The fleet's new eyes

The new carrier-based E2-D Hawkeye, which will enter the fleet in 2011, looks much like the current Advanced E2-C version but will carry an upgraded radar, radios, passive-detection gear, and other hardware.

The new E2-D Hawkeye gives the Navy a more advanced early-warning radar and an important node in the net-centric warfare it wants to wage in the 21st century.

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Senior Editor

Few U.S. military forces are more powerful than a carrier task force. It is well armed, well defended, and highly mobile. But it relies, in large part, on unarmed, prop-driven aircraft, the Hawkeyes of airborne early-warning squadrons, to keep its defensive umbrella intact, monitor and guide attacks, and, in the future, help anchor the U.S. military's net-centric strategies for fighting a war.

That's why the E2-C Hawkeye, a **Northrop Grumman** plane, is undergoing a massive makeover, one that will lead to the E2-D, a plane that will serve as the eyes of the fleet for at least the next decade or two.

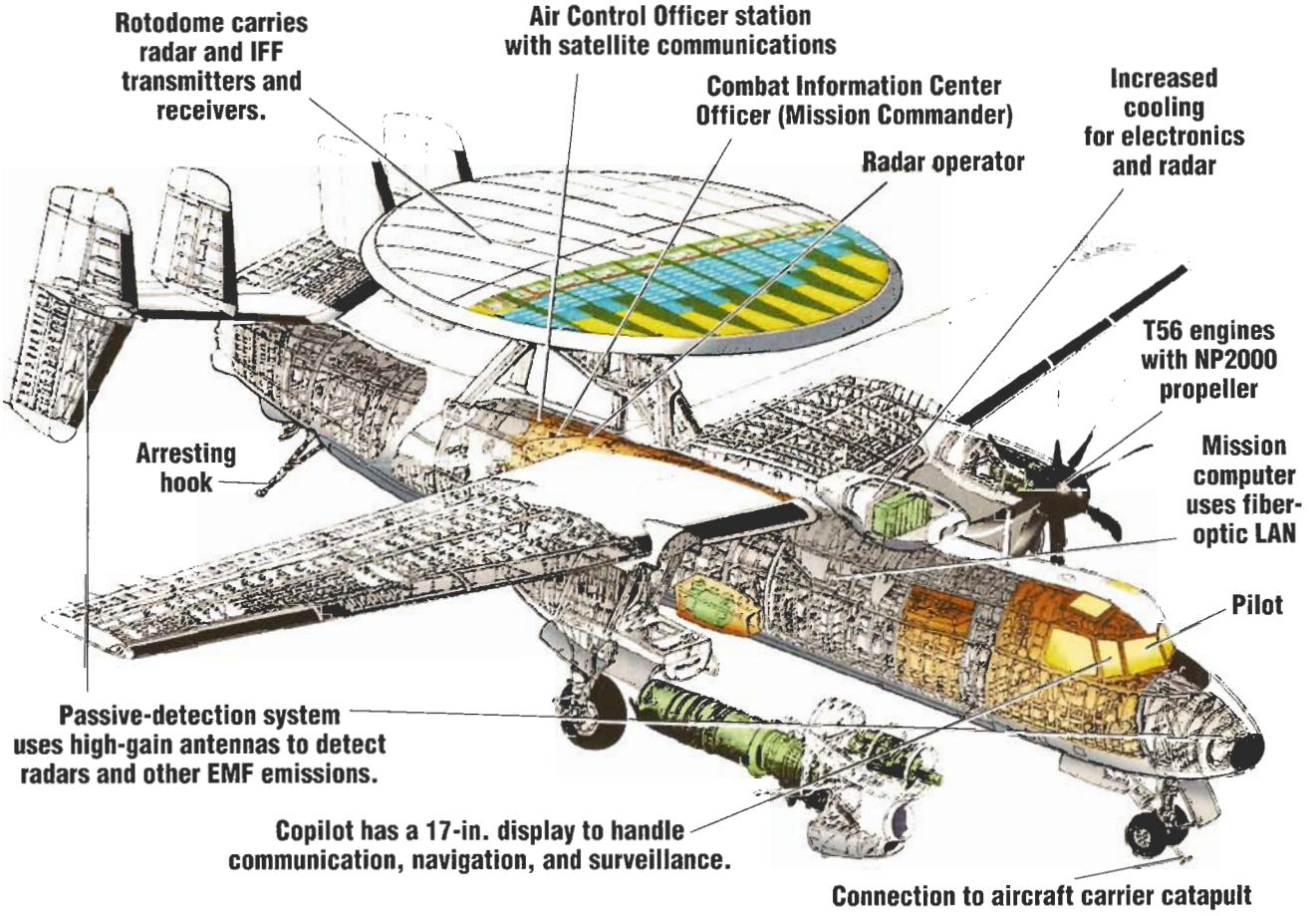
AVIONICS

Shipborne raiders, no matter how powerful, are limited by line of sight. This means radar can pick up high flyers relatively easily, but planes or missiles skimming just above the water but beyond the visual horizon can go undetected until within 10 or 20 miles of the ship. And for an incoming missile flying 300 mph, that gives crews less than 4 min to detect, track, identify, and destroy it. So carrier task forces rely on airborne Hawkeyes to provide an overall picture of the aircraft and ships in the surrounding waters and airspace. From their perch at 18,000 ft or more, their radar can pick out low-flyers "down to the deck."

The E-2Ds will be equipped with **Lockheed Martin**'s new AN/APY-9 radar. It should let crews detect targets out to about 350 miles and more than double the search volume of the E2-C. The new UHF radar features a solid-state transmitter, digital receivers, and upgraded algorithms for detection and tracking. These will let the radar track smaller objects than the one it replaces, according to Northrop Grumman.

The new radar should also pick out targets along shorelines and over land where it can be difficult for radar to distinguish legitimate targets amid radar returns bouncing off the ground, the moving sea, and especially waves hitting the shore. This fits in well with the Navy's emphasis on littoral or near-land warfare, a switch from

E2-D Hawkeye



the blue-water operations common during the Cold War.

