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A NEED FOR SPEED
With twice the speed and maneuverability of any rotorcraft currently in use, Sikorsky's next-generation X2 design will bring new capabilities to the National Guard

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SUPER HELOS

WITH TWICE THE SPEED AND MANEUVERABILITY OF TODAY'S HELICOPTERS, SIKORSKY'S NEXT-GENERATION X2 DESIGN IS THE CATALYST FOR A NEW ERA IN ARMY AVIATION.

By Matt Alderton

If Superman were a helicopter, he'd be one of Sikorsky's X2-design models. Incredibly fast and nimble, able to perform flight maneuvers and achieve speeds that no other helicopters can, the X2 design is a blueprint for a new breed of super helos.

In September 2010, the X2 Technology demonstrator aircraft reached 260 knots—twice the speed of a conventional helicopter. The National Aeronautic Association honored the achievement with its highest award, the Robert J. Collier trophy.

Sikorsky engineers are currently developing the X2-configured S-97 Raider light tactical helicopter. This new 11,000-lb aircraft, Sikorsky believes, will one day find its way into the Army's aviation inventory to fill the Armed Aerial Scout (AAS) requirement to replace the OH-58 Kiowa Warrior scout helicopter.

IT'S ALL IN THE DESIGN

So what's special about an X2 aircraft?

"Helicopters are very useful vehicles, but they've always had a problem: They don't go as fast as conventional airplanes," says Sikorsky Aircraft Corp. Director of Engineering Sciences Steve Weiner, the X2's chief engineer. "The difference between an X2 and a conventional helicopter is the ability to go faster, farther and, in doing so, expand the whole operational envelope of a conventional helicopter. That's what we're trying to do."

Conventional helicopters feature a single main rotor hub spinning two or more long and flexible rotor blades. Much shorter rotor blades attached to an anti-torque tail rotor provide directional control.

Sikorsky's X2 design takes a radically different approach. Instead of one main rotor hub, there are now two—one stacked above the other in a co-axial configuration. Each rotor hub spins a set of four rigid rotor blades in opposite directions. This counter-rotating co-axial setup provides the same lift, hover and forward flight characteristics of a conventional helicopter, but without the need for an anti-torque tail rotor.

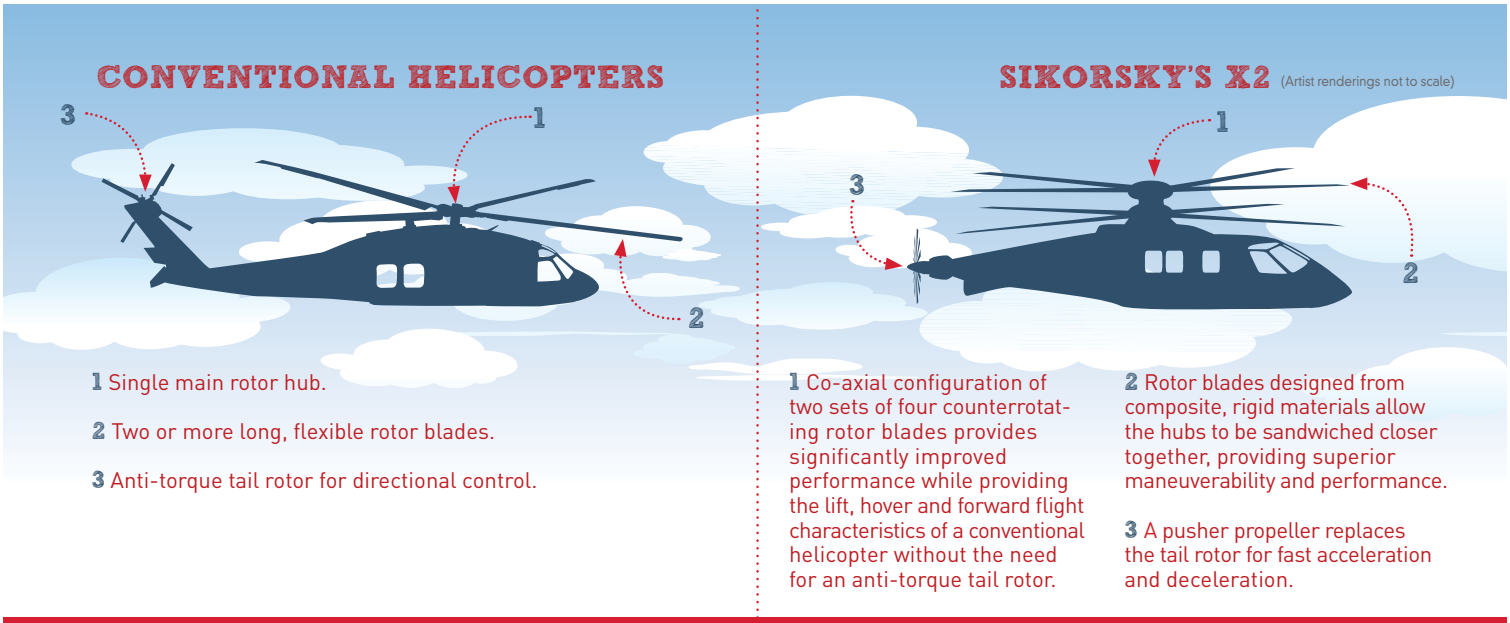
In place of that tail rotor, Sikorsky has added a pusher propeller for fast acceleration to high speeds, or equally fast deceleration. Another significant difference is the use of composite, rigid rotor blades. With little flex along a blade's length, the two rotor hubs can be sandwiched closer together for reduced drag and incredible maneuverability.

