The first one was nothing more than a Chinese toy. Now, it's the world's most versatile flying machine.

The Choppy Course of the Helicopter

BY BRUCE D. CALLANDER

WHEN its spy balloons failed to do the job, the Union Army cast about for new ways to scout the enemy. Someone demonstrated a small, toy flying top. Impressed, the Army ordered a full-size model. The South was at work on a similar craft when Appomattox obviated both aviation projects.

The toy top, however, continued to exert an influence. In 1878, Bishop Milton Wright came back from a trip bearing a similar gadget for his boys. Wilbur was eleven years old, Orville not yet seven. Historians date the Wright brothers' lifelong interest in flight from the moment that they gazed upon the odd little hovering device.

The flying toy—nothing more than a wooden stick fitted with a propeller on one end—is traceable to fourth-century China. In Europe, where it arrived in the fourteenth century, it was known as a "Chinese top." Westerners later combined Greek words for "spiral" and "wing" to coin its name: "helicopter."

This ancient toy, precursor of the twentieth century's most versatile flying machine, held the secret of flight. Its wooden shaft, spun between one's palms, set the propeller rotating. Then the toy would rise, hover briefly, and float to earth.

Centuries passed, however, before it was discovered that the propeller's curved surface, churning through the air, produced the mysterious force that could lift an object. More years were needed to build a lightweight, powerful engine and even more to solve the problem of flight control. Progress was spurred