The plane will also get a new multichannel ESA (electronically scanned array) antenna for its rotodome, the saucer mounted above the fuselage and the Hawkeye's most identifiable feature. The rotodome and antenna will spin at 4, 5, or 6 rpm. The new antenna can also be electronically steered while the dome and antenna are stationary to scan a particular area of interest. There's also a hybrid mode in which the antenna is electronically steered while it is spinning. This increases system flexibility, according to Northrop Grumman.

The antenna is actually 18 individual antenna elements, each with its own receiver. This lets the radar system use space-time adaptive processing. This technique takes signals from all the antennas to calculate and use a pattern of antenna elements that minimize ground returns and interference. And all of this is done on a pulse-by-pulse basis. In other words, every time the radar transmits a pulse, the system reconfigures which antenna elements to use so that it pick up returns but eliminates as much clutter and interference as possible.

The IFF system (identification friend or foe), or secondary radar, will be upgraded so that its range still matches the radar.

Radio, like radar, is often limited to line-of-sight transmission. And just as the E2-D's altitude gives it great radar coverage, it also puts the plane in radio contact with practically the entire surface fleet and its aircraft. So the plane often relays communications, issues instruction, and maintains data links. Engineers, therefore, improved the plane's communication suite to take advantage of that. It now consists of six ARC 210 radios that transmit voice or data, in the clear or encrypted, at 30 to 400 MHz. These six radios also handle Link 11 and 16, two radio-based networks that exchange data on radar and IFF tracks. The E-2D will also carry at least two satellite communication radios and a secure HF radio.

Much of this is in preparation to use the Hawkeye in a pivotal role in net-centric warfare, a tactic that emphasizes situational

awareness and maximum data sharing. And data can be target info, photos, video, voice messages, anything that gives the task force a military edge. The new Hawkeye is also slated to work more closely with the Navy's missile/sensor-defense network rather than control fighter aircraft to defend the carrier and task force.

Inside, the three flight officers in the back will get 21-in. full-color displays that let them see in excess of 500 ground and air tracks. They will also talk to each other over a digital, fiber-LAN intercom. To spread the workload, the cockpit will be equipped with three 17-in. displays that can show a variety of flight and engine data, including everything the flight officers in the back can see. This will let the copilot, a rarity among carrier-based planes, handle some mission tasks.