An X2 aircraft will be able to perform a 3G maneuver at high speed, accelerate and decelerate at level body attitudes, fly backwards from a hover, pirouette around a target, hover at a nose-up or nose-down angle to keep guns on target, climb ridge lines with ease at nap-of-the earth heights, hover at 10,000 feet in 95°F, and cover twice the distance without refueling.

Turn off the pusher prop, and the aircraft reduces its acoustic signature by half. "When you disengage the prop, the aircraft's acoustic signature

The Sikorsky S-97 Raider, depicted here in a graphic illustration, will soon be a reality. Currently in final assembly, the prototype's first flight is planned for late 2014.

(Photo illustration courtesy of Sikorsky)



goes way down, so in a combat zone you can hover quietly and cover the troops," says Sikorsky Director of Flight Operations and Chief Test Pilot Kevin Bredenbeck. "If you were to land at a roadside accident, or a hospital, or on an oil rig, disengaging the prop will ensure someone walking around the rear of the aircraft doesn't run into it."

NEXT-GENERATION AVIATION

Early on in Operations Iraqi and Enduring Freedom, the Army had a moment of reckoning: As it executed aerial missions in Iraq and Afghanistan, it realized its fleet of Kiowa helicopters was getting old.

A scout helicopter often dubbed the "pointy end of the spear," the Kiowa is an armed reconnaissance aircraft that has served the Army well since its inception during the Vietnam War. The latest model, the OH-58D, entered service in 1985 and ceased production in 1989, making the current fleet between 25 and 29 years old—hardly ancient, but in airframe years decidedly middle-aged. Now, after more than 10 years at war, during which time they flew as many as 80 hours a month, the aging Kiowas are winded. At press time, the Army had proposed eliminating the Kiowa Warrior fleet—to be replaced in the scout role with Apaches.

Sikorsky predicted the need for a next-generation helicopter design a decade ago. In 2004, its then-president Steve Finger ordered a study of previously tested internal technologies. When the Kiowa and other aging rotorcraft—including the Army's utility and attack helicopters, the Black Hawk and the Boeing AH-64 Apache, respectively—reached the end of their lifespans, he wanted Sikorsky to be ready with successors.

"We started out looking at a whole bunch of advanced concepts for high-speed vertical-takeoff vehicles," recalls Weiner. "Among those vehicles was a helicopter we'd built in the 1970s called the XH-59A Advancing Blade Concept Demonstrator."

When Weiner and his team revisited the XH-59A, they realized that technological advancements since the '70s could solve the prototype's shortcomings. The problem, then, was no longer physics; rather, it was funding. The Army needed a new breed of helicopter, but it lacked the budget to finance one.

SO MANY CAPABILITIES

Sikorsky invested approximately $50 million to take the X2 Technology demonstrator aircraft from idea (in 2005) to 250 knots flight speed (in 2010). Although it featured the same rigid coaxial rotor system as the XH-59A, the X2 demonstrator actually improved upon it with all-composite blades that provide double the lift-to-drag ratio as the XH-59A. Other key design features included a low-drag fuselage shape; an active vibration control system; fly-by-wire controls, which reduce pilot workload by replacing manual flight controls with digital ones; and, instead of the jet engines used for propulsion on the XH-59A, an efficient six-bladed rear pusher propeller that provides superior thrust.

The sum of these features isn't just greater speed, but also better maneuverability and enhanced hover capability. For both the active-duty Army and the National Guard, which eventually could

utilize attack, rescue and utility variants of the X2, the mission implications are powerful. Consider, for example, the fact that the X2's pusher propeller features pitch control; that allows the helicopter to change its orientation while hovering, which could be advantageous for delivering weapons to troops in combat, or to landing in sloped conditions for the purpose of search and rescue.

Ultimately, though, all roads lead back to speed. "When there are domestic crises like hurricanes and fires, the National Guard can respond quicker with this aircraft," Bredenbeck continues. "Or, there's a medevac mission; think about what this aircraft means in terms of saving lives. It just opens up so many capabilities."

