Setting a Course for the

PH3 Chris Vickers

By David A. Perin

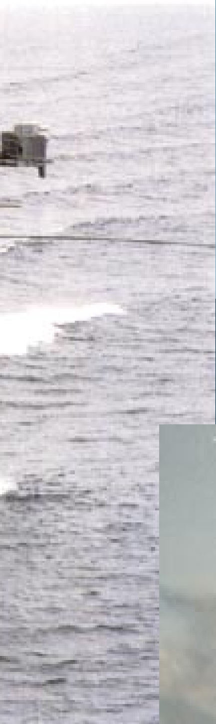
Since its inception 75 years ago—when the collier *Jupiter* was converted to the first U.S. aircraft carrier, *Langley*—the carrier force has generated millions of sorties, responded to hundreds of crises, played central roles in WW II, Korea, Vietnam and the Gulf War, and served as a centerpiece of the maritime strategy that helped win the cold war. The 20th century has unfolded a great success story for Naval Aviation and the carrier force, and today's *Nimitz*-class carriers with their multipurpose air wings represent the culmination of that success.

But ongoing changes in missions, threats, technology and budgets are creating new challenges and opportunities for planning the carrier force of the 21st century. How the Navy responds to these challenges today will shape the broad debate about the future role of aircraft carriers and affect the design of the next-generation carrier, currently called CVX.

The Role of Aircraft Carriers in the 21st Century

Long-term planning for major force elements such as a new generation of aircraft carriers is complicated by the uncertainty in international affairs and by the rapid change in military

21st C ntury Carri r Forc



technology. Predicting the future is risky business, but the Navy cannot ignore ongoing changes in missions, threats, technology and resources while deciding on a next-generation aircraft carrier that will serve the nation throughout much of the 21st century.

International Security

What will be the economic, social, environmental and associated military challenges of the 21st century? What forms of military power will be most relevant to solving these problems? Who can we count on to be our allies, and who will be our potential adversaries? Who will give us access to bases, and under what circumstances?

These questions are central to planning future U.S. military forces, including the carrier force. But coming up with detailed answers now is simply not possible. By the time the first CVX reaches the mid-point in its service life (in about 2037), the details of the international security environment will almost certainly look different from what we predict today. What *is* predictable today:

• The United States will retain worldwide economic, political and military interests.

• Crises and conflict will continue to threaten those interests.

• The time and place of conflict will often be beyond our control.

• Access to overseas bases will not always be available when and where needed.

These factors imply a continu-

Left, *George Washington (*CVN 73) completes her turnover with *America* (CV 66) in the Mediterranean Sea in February 1996. Below, LCdr. (now Capt.) John Leenhouts sits in his A-7 *Corsair* ready to catapult into action from the deck of *Dwight D. Eisenhower* (CVN 69) in the late 80s.


JOC Gregg Snaza

The flexibility of the carrier was demonstrated once again as Army MH-47D *Chinooks* from 2nd Battalion, 160th Special Operations Aviation Regiment embarked aboard *George Washington* (CVN 73) during Fleet Exercise 2-94.

ing need for the capability to operate from the sea—free from the need for immediate access to facilities ashore, free to act upon ambiguous indications and warnings, and ready to provide immediate and sustainable combat power for an indefinite period when and where needed.

The uncertainty in future events emphasizes the need for a next-generation carrier that can adapt to missions and circumstances that cannot be foreseen today. Aircraft carriers have inherent flexibility because of their large size, mobility and their ability to operate a variety of aircraft. However, we must ensure that the next-generation aircraft carriers will meet the challenge of an uncertain future as well as take advantage of new technologies and new types of aviation systems that emerge in the 21st century.

Battlefield of the Future

The battlefield of 2037 will almost certainly be different from that of 1997. But one important trend seems clear: weapons will be more accurate and lethal; and advanced intelligence, surveillance and reconnaissance systems will make the battlefield more transparent and allow operational commanders to employ the greater firepower of new weapons—including long-range unmanned weapons like the Tomahawk Land Attack Missile (TLAM), Army Tactical Missile System (ATACMS) and their successors.

