How Black Hawk Helicopters Work

Photo courtesy Department of Defense - Defense Visual Information Center

An HH-60H Sea Hawk flies a training mission over the Persian Gulf during Operation Southern Watch in 2000.

As the twin engines of the Black Hawk roar for a new mission, the powerful blades sweep through the air creating a cloud of dust and dirt. Within minutes, the pilot has the chopper rising thousands of feet in the air and racing at 150 miles per hour over the landscape of a foreign land. Today's mission is to pass over enemy territory and deliver an 11-team crew to a strategic location on the battlefield.

The Black Hawk UH-60L helicopter has been a mainstay of American armed forces since it entered service in 1978. Its flexible configuration, survivability, and maneuverability make it the medium utility helicopter of choice by military forces around the world. The UH-60L and its derivatives have amassed more than 5 million flight hours, including casualty evacuations, troop transports, and search-and-rescue missions.

In this article, you'll learn about the Black Hawk helicopter. We're going to focus on the UH-60L Black Hawk, describing its ability to fly, its use in combat operations, its development and its future prospects.

A Black Hawk takes to the air like any other helicopter. Flight is achieved when the helicopter engines turn the **tilted blades** fast enough to generate **lift**. Lift is generated as the angled blades spin through the air. The blade rotation causes the air below the blades to move faster than the air above them, which creates pressure. Once that pressure under the blades is heavier than the air above the blades, the helicopter lifts off the ground. To learn more about lift, read How Airplanes Work.

Photo courtesy Department of Defense - Defense Visual Information Center

UH-60A Black Hawks transport ground forces during a riot control exercise.

Two General Electric T700-GE-701C turboshaft engines turn the **drive shaft**. The drive shaft extends to the top of the helicopter, where it connects to the **rotor head**, which is comprised of the rotor hub and four rotor blades. Each blade consists of a titanium spar, which is a metal strip that runs from the base of the blade to its tip, and a Nomex honeycomb material.

Photo courtesy Department of Defense - Defense Visual Information Center

Soldiers perform a check of the top rotor on the UH-60 Black hawk on the ramp.

Photo courtesy Department of Defense - Defense Visual Information Center

A soldier performs a maintenance check on the top rotor of a UH-60 Black Hawk.

The blade skin and trailing edge are made of composite materials. The stronger, leading edge of the blade is made of titanium and nickel and is trimmed with an anti-erosion strip, which protects the blade from wear as it skims across the tree tops or flies in abrasive desert air.

As the drive shaft turns the rotor head, the blades begin to spin. As the blades cut through the air, they create the **rotor disc**, which is the circle created as the blades spin. The diameter of the Black Hawk's rotor disc is 53 feet, 8 inches (16.36 m). Larger helicopters or helicopters that carry heavy loads, such as the Black Hawk, require a large rotor disc. The disc rotation of the Black Hawk generates enough force to lift the vehicle with crew, troops, and as much as a 9,000-pound (4,082.33-kg) external payload.

Maneuverability

In addition to controlling the disc rotation, the pilot can further increase lift by adjusting the **swash plate assembly**. This mechanism is a combination of two plates -- one fixed and one rotating -- that are attached to the main rotor. These plates control each blade's pitch, or angle of attack. A change in each blade's pitch creates uneven lift, allowing the helicopter to tilt and fly in a particular direction.

Torque created by blade rotation is exerted on the helicopter's fuselage, which will spin in a counter direction unless it's neutralized. A tail rotor, which is attached to the tail boom, is how most helicopters counteract the torque created by the main rotor. The tail rotor of a Black Hawk has an 11-foot (3.35-m) blade that spins to create lateral force and stabilize the helicopter. By adjusting the pitch of the tail rotor, the pilot can turn the helicopter left or right.

Photo courtesy Department of Defense - Defense Visual Information Center

A soldier performs a maintenance check on the tail rotor of a UH-60 Black Hawk.

Its power and maneuverability allow the Black Hawk to move soldiers quickly to strategic locations on the battlefield, and just as quickly get those soldiers back to safety. In the next section, you will learn more about how the Black Hawk is used to transport soldiers, artillery, and other equipment, and more about the built-in safety features that help the chopper survive if it comes under attack.