AIRFRAME

Some Hawkeye got new turboprop engines, the T56-A-425, during the 1990s. These engines will be standard on the E2-D and should let the plane carry the weight of all the new equipment. Despite the boost to from 4,600 to 5,100 hp, the engines will use 13% less fuel, which increases range and time on station, and give the aircraft a 6% faster cruise speed of 260 kt. The engines also helped earn the plane 20 world records for altitude and time-to-climb in the medium turboprop category.

For the E2-D, engineers are improving the propeller shafts so they get three times their current life, beefing up engine mounts to better handle the loads associated with the heavier aircraft, and adding a propulsion monitoring system that provides full-author-

21st century aircraft carrier

Shortly after the E-2D Hawkeye enters service in 2011, it will have a new part-time home: the USS *Gerald R. Ford*, CVN-78, the namesake of an entirely new class of aircraft carriers. Here are a few features planned for the $8 billion warship:

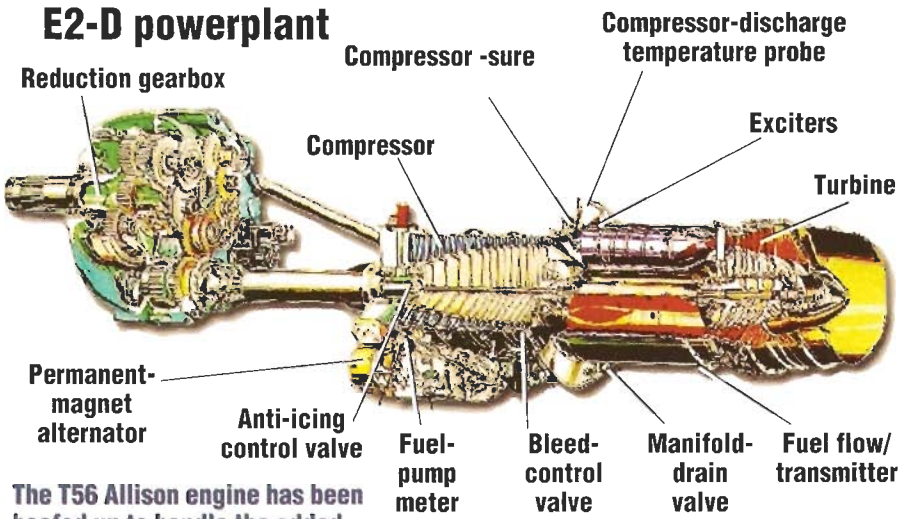
- It will carry two A1B nuclear reactors. The A stands for aircraft carrier, the 1 indicates it is the first-generation core designed by the contractor, and the B stands for **Bechtel**, the reactors' designer and contractor. The reactors will provide 25% more power for propulsion but need only half the usual crew and maintenance to keep them running, according to the Navy.
- The ship will have three times the electrical generating capacity as the previous *Nimitz*-class carriers, thanks to more powerful reactors and additional electrical generation equipment. It will need some of that electricity for the following systems, yet is planned to have enough left over to power defensive beam weapons when they become available.
- Electromagnetic aircraft launchers will replace steam catapults currently used to launch aircraft from the deck. The catapults, which consume about 1,350 lb of steam for each plane launched, are large and heavy. They're also reaching their limit in terms of how heavy an aircraft they can launch. The old catapults also give planes a large initial shove, which is hard on airframes. The new ones increase launch energy by up to 30%, and accelerate planes smoothly and continuously down the rail. In addition, they should deliver up to 90 million ft-lb of energy with an end speed between 55 to 200 knots, and be able to launch a plane every 45 sec.
- An electromagnetic aircraft-recovery system (EARS), a hybrid electrohydraulic system, will replace the totally hydraulic system that controls arresting wires. EARS will put increasing resistance on the wires as landing aircraft catch them with their arresting gear. It should also let designers create tailored resistance profiles, something impossible to do with the current system. EARS will also handle heavier planes than current arresting gear, which means planes can land with more unused munitions.
- Radars will use phased-array technology to do away with rotating structures on the island. This should reduce maintenance, as well as the ship's radar signature. The island will also be located about 100-ft further aft, a suggestion from enlisted personnel that direct and move aircraft on the flight deck. This is predicted to reduce the traffic jam of planes lining up behind the forward catapults prior to a launch. And command and control spaces once located in the island will move below decks to save space and ensure survivability.
- Weapon-handling conveyors and elevators will use linear motors, much like the launch system. This will eliminate wire ropes, drums, and turning motors.
- Overall, improvements should let the carrier launch and recover 20% more aircraft per day. And the ship's crew will go from 3,000 to 2,500, possibly as low as 2,100. (The 2,500 officers and enlisted of the airwing will still be needed.)