WHY GO IT ALONE?

Sikorsky is not alone in their belief that the X2 design is revolutionary. Thirty-five industry partners are investing with Sikorsky and its parent company United Technologies Corporation in the S-97 Raider light tactical helicopter.

XH-59A Helicopter
(Image courtesy of Sikorsky)

FORM FOLLOWS FUNCTION

The predecessor to the X2, the XH-59A utilized a rigid coaxial rotor system to alleviate a problem known as *retreating blade stall*. In conventional helicopters, the blade spinning in the direction of flight is called the advancing blade; the one on the opposite side of the aircraft is the retreating blade. Forward motion during flight reduces airflow over the retreating blade, which is necessary for lift; the faster the helicopter goes, the more airflow is reduced. To compensate, the retreating blades need a steep blade angle to produce enough lift to keep the aircraft level. At a certain point, the angle is so great that it becomes counterproductive, compromising lift and stability. This is called *stall*, and it's the reason conventional helicopters are limited to low speeds.

The XH-59A solved retreating blade stall with a system of two rotors—one on top of the other—spinning in opposite directions, the advancing blade on each side providing balanced lift at any speed. The combination allowed the XH-59A to achieve speeds of 240 knots—but required four engines, two pilots and untold amounts of fuel to do it, rendering it impractical.

Sikorsky Director of Flight Operations and Chief Test Pilot Kevin Bredenbeck achieved an unofficial helicopter airspeed record of 260 knots (299 mph) in the X2 Technology demonstrator aircraft on its 18th test flight in September 2010.
(Image courtesy of Sikorsky)

Additionally, the Army is co-funding the design and construction of a JMR-FVL technology demonstrator—the medium class, X2-configured SB-1 Defiant. Sikorsky has partnered with Boeing to develop this aircraft.

As fiscal realities continue to place unprecedented demands on the U.S. military, the U.S. Army in general and the National Guard in particular will be challenged to maximize performance and minimize spending. X2 Technology will help them do both, Sikorsky promises. Not only by spawning a new generation of Army aircraft, but also demonstrating a rapid prototyping model for developing them.

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– Kevin Bredenbeck, Sikorsky Director of Flight Operations and Chief Test Pilot

Whether the mission is winning a war or saving a life—in Superman's case defeating Lex Luthor or rescuing Lois Lane—rotorcraft utilizing X2 Technology will be better equipped than any other helicopter, past or present.

R&D: REDEFINED

As exciting as the mission potential for X2 aircraft might be, its implications for R&D are equally salient.

"At the time we started this program, the helicopter industry in general was quite stagnant," Weiner says. "There wasn't much performance left to be gained; the only thing we could do to make helicopters better was to make them cheaper. And yet, we knew there was nothing in the laws of physics that said we couldn't make a better helicopter."

In an environment of escalating fiscal constraints, Weiner observes, government can no longer afford to be the source of innovation it was 40 years ago, when the Army and NASA funded the X2's predecessor, the XH-59A.

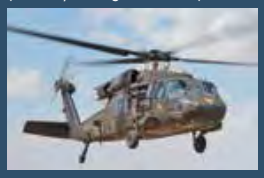
"With the budget issues in Washington, the military investment in truly new technology isn't as large as it once was," Weiner continues. "Developing a truly new vehicle takes a lot of money, and most of it has to do with initial risk reduction around the basic concept. We're trying to do that initial risk reduction so that once we're done working on our design, it's pretty much production-ready."

"I'm optimistic that in less than a decade we'll see some of the first Raiders or Future Vertical Lift aircraft coming off the assembly line," Bredenbeck says.

To be sure, conceiving three variants on a new design within 10 years is no easy feat. With an end customer like the Guard, however, inspiration and motivation are in ample supply, according to Weiner. "What the National Guard does every day is pretty remarkable, and I think they need the most remarkable kind of equipment," he says. ≡

FUTURE VERTICAL LIFT PROGRAM

Black Hawk
(Photo by Staff Sgt. Joe Armas)



Apache Longbow
(Photo by Staff Sgt. Ryan Matson)

SB-1 Defiant
(Image courtesy of Sikorsky)

Looking to the 2030s and beyond, the Department of Defense (DoD) announced the Joint Multi-Role Technology Demonstrator (JMR TD) design competition to help it identify potential replacements for a Future Vertical Lift aircraft. The Future Vertical Lift program is a family of multiservice, multimission aircraft designed at various weight points around a common airframe that will meet future battlefield requirements.

Because it's fully scalable and completely versatile, X2 Technology will be the basis for Sikorsky's submission to the JMR competition, as well. Should the Sikorsky-Boeing JMR team receive the go-ahead from the Army this summer, the team aims to fly the SB-1 Defiant helicopter by 2017. The Defiant is a medium-class replacement for Black Hawk and Apache helicopters.