• Land attack missiles and supporting intelligence, surveillance and reconnaissance systems represent an important element of our future strike capabilities. Nonetheless, tactical aircraft will remain a core element of our military posture for future decades for several reasons:

• Aircraft are multimission. TLAM is an effective strike weapon, but aircraft can perform a wide range of combat missions, including air superiority, suppression of enemy air defenses and close air support.

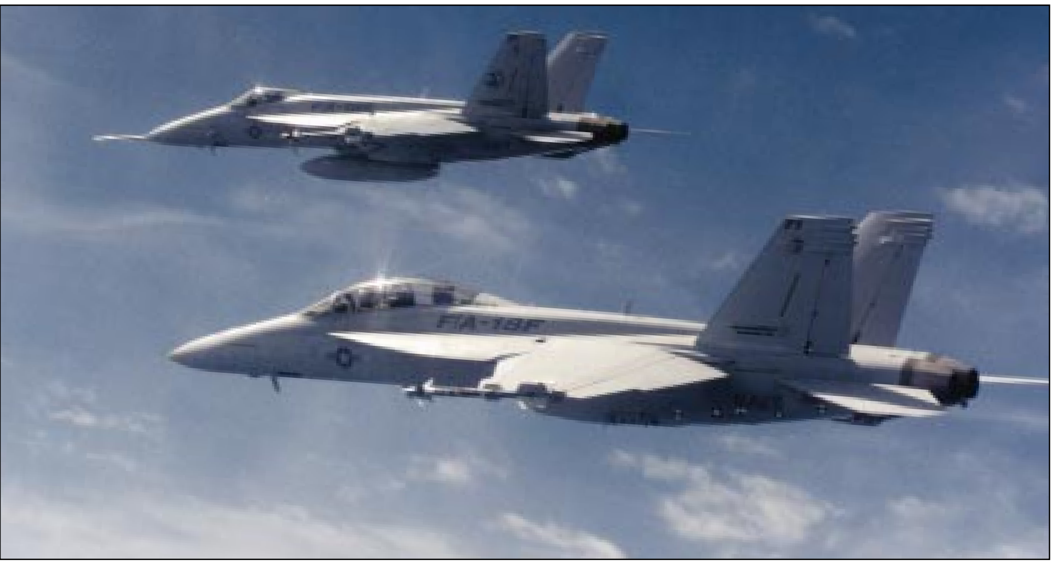
• Aircraft can strike a broader range of targets. TLAM is an effective weapon against soft to moderately hard, fixed targets. Aircraft can deliver a wide variety of weapons against the full range of fixed and moving targets.

• Man in the loop is an advantage. Eventually, the guidance and sensor systems on missiles may be able to approach the perceptual and processing capabilities of a cockpit crew. But for now, the ability of a person in the loop to gather and process information and to react to unexpected circumstances provides a significant operational advantage, particularly against battlefield targets.

• Aircraft are more economical for sustained strikes. Though expensive to buy and operate, aircraft are more cost effective for sustained strike operations because they are reusable.

Current plans to invest many billions of dollars to field the next generation of tactical aircraft—the F/A-18E/F, F-22 and the Joint Strike Fighter (JSF)—reflect the Department of Defense's belief in the continuing centrality of tactical aviation. At issue is not whether tactical aircraft will be needed in the future, but how the characteristics and force structure of future tactical aircraft should be shaped by the improved technologies. For example, future versions of TLAM could have greater accuracy and deliver a wider range of warheads, possibly including terminally guided submunitions and hard-target penetrators. Improved surveillance and reconnaissance systems and associated command, control, communications and intelligence support systems may allow land attack missile systems to attack a wider range of targets on the battlefield.

How would such improvements shape the employment of tactical aircraft? The improving capabilities of TLAM to strike fixed targets deep in the theater would allow sea-based aircraft to focus on air superiority and battlefield targets and to operate closer to the littoral. And improved sea-based surveillance and reconnaissance systems, such as satellites, unmanned aerial vehicles (UAVs) and long-range theater surveillance aircraft, may affect the number of surveillance aircraft needed aboard a carrier. These considerations could have implications for the design requirements of the JSF or CVX, and the planned next-generation support aircraft, the Common Support Aircraft (CSA).