ity digital engine control (FADEC) and an automatic power reserve. The reserve kicks in if one engine fails on launch. The system raises the turbine temperature limit on the good engine, letting it put out 5,450 hp rather than 5,100. This lets the plane meet the Navy's single-engine rate of climb mandates.

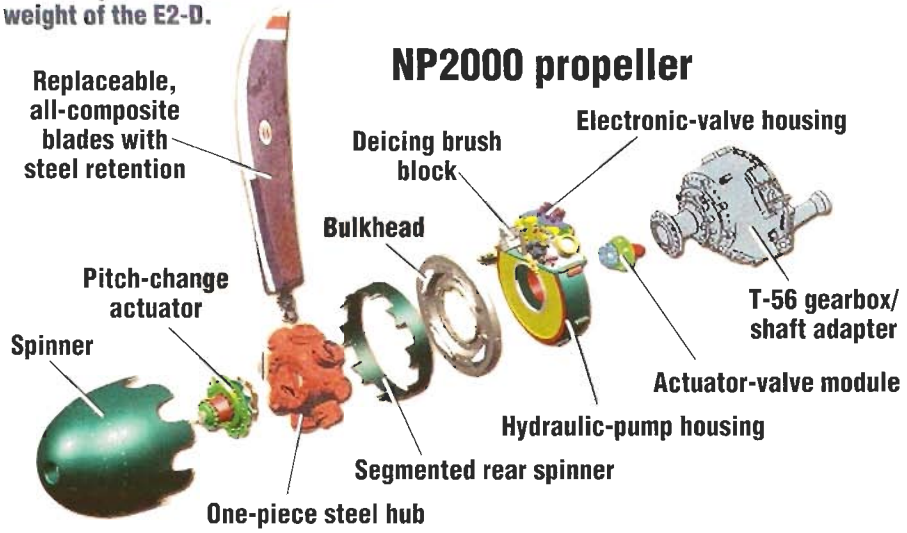
With the added equipment and weight comes the need for more electric power. So the twin-engine E2-Ds will have updated gearboxes and carry larger, oil-cooled **Hamilton-Sunstrand** generators. Two 170/225-kVA units will replace the current 60/90-kVA generators. This should provide enough for the current E2-D's needs and still have a margin for handling future upgrades.

The engines will be turning an eight-bladed prop, which first saw service on some E2-Cs along with the improved engines. The composite blades can be changed while the prop is mounted on the engine, says Northrop, which should reduce maintenance. The 13.5-ft-diameter props make less noise and vibration than the previous four-bladed design. They also create less drag when they are feathered, i.e., turned into the wind so that they are not generating thrust. This means a feathered engine doesn't induce yaw, so engine shutdowns and restarts in-flight are smoother. And to make things less hectic on the carrier's flight deck, the props can be adjusted to make less thrust during ground idle and let the plane taxi slower than with the previous props.

The Navy is planning to buy 75 E-2Ds, and the cost of the planes, including R&D is about $15.5 billion, or around $206 million per plane. The plane's first flight is scheduled for this summer and the Navy expects it to join the fleet in 2011. **MD**



The T56 Allison engine has been beefed up to handle the added weight of the E2-D.



The NP2000 prop assembly has fewer mechanical parts than the previous prop, which should give them 1,200-hr mean time between failures.

Northrop Grumman Corp. is working on the first E2-D at its Bethpage, N.Y., factory.