On the next page, you'll find out about the specifications of a UH-60L Black Hawk.

UH-60L Black Hawk Specifications

- **Length** (with rotors turning): 64 feet, 10 inches (19.76 m)
- **Fuselage length**: 50 feet, 0.75 inches (15.26 m)
- **Fuselage width**: 7 feet, 9 inches (2.36 m)
- **Height**: 16 feet, 10 inches (5.13 m)
- **Main rotor diameter**: 53 feet, 8 inches (16.36 m)
- **Tail rotor diameter**: 11 feet (3.35 m)
- **Cabin Dimensions:**
  - **Length**: 12 feet, 7 inches (3.84 m)
  - **Width**: 6 feet, 2 inches (1.88 m)
  - **Height**: 4 feet, 6 inches (1.37 m)

- **Weight** (empty): 11,605 pounds (5,263 kg)
- **Mission gross weight**: 17,527 pounds (7,950 kg)
- **Maximum cruise speed**: 155 knots (178 mph, 287 km/h)
- **Never-exceed speed**: 195 knots (225 mph, 361 km/h)
- **Vertical climb rate** (at sea level): 3,000 feet (915 m)/minute
- **Service ceiling**: 19,150 feet (5,837 m)
- **Range**: 373 miles (600 km)
- **Unit cost**: $5.9 million

Source: Brassey's World Aircraft & Systems Directory, Naval Air Warfare Center Aircraft Division

Now let's take a look at how the Black Hawk is used in combat situations.

Providing Combat Support

Military or combat support requires moving many troops and tons of equipment to locations where planes or ground-based vehicles often can't reach. The Black Hawk was designed with these types of logistical missions in mind. Combining power and an adaptable configuration, the Black Hawk can ferry thousands of pounds of equipment, weapons, and nearly a dozen men to remote locations quickly.

Photo courtesy Department of Defense - Defense Visual Information Center

U.S. Army Paratroopers board a UH-60 Black Hawk helicopter.

Three crewmembers are required to operate the UH-60L Black Hawk, including two pilots and one crew chief. In addition to the crew, the Black Hawk can carry **11 fully equipped soldiers**. Multiple tie-downs on the cabin floor allow the interior and seat arrangements to be reconfigured to accommodate varied missions.

Photo courtesy Department of Defense - Defense Visual Information Center

A UH-60 Black Hawk removes a destroyed Iraqi anti-aircraft gun from the rooftop of a building during Operation Iraqi Freedom.

Photo courtesy Department of Defense - Defense Visual Information Center

A UH-60 Black Hawk helicopter assigned hovers above the Prince Sultan Air Base, Kingdom of Saudi Arabia, during a training session.

Externally, the Black Hawk uses its **External Stores Support System** (ESSS) to carry additional cargo. The ESSS consists of removable stub wings that attach to each side of the fuselage above the cabin. Each wing has two pylons, which can carry a total of 9,000 pounds (~4,082 kg) of external loads, including fuel tanks, electronic countermeasure (ECM) pods, 16 Hellfire anti-armor missiles (16 additional missiles can be carried internally for reload), guns, and mine dispensers. A **cargo hook** located on the undercarriage gives the helicopter another method for carrying heavy loads, such as small vehicles, artillery, and large amounts of supplies.

Inside the cockpit, the pilots can use an **auto-flight control system** that includes autopilot and autostabilization features. The navigational equipment includes:

- An AN/ASN-128 Doppler search radar (a radar altimeter that collects elevation signals used to determine topographical features)
- An Automatic Direction Finder (ADF)
- A VOR/marker beacon

Photo courtesy Department of Defense - Defense Visual Information Center

A soldier directs a U.S. Army UH-60L onto the flight deck of the USS Constellation aircraft carrier.

Although it was not designed to be an assault vehicle like the Apache, the Black Hawk must be loaded with equipment for the crew and passengers to protect themselves in flight and on the ground. In the next section, we'll look at some of the built-in protections and artillery that provide defense for the Black Hawk.

