missile shooters, manned or unmanned, will require air superiority. And naval or other military supply ships, commercial tankers, transports—none of these can survive on the surface of the sea without air superiority above them.

The current great-power competition is playing out in at least three major geographic areas. Given the Chinese navy's growth and hostile intent, the geography of the Indo-Pacific—containing few and limited land bases—is a matter of particular concern.

Considering the current and increasing commitments of U.S. naval forces to multiple deployment hubs, the corrosive strain those deployments have placed on the current carrier fleet, the absence of any suitable alternative platform or system, and the lack of any available replacements for our current carriers, it is urgent that we build a larger carrier fleet than the present eleven- or twelve-flattop force. An increased level of sea-based aviation is of paramount importance, so more aircraft carriers are needed. However, they need not all be nuclear-powered supercarriers.

Factors

This article confirms the irreplaceable value of sea-based aviation as provided by the aircraft carrier, and it tees up the choices regarding that platform. A robust carrier force is required if the U.S. Navy is to do its part in assuring allies and partners of its credibility to deter and, if necessary, compel opponents to cease hostile actions and support war termination on terms favorable to the United States, its allies, and partners.

The following summarized principles apply.

Missions. The missions for airpower at sea in the third decade of the twenty-first century remain robust and varied as the Navy returns to great-power competition with China and Russia. As noted above, the Indo-Pacific region, and the Arctic as well, offers few locations for land-based aviation. Regions more familiar from recent U.S. combat action, such as the eastern Mediterranean and Persian Gulf, do offer provisions for land-based aviation, but shifting political climates can limit access, and improved ballistic- and cruise-missile technologies threaten all fixed installations.

These geographic and political issues suggest that carrier-based aviation will remain a vital component of U.S. joint-force action in forward locations not only at the beginning of but throughout any sustained conflict. The carrier and its embarked aircraft are agile in their missions and can shift at short notice from performing sea control to power projection ashore to humanitarian-service

operations. The need for robust airpower at sea will remain a constant for the near future.

Survivability. No surface warship is more survivable than the large aircraft carrier. Dispersal of forces among smaller flattops might reduce susceptibility to attack, but any flattop smaller than fifty thousand tons displacement will be more vulnerable to and less able to recover from damage.

The return to active competition with the Soviet Navy in the 1980s (after a focus on air strikes ashore in Vietnam) led to innovations in operations that reduced carrier vulnerability. The new Chinese and returning Russian threats likewise will spur a return to a more aggressive carrier posture at sea, with more deception operations to reduce vulnerability.[66]

Just as threats have increased, so have the carrier's defenses. These come in the form of attack-submarine escorts, antisubmarine helicopters, and constantly improving technology in its Aegis escorts.

Finally, if carriers are attacked successfully, the accidents of the 1960s and the recent SINKEX of the ex–USS *America* suggest that large carriers can survive tremendous punishment. The recent *Bonhomme Richard* fire tells us, however, that ships not purpose-built as fleet carriers may suffer catastrophic failure even in cases of moderate damage, and they lack the ability of larger flattops to return to flight operations after taking heavy damage. Amphibious-warfare ships such as *Bonhomme Richard* can support Marine aviation in a ground-support role and might serve as auxiliary carriers in low-threat regions, but they cannot pretend to be fleet carriers.

A new, twenty-first-century design of the size of . . . USS Midway *and supporting an air wing of sixty to sixty-five aircraft could serve as a complement to the larger nuclear flattops while still incorporating rugged survivability and being capable of independent operations.*

Numbers. How many carriers does the U.S. Navy need to carry out its global operations? Adversaries may change but geography does not, and analyses from diverse periods (the 1980s, 1993 [the Bottom-Up Review], and 2015) suggest that the U.S. Navy needs at least fifteen carriers to cover three deployment hubs effectively without prematurely exhausting both the ships themselves and the sailors who crew them.[67] Actual wartime operations likely would require more flattops.

Cruise missiles launched by surface ships are an important component of naval power, but it would take dozens of those ships—as well as a currently nonexistent rearming and resupply force to keep enough of them at sea—to serve as an effective deterrent or a sustained strike capability. Even then, they would require an escorting carrier to protect them from aerial attack.

Cost. The *Ford* class is too expensive for it to be the ship that increases the carrier fleet. A smaller, conventionally powered flattop that is large enough to support a sixty-five-plane air wing would take advantage of the new U.S. status as a net oil provider to operate at a lower cost than can a nuclear flattop.

Above all, a carrier of this size can be built competitively—in multiple yards, by more than one builder—and that competition will improve innovation and drive down costs. Restoring competition in the defense marketplace, for both ideas and products, is essential if we are to regain control of the current runaway costs.

Choices

The Navy needs fully capable, nuclear-powered carriers. The *Nimitz* class represents one such option, but half of the operational lifespan of those vessels is already behind them.

The *Ford* class, encumbered with immature technologies and a rising price tag, cannot be the only carrier solution going forward into the next decade. Increasing threats from peer competitors and regional powers demand a mix of carrier capabilities.

The existing USN big-deck amphibious warships—LHDs of the *Wasp* class and LHAs of the *America* class—have been adapted as Lightning carriers, embarking upward of two F-35 squadrons. However, they are too slow, they lack survivability, and in the absence of catapults they cannot support the vital early-warning and electronic-warfare aircraft crucial to the success of the strike/air-defense aircraft.

A new, twenty-first-century design of the size of the very successful USS *Midway* and supporting an air wing of sixty to sixty-five aircraft could serve as a complement to the larger nuclear flattops while still incorporating rugged survivability and being capable of independent operations. Such a ship could be designed and built in far less time than *Ford,* could be built competitively in more than one shipyard, and would cost far less. Even if, for industrial-base reasons, such a ship were nuclear powered, it might use reactors already developed for our submarine fleet.

The aircraft carrier's roles and missions have remained controversial in the hundred years since its introduction to world navies. Critics have declared that carriers could not survive bombs from dirigibles, battleship guns, dive-bombers, kamikazes, submarine torpedoes, cruise missiles, sea-skimming supersonic missiles, ballistic missiles, and hypersonic missiles.[68] Yet in the age-old seesaw of offense versus defense, carrier critics consistently have been proved wrong.

Since World War II, the U.S. Navy has faced existential questions concerning the future of the flattop on three distinct occasions (in 1949, during the late

1970s, and during the early 1990s), in addition to the current debate over carrier choices. All those debates eventually were resolved in favor of the carrier's continued role in naval operations. It remains clear that the aircraft carrier should continue as the centerpiece of USN combat power. Submarine- and surface-launched missiles are indeed important components of naval combat power, but they cannot replace the carrier.

The authors believe that the ships presented here constitute a complete set of practical candidates. Unending debate about and continued drift among the carrier choices presented by the executive and legislative branches, as well as the Navy itself, will result only in further erosion of naval capability, and thus national security.

In our judgment, the best choice is the *Midway*-size CVM carrier. It would be big enough to carry a full, three-dimensional air wing; could make speeds well above thirty knots; would deploy the highest-technology, close-in, electronic, cyber, and kinetic defenses; and would enjoy all the survivability of the *Nimitz* and *Ford* classes, not only owing to size but by incorporating multiple hulls, armored decks and side protection, full watertight compartmentation, and the latest firefighting technology. Finally, such a carrier would be small enough to be built in at least four American shipyards at a competitive price, at a fraction of what the *Ford* class costs.

The Navy—not a joint or multiservice committee—should design and procure this ship, and then the Navy must be held accountable. It is time to make a choice and proceed to construction.

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