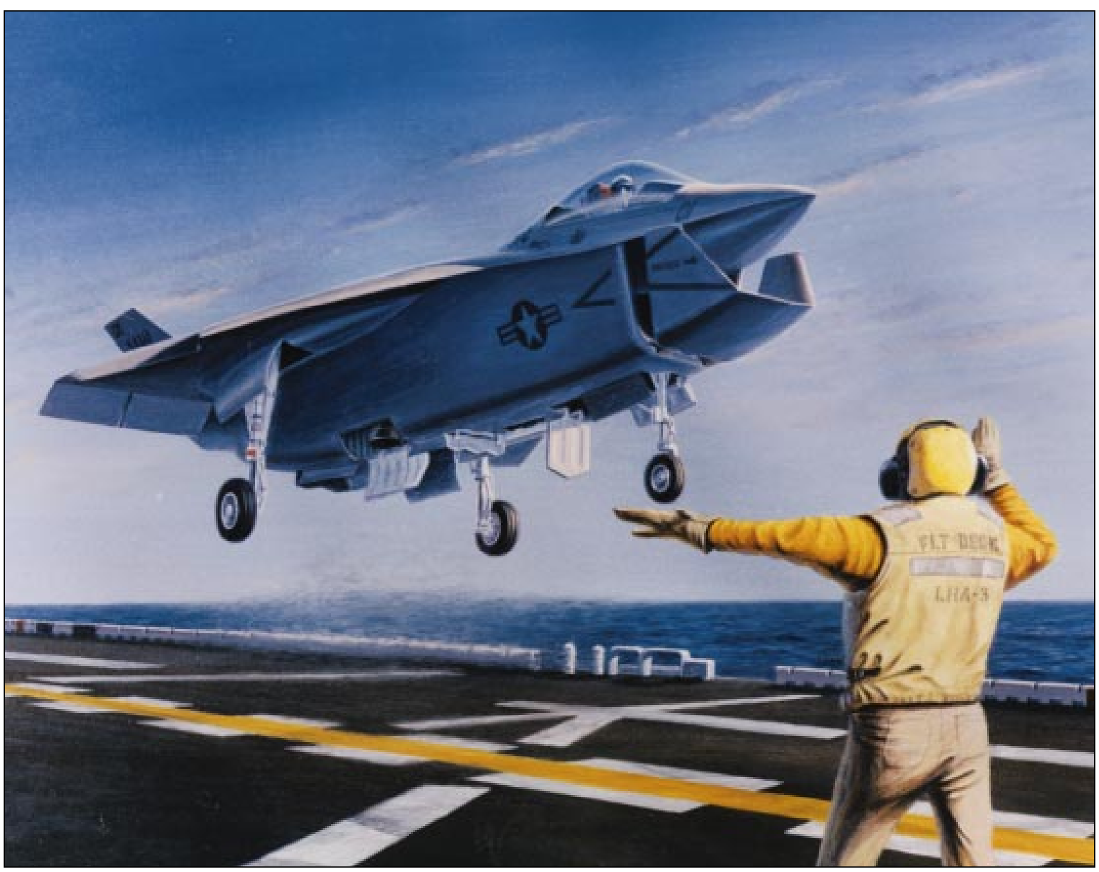
Randy Hepp

The Next-Generation Carrier Design

The design of CVX will be influenced by a variety of factors, especially advances in subsystems technologies (see "On Track to Tomorrow's Carrier," p. 24). Two of the most significant aspects of the new carrier will be how aircraft launch and recover, and the overall machinery concept of the ship.

Aircraft

Launching and recovering aircraft is likely to remain the central func-


Boeing Defense & Space Group

Above, the latest additions to the Naval Aviation arsenal: a two-seat F/A-18F (foreground) flies in formation with an F/A-18E. The *Super Hornet* is scheduled to join the fleet by 2000. Right, Boeing's short takeoff and landing entry in the Joint Strike Fighter competition.

tion of aircraft carriers and the one that has the greatest influence on their design. Operating today's conventional takeoff and landing (CTOL) aircraft requires powerful catapults and arresting gear, which have a major impact on the overall machinery concept of the ship and also drive the size and layout of the flight deck.

