The tiltrotor V-22 is built for versatility. Its roles will include special operations, airlift, combat rescue, and more.

The Amazing

The "amazing airplane" that General Cassidy speaks of, the V-22, is the first airplane program to be designed from the ground up for all the services. Deliveries of the first aircraft are planned for the US Marine Corps.
In an age of specialization, the Bell-Boeing V-22 Osprey stands apart. The V-22, which is a joint-service program, will cover the bases for a number of different missions.

"Asking what good is the CV-22 [Air Force designation] is like asking what good is a newborn baby," Gen. Duane H. Cassidy, Commander in Chief of the Military Airlift Command, said recently. "It can do almost anything you can imagine, and I have a big imagination. I see a big role. It will have a major role in SOF [Special Operations Forces], in short airlift, and in combat rescue, and it will have a major role in low-intensity conflicts of all sorts. It will be an amazing airplane."

The feature that most sets the Osprey apart from almost everything else is the fact that it is part helicopter, part conventional airplane. The Marine Corps's AV-8A Harrier was this country's first operational vertical takeoff and landing (VTOL) airplane, but the V-22—originally known as the JVX—will be the first large-scale effort to employ tiltrotor technology for vertical and/or short takeoff and landing (V/STOL).

While on the ground and while hovering, the Osprey's engine nacelles will be perpendicular and the large-diameter rotors parallel to the wings. After takeoff and for straight-and-level flight, the rotor/nacelle combination will rotate forward ninety degrees, allowing the V-22 to fly like a "normal" airplane at speeds of more than 300 knots. It is precisely this neither-fish-nor-fowl configuration that will make the Osprey such a versatile performer.

New Concepts in Design and Construction

The V-22 is the first airplane program to be designed entirely on computer. With computer-aided design (CAD), engineers were freed from having to draw a multitude of blueprints and could easily make changes in the design. Another great advantage to the CAD system is that it allows designers at Boeing Vertol's plant in Philadelphia, Pa., to communicate instantaneously with their brethren in Bell Helicopter Textron's Fort Worth, Tex., facility.

The two companies have split the work on the V-22, with Boeing Vertol being responsible for the fuselage, empennage, overwing fairings, and systems integration. Bell is building the wing, nacelles, transmissions, and rotor and hub assemblies and is handling the integration of the Allison T406-AD-400 engines. These engines are a derivative of the T56 engines that power the Grumman C-2A and E-2C and the Lockheed C-130 and P-3 aircraft.

The Osprey is also the first major military aircraft design whose airframe will be made up almost entirely of composites. Slightly more than 6,000 pounds of the aircraft's almost 13,200-pound structure will be made of a graphite-epoxy laminate. The composite materials are very lightweight (about a quarter of the weight of aluminum), and because of the buoyant fuel sponsons, the V-22 will have good flotation characteristics in the event of a ditching at sea. There will only be about 1,000 pounds of metal in the airframe, and most of that comes in the form of perforated copper that will be laminated to the outer skin panels for lightning protection.

Hatching the Osprey

Bell and Boeing entered full-scale development (FSD) on the V-22 program in earnest in May 1986 after the Naval Air Systems Command (NAVAIR) awarded the two companies a $1.714 billion, seven-year, fixed-price-contract for the design, development, production, and initial operating fleet equipment.
incentive contract. When engine development is included, the total contract value comes close to $2.5 billion.

One part of the V-22 contract that is a first for a military procurement is that Boeing and Bell will each pay roughly $300 million of the tooling costs. The Navy will pay the other one-third of the costs. The tools and jigs themselves are unique in that they are made of composites also, although they were not made by the same process as the V-22's components.

The two companies, though, began limited FSD with their own funds in June of 1985 in order to keep up with the Navy's development schedule. In addition, Boeing Vertol alone has invested some $200 million in upgraded and expanded facilities over the last few years in preparation for work on the V-22. The limited FSD work came after the completion of two predesign stages that began in April 1983 and May 1984, respectively.

The first predesign stage demonstrated to the government that the V-22 was a low-risk program. The longest wind-tunnel test program in history—6,600 hours—was also undertaken during this time. The second predesign stage included testing of components and the designing of lead-time items. During the second stage, the Allison engine was chosen as the winner of a competition that also included Pratt & Whitney (which was recently chosen as the second-source engine contractor) and General Electric.

As part of the FSD effort, Class III (or full-scale) mockups have also been made to check the fit and function of the various subsystems. The mockups are being built in the Marine Corps's MV-22A version, since the Corps will be the largest customer and the first service to receive the Osprey.

Full-scale mockups have been built to check the fit and function of the various subsystems. The weight growth that creeps into any new aircraft is being carefully watched and kept in check through the wide use of composite materials in the Osprey.

The mockups (there are five at Boeing Vertol and three more at Bell) include most of the features that will be found on the real article. As an example, there will be access doors in the bottom of the V-22's fuselage that will allow in-flight inspection of the tandem external cargo hooks, which will hold up to 10,000 pounds each or 15,000 pounds together. Another design innovation included on the mockup is the downward-hinged access panels on the engine nacelles that will be strong enough for mechanics to use as work platforms.