Performance in Battle: Defense

Crossing the battlefield, the Black Hawk is an inviting target for enemy gun fire and anti-aircraft fire. Due to the nature of its combat role, the Black Hawk must be able to withstand these types of small- and medium-arms strikes.

Photo courtesy Department of Defense - Defense Visual Information Center

A soldier prepares to fire a 7.62-mm machine gun aboard an HH-60 Black Hawk helicopter during a training exercise.

The chopper's airframe is metal; other components, including floors, doors, and fairings, are composite. A fairing is used between joints of the helicopter to streamline those points for maneuverability and speed.

To reduce damage during attacks, the helicopter has built-in tolerance to small-arms fire and most medium-caliber, high-explosive projectiles, according to Sikorsky. If it is hit, it also has a self-sealing, crash-resistant fuel system and ballistic-hardened flight controls. Additionally, armored seats and swing-out armor side panels protect the pilots.

In case of emergency or hard landings, energy-absorbing landing gear and seats help protect crew and passengers. The Black Hawk can survive a vertical impact rate of 38 feet (11.6 m) per second. The fin connected to the end of the tail can be swiveled up and down to help control the helicopter if the tail rotor fails or is lost. Additional protection is built into the fuel cells, which are crashworthy from a drop as high as 65 feet (~20 m). Pilots can quickly escape after a crash by jettisoning the cockpit doors and exiting through the emergency pop-out windows.

Performance in Battle: Retaliation

Not only does it need to withstand bullet and rocket fire, it must also be equipped so that the crew can retaliate with ammunition.

Two gunners can be stationed to fire the helicopter's two 7.62-mm machine guns mounted in the cabin windows to return fire and provide protection for soldiers entering and exiting the vehicle during battle. It can also use Hellfire missiles if so equipped. Some types of Black Hawks, such as those used as medevacs, are typically not equipped with missiles. Medevacs carry pods containing medical supplies. The ESSS can also be outfitted with a 20-mm gun pod or a 30-mm chain gun.

Photo courtesy Department of Defense - Defense Visual Information Center

A UH-60 Black Hawk test fires an AGM-114A Hellfire tactical air-to-surface missile.

The Black Hawk is a product of the Vietnam War in as much as it was developed to address the weaknesses of Vietnam-era helicopters. In the next section, you will learn more about the Black Hawk's early development and how the U.S. military plans to keep it operable for another 20 years.

Recent Black Hawk Crashes			
Date	**Location**	**Killed/Injured**	**Details**
1/2003	Bagram Air Base, Afghanistan	4 Americans killed	MH-60; Cause not clear, although some witnesses say they saw a rocket hit the helicopter.
2/2003	Kuwait (31 miles northwest of Kuwait City)	4 Americans killed	UH-60
3/2003	Fort Drum, NY	11 soldiers killed/2 injured	UH-60; Two Black Hawks experienced hard landings.
4/2003	Karbala, Iraq	7 Americans killed/4 injured	UH-60
5/2003	near Samara, Iraq	3 Americans killed/1 wounded	UH-60; Crash ruled an accident.
9/2003	Baghdad, Iraq	1 American killed/1 injured	UH-60
10/2003	Tikrit, Iraq	5 Americans injured	UH-60; Helicopter was apparently hit by a rocket-propelled grenade.
11/2003	Mosul, Iraq	17 Americans killed/5 injured	2 UH-60s collide after coming under fire.

11/2003	Tikrit, Iraq	6 Americans killed	UH-60
1/2004	southeast of Fallujah, Iraq	9 Americans killed	UH-60
2/2004	Queensland, Australia	6 Australian soldiers injured	S-70A; Hard landing

History and Development

Helicopters entered military combat for the first time during World War II. Since then, their use has transformed from only search-and-rescue and medevac to that of assault weapon (see How Apache Helicopters Work). Tactically, the helicopter evolved during the Vietnam War with the advent of the Bell UH-1 "Huey" Iroquois helicopter, according to Stephen F. Tomajczyk, author of "Black Hawk".

Photo courtesy Department of Defense - Defense Visual Information Center

A U.S. Marine UH-1N Iroquois helicopter surveys an Iraqi military complex West of Diwaniyah, Iraq, during Operation Iraqi Freedom.