The JSF program provides an opportunity to review the commitment to CTOL aircraft for the carrier force. The current official plan for JSF is to develop separate aircraft tailored to the specific needs of the Navy and Marine Corps. The Marines would get a short takeoff and vertical landing (STOVL) aircraft to support Marine Air-Ground Task Force (MAGTF) operations from amphibious ships and expeditionary airfields. The Navy would get a CTOL aircraft with greater range and payload, and with increased stealthiness to ensure survivability.

In view of the outstanding record of CTOL aircraft and carriers, sticking with CTOL would be a natural choice. However, alternative paths might result in a greater effectiveness or lower cost for the overall ship/aircraft system. Now is the time to explore the alternatives, because the next generation of fighter-attack and support aircraft are in the early stages of development. They will enter the fleet at roughly the same time as the first CVX, which creates an opportunity to reevaluate how aircraft are launched and recovered. Once JSF, CSA and CVX are decided, it will be a long time before the Navy will have another chance to develop new fighter and support aircraft and design a new aircraft carrier.

One alternative is to develop a common STOVL strike fighter in the JSF program for both the Navy and Marines. For compatibility, CSA would probably need to be a STOVL or STOL (short takeoff and landing) design.

This path has several potential, but unproven, advantages. A common JSF aircraft for the Navy and Marines might save the Department of the Navy (DON) money because of lower development costs for a single aircraft, larger production runs and lower support costs. In addition, a common STOVL aircraft should give DON greater leverage in the JSF program, and it might foster greater synergism between Navy and Marine Corps aviation planning and operations.

Lockheed Martin

The Marine Corps version of Lockheed Martin's Joint Strike Fighter concept.

A common DON STOVL aircraft would open up a wider design arena for CVX. It would also lead to increased sortie rates under some conditions and allow greater flexibility in the basing for naval aircraft.

The STOVL aircraft under consideration in the JSF program are much more capable than the original AV-8 or even the current AV-8B *Harrier*. Nonetheless, the STOVL path raises serious issues about performance and risk:

Can a DON STOVL aircraft meet the requirements of both the Navy and the Marines?

Marine aviation focuses on support of the MAGTF, which involves battlefield support missions at fairly close ranges. Support to Marine forces is only part of the Navy's interests, which cover the full spectrum of theater air operations. To support these missions, the Navy requirements for JSF call for additional range, payload and stealth, which raises the issue of whether a common STOVL aircraft would be good enough for the Navy.

For example, a STOVL aircraft may not provide the same degree of all-aspect stealth that is achievable in a CTOL aircraft. Would such an aircraft be suitable for strikes against a range of targets on the first day of the war when enemy air defenses are at full strength?

Lethality is another concern. The internal weapons bay of a CTOL variant of JSF will accommodate 2,000-pound weapons, whereas STOVL aircraft may be able to accommodate only 1,000-pound weapons internally. This might limit their use against certain targets. How serious is this limitation in view of STOVL's ability to carry 2,000-pound weapons externally, and possible improvements in warhead technology to increase the lethality of 1,000-pound weapons against hard targets?

One idea that might help with the range and payload tradeoffs would be to operate STOVL aircraft in different modes, depending on the operating base. When operating from amphibious assault ships and perhaps forward land-based operating sites, the aircraft would operate in the basic STOVL mode. When operating from carriers, the aircraft would be catapulted (perhaps in conjunction with a ski jump) and arrested, but at lower energies than existing CTOL aircraft—the "soft-cat, soft-trap" concept.

The powered-lift features of STOVL would reduce launch and recovery speeds and the associated catapult and arresting energies, so that a STOVL aircraft would not require the heavy structure of a CTOL aircraft. At the same time, the additional energy from the catapult might be sufficient to increase the range and payload of the STOVL aircraft to meet Navy requirements. Similarly, the soft trap would enable the aircraft to recover on carriers at heavier weights (i.e., with additional fuel and stores) than in the vertical landing mode.

How serious are the technical risks of STOVL?

Controlling weight is a difficult task in the design of high-performance combat aircraft. STOVL aircraft are more sensitive to weight growth than CTOL aircraft because of their need to land vertically. Achieving the type of capabilities envisioned for a DON STOVL aircraft would push the limits of engine technology, creating a technical risk for the program. Understanding the magnitude of these risks and the consequences of failing to achieve performance goals is essential when evaluating the costs and benefits of the STOVL path.