Other features in the V-22 include a sensor track handle in the middle of the console to let either crew member operate the forward-looking infrared radar (FLIR) system. This control was added to the console instead of located on the stick to prevent the flight crew from "fighting" with each other while one was flying the plane and the other was operating the sensor. A 2,000-pound-capacity fold-down winch, standard in the Navy's combat search and rescue HV-22A variant, will be available as a kit for the other versions.

The winch is unique in that it will be operated from a pistol grip stick just inside the starboard crew door. The grip serves as a stationary grab handle, but can be removed and connected by a fifteen-foot umbilical cord so that the loadmaster can also operate the rear loading ramp or the external hooks from outside the plane or while inside the cabin. This grip will also give the loadmaster limited longitudinal and lateral control in hover.

The Air Force's Version

While work is progressing toward construction of the actual prototypes (more than 10,000 composite parts have already been manufactured), cockpit design work continues on the Air Force's CV-22 version. The Air
Prominent features in the CV-22’s cardboard cockpit mockup include two color MFDs that show engine or flight instrumentation and, on the left, the sensor track handle for crew FLIR control.

Force intends to use the CV-22 for special operations, and, as a result, almost 3,000 pounds of avionics alone must be incorporated into the design.

The CV-22 will have no dedicated gauges, but instead will have four six-inch-by-six-inch color multifunction displays that will show engine or flight instruments when called up by the crew members. The avionics package also includes an AYK-14 redundant mission computer that operates in a prime and “hot shadow” configuration and that provides emergency backup. There will also be a triple-redundant fly-by-wire control system.

The avionics package works on the 1553B data bus, and this package includes such equipment as a helmet-mounted display (HMD) for the night-vision system (NVS) and/or the FLIR system. There will also be a medium-accuracy ring-laser gyroscope (RLG) for extended self-contained navigation flight, along with a whole host of other equipment.

A digital moving map system is in the works for the CV-22, and further along, a chaff/flare dispenser, a radar detection system, and a missile warning system could be included.

The weight growth that creeps into any new airplane, and especially in the CV-22, is being carefully watched by the two companies. There are signs posted everywhere in the design areas that bear such slogans as “Nobody Likes a Fat Osprey” and “I Think I’ll Have a Light . . . Airplane.” In fact, Boeing rewarded the employee who came up with the best weight-saving suggestion last year with a company-paid vacation to Hawaii.

Because the CV-22 will be heavier than the other V-22 versions, the 700-nautical-mile range cannot be reached as the aircraft is currently configured. The company can guarantee a 520-nm radius for the CV-22 now, and if the weight can be kept down, the range should stretch to 641 nm in the near future.

Allison anticipates that power upgrades to the T406 engines can be realized during the course of development. If this should come to pass, then meeting the 700-nm requirement would be feasible. Even with the range limitation, the CV-22 will still be able to get to more target areas than the MH-53 Pave Low III helicopters it will replace.

**Onward and Upward**

The FSD contract calls for the production of three Ospreys for ground, static, and fatigue testing as well as six flying prototypes. As a result of extensive testing of models and components, there will be no need for a drop-test article. After an exchange of components, Bell will assemble three of the prototypes, and Boeing Vertol will complete the other three examples. The first three flying aircraft will be fitted with Martin-Baker ejection seats, while production aircraft will have bulkhead-mounted armored seats.

First flight is expected to be made by a Bell-assembled aircraft in June of 1988, and a Boeing Vertol V-22 will be flown in August of that same summer. A pilot lot of twelve aircraft is expected to be delivered in 1991 and 1992. Each of the companies will completely build one of the last two aircraft in this lot to demonstrate that the companies can compete against each other.

After production of this initial batch, Bell and Boeing Vertol will compete against each other. The low bidder will build a majority of the aircraft in each lot, while the higher bidder will produce the remaining percentage of airplanes.

The twelve aircraft of the initial run will be MV-22As, and the first of the additional 540 aircraft in the Marines’ order will be delivered in early 1992. The first of fifty HV-22As ordered by the Navy will arrive in mid-1992, and the Air Force will get the first of its eighty CV-22As at the end of that year. The Army, which will use MV-22As for utility and medevac missions, will get the first of its 231 aircraft in early 1993.

While the total buy of 913 aircraft (at approximately $16 million each flyaway cost) will keep the two firms busy until the mid-1990s, there is considerable discussion of an additional Navy order for 300 Ospreys to replace the Lockheed S-3 Viking in the antisubmarine warfare role. There is also the possibility that the Air Force could order more of the aircraft for either the SOF mission or for combat rescue, given the cancellation of the HH-60 Night Hawk program. One further role under discussion for the Osprey is as a replacement for Marine One, the President’s VH-3 helicopter.

The V-22 Osprey might appear to some to be a novelty, but the technology is mature, and the support is there from all quarters. It does indeed appear that there is no limit as to what the Osprey can be made to do.