Tomajczyk credits Lieutenant Colonel Hal Moore with developing the battle tactic of sending troops into the battlefield using the Huey, and then quickly transporting soldiers back to safety when the fight was over. Moore and his role in the first major battle of the Vietnam War at Ia Drang was the basis for the book and movie "We Were Soldiers."

Based on the success of helicopter combat during the Vietnam War, the U.S. Army sought to devise a more advanced helicopter for use in battle. While the Huey showed that it was capable of moving troops to battle, the Army sought a design that was adaptable for different configurations, provided more power, and was quieter and more maneuverable than the Huey. The Army set up the Utility Tactical Transport Aircraft System (UTTAS) program to develop this new transport helicopter.

Photo courtesy Department of Defense - Defense Visual Information Center

In 1972, both Boeing and Sikorsky were contracted to develop prototypes for this new breed of combat helicopter. Four years later,

Sikorsky eventually won the competition to build the Army's new **UH-60A** helicopter. It is tradition to name Army helicopters in honor of a Native American tribe. In that tradition, the UH-60A was named the Black Hawk.

The Black Hawk entered service in **1978**, and it saw its first combat action in 1983, when United States forces invaded **Grenada**. Since it entered service, the Black Hawk has logged more than 5 million flight hours. It has provided transport for troops in Panama, Southwest Asia, Somalia, Haiti, Bosnia, Afghanistan, and Iraq.

Photo courtesy Department of Defense - Defense Visual Information Center

An air-to-air rear view of a UH-60 Black Hawk air ambulance in use during a training exercise in Egypt in 1983. (Visible in the background are the Great Pyramids and the city of Cairo.)

A new power train was added to the Black Hawk in 1989, and the helicopter's designation changed from UH-60A to **UH-60L**. Future upgrades are planned that will focus on advanced avionics, enhanced survivability, and improved reliability. These improvements will ensure that the Black Hawk stays in the U.S. arsenal through at least 2025. An upgraded Black Hawk, the **UH-60M**, should enter production in 2007.

Today, the Black Hawk is adapted to serve varying purposes. In the next section, we will look at some of the variations that are derived from the UH-60L.

Variations

You can think of the UH-60L as the base version of this model of helicopter. It's much like a car in that it can be upgraded and refitted with different components depending on what you want to use it for. Every branch of service in the U.S. Armed Forces and many foreign militaries use the Black Hawk or one of its many offshoots.

Photo courtesy Department of Defense - Defense Visual Information Center

A U.S. Air Force HH-60 Black Hawk helicopter from the 33rd Rescue Squadron (RQS) lifts off for a search-and-rescue mission at Korat, AB, Thailand, during a training exercise.

Here is a look at the different variations of helicopter that are derived from the UH-60L.

Variation	Operators
SH-60F Ocean Hawk	**U.S. Navy**
VH-60 Executive Transport	**U.S. Marine Corps**
S-70A International Hawk	**Argentina, Australia, Brazil, Brunei, Chile, Hong Kong, Japan, Jordan, Malaysia, Mexico, Morocco, Philippines, Turkey**
S-70A FireHawk	**Various**
EH-60L Advanced Quick Fix	**U.S. Army**
SH-60B Seahawk	**U.S. Navy**
MH-60L "Velcro Hawk"	**U.S. Army**
MH-60K	**U.S. Army**
HH/MH-60G Pave Hawk	**U.S. Air Force, Air Force Reserve, Air National Guard**
UH-60Q Medevac	**U.S. Army**
UH-60L	**U.S. Army, U.S. Army National Guard, Army Reserve, U.S. Customs, Medical Service Corps**
HH-60H "Warhawk"	**U.S. Navy (SEALs)**
HH-60J Jayhawk	**U.S. Coast Guard**
HH-60L Medevac	**U.S. Navy Reserve**
MH-60S Knight Hawk	**U.S. Navy**
***MH-60R Strike Hawk**	**Future: U.S. Navy**

***The MH-60R will replace the SH-60B and SH-60F when it goes into production in 2005.**

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