Is there a reasonable transition strategy to a new force if CVX could not operate all existing aircraft?

A DON STOVL aircraft could lead to a carrier without catapults, or a new type of low-power catapult. At the lower energies envisioned for soft-cat operations, alternative catapult technologies might be feasible, including hydraulic and even flywheels. These technologies would open up the options for the machinery concept of a future carrier. However, a future carrier with only low-power catapults would not be able to launch certain current aircraft, which raises the issue of the transition strategy from today's all-CTOL force to a mixed force of the future.

In short, the STOVL path has exciting possibilities, but it also entails significant risks. Now is the time to address these issues if STOVL is to influence the design of CVX.

Machinery Concept

A second major issue affecting the design of a future carrier is the overall machinery concept for propulsion, aviation launch and recovery equipment, and other ship systems. There are a variety of alternatives, but the debate revolves around nuclear power: Can the Navy afford nuclear power for future carriers? Can it afford not to have nuclear power?

Even more critical is the development of a new, non-steam catapult because generating sufficient steam for existing catapults is not practical in a non-steam propulsion system.

PHAN Joe Hendricks

Sailors aboard *George Washington* (CVN 73) replace a piston in catapult number one. The CVX design team is considering the feasibility of alternative catapult technologies such as electromagnetic or internal combustion systems for the next-generation aircraft carrier.

The outstanding effectiveness of nuclear power has been thoroughly demonstrated in the *Nimitz* class; the issue is not performance, but cost. Previous cost estimates predict that the additional cost of a nuclear plant might be as large as 30 to 50 percent in initial procurement cost and, at today's oil prices, 10 to 20 percent in life-cycle cost. For this price, the Navy gets unlimited high-speed endurance, the ability to respond to distant crises in minimum time, and insurance against future increases in the price of oil.

The leading candidate for a new non-nuclear plant is an integrated electric propulsion system powered by gas turbines. Electric drive is essential to this concept because the existing geared mechanical drive requires location of the gas turbines deep within the ship. But the turbines' intake manifolds and exhaust stacks require a large amount of shipboard space. Electric drive permits placement of the gas turbines closer to the skin of the ship, minimizing the intake/exhaust problem. Electric drive would also enhance ship survivability (because of redundant routing of electricity), and it would enable the Navy to eliminate maintenance-intensive steam auxiliaries.

Although gas-turbine integrated electric drive is an exciting concept, it has not been proven for the scale of an aircraft carrier. Even more critical is the development of a new, non-steam catapult because generating sufficient steam for existing catapults is not practical in a non-steam propulsion system. Other options include using an electromagnetic catapult or liquid propellants instead of steam. However, significant develop-

AN Kris White

ment would be required before either concept is ready for a new carrier.

If the technology proves out, the gas-turbine electric drive would offer (compared with existing nuclear plants) reduced manning and lower procurement and maintenance costs. Cost savings might also be achieved in a new-design nuclear plant. Integrated electric drive is possible with a nuclear plant, and the Navy is exploring ways to reduce manning and improve maintainability of nuclear systems.

Given the outstanding record of nuclear power, the burden of proof lies on new systems to demonstrate equal reliability, acceptable performance and significantly lower cost. At this point, the argument is that the Navy should thoroughly examine non-nuclear alternatives.

Operations

Exploring innovative concepts of operations should be an integral part of the development process for a new aircraft carrier.

At the level of individual platforms, the central issue concerns which functions should be performed by the carrier and its air wing. Improvements in the capabilities of offboard and unmanned systems and the increasing capacity and reliability of communication links to the carrier imply an opportunity to reexamine whether some current functions could be performed more efficiently by offboard systems. Various intelligence, surveillance and administrative functions are candidates to move off board.

A related change in concepts of operations concerns the size of the crew. Moving some functions off board and automating others has promise for major reductions in manpower, which accounts for more than one-third of the life-cycle costs of existing carriers. Truly significant reductions are feasible only by combining new technology with new concepts for operating the ship.

New technology and concepts of operations may create opportunities for sea-basing platforms to assume new tasks that are important in the joint littoral warfare environment of the future. For example, perhaps TLAMs and UAVs could be added to the aviation systems of a future carrier.

Changes in concepts of operations could apply to the battle group or the force as a whole, as well as to the individual platforms. One possibility is to rethink the assignment of functions among platforms. The current division of labor among carriers, surface combatants and amphibious ships is the product of long experience, and it has worked well. But now is an appropriate time to consider out-of-the-box ideas, because the concurrent development of the 21st century surface combatant (SC 21) and CVX and the not-too-distant replacement of amphibious assault ships provides a once-in-a-generation opportunity to consider a major change of course.

One radical change would be to incorporate certain functions of surface combatants or amphibious ships into the design of a new carrier. For example, CVX could include a multifunctional phased-array radar, improved helicopter support for Marines and special warfare forces, and perhaps even some form of well deck to support future surface craft.

Another area that deserves serious thought concerns options for getting increased forward-deployed time out of the carrier force. Today's carrier force levels and deployment patterns result in significant gaps in coverage in key theaters. For example, the Indian Ocean was gapped in October 1994 when Iraqi troops moved south toward Kuwait. This resulted in a one-week delay while *George Washington* (CVN 73) responded from the Mediterranean, leaving a gap in carrier presence off Bosnia.

Increasing carrier force levels could resolve the gap problem, but in the present budgetary climate, force levels are more likely to move in the opposite direction. Thus, there is a strong incentive to come up with new concepts that can enable a future carrier to spend more of its time in crucial forward deployments, including new schemes for rotating ships, aircraft and crews.

Some of these ideas represent a significant departure from current systems and operational practices. But the Navy is likely to improve upon current capabilities within a constrained budget only by combining new concepts of operations with new technology and design.

Opposite, crew reduction is a major concern for the CVX design team. *George Washington* (CVN 73) crew members participate in a flight deck scrub under the scorching sun while under way in the Arabian Sea. Below, officers on duty in *Abraham Lincoln's* (CVN 72) Combat Direction Center monitor contacts while operating in the Indian Ocean.

PHAN Timothy M. Altevogt

Affordability

A major focus in the development of the carrier of the future is the need to reduce costs. The problem is not that the cost of nuclear-powered aircraft carriers has gone up. When adjusted for inflation, the cost of *Nimitz*-class carriers has remained nearly constant. The problem is that the Navy's budget has declined significantly, and the Navy will have great difficulty affording as many CVNs as needed at the current estimated life-cycle cost of $18 billion (in FY-96 dollars, not including the aircraft). Unless the budget increases or DON realizes huge savings in infrastructure, the Navy must reduce the cost of buying and operating new carriers or face the inevitability of smaller force levels.

Because an increase in budget is unlikely, reducing the cost of the next-generation carrier is absolutely essential to preventing devastating cuts in carrier force levels.

Putting affordability near the top of the priority list would force the Navy to contemplate significant changes. To achieve a 20-percent reduction in the life-cycle cost (which is used here as a benchmark for significant savings), there are only three major options:

• Reduce the size of the ship and the air wing.

• Give up nuclear propulsion.

• Reduce the crew by 50 percent.

Any one of these changes would represent a significant change in carrier capabilities or in the concepts of operations.

Reducing costs must be given high priority. We must be willing to consider selected tradeoffs in capabilities and new ways of doing business to reduce costs. Such changes will not occur without some risk. But given the continuing squeeze on resources, either we will find new ways to perform the essential tasks more efficiently or the fleet of the future will be even smaller than we now imagine.

Conclusion

The 20th century has told a great success story for Naval Aviation and for aircraft carriers, and carriers will continue to serve the nation well in the 21st century. But this will require anticipating and adapting to change and a willingness to explore new ideas and new ways of doing business.

Change is difficult and risky. History shows that most visionary ideas do not pan out, and many are just flat wrong. History also shows that most successful innovations, including Naval Aviation itself, are initially viewed as radical and risky departures from the tried and true and, thus, are often dismissed by those in power.

There is no simple solution to this dilemma. The Naval Aviation community must encourage innovative ideas for its next-generation aircraft and aircraft carrier, including ways to improve efficiency and reduce costs. At the same time, it must maintain core capabilities—including mobility, survivability, sustainability, flexibility and the ability to generate high-volume firepower—all essential for an effective sea-based aviation platform in the 21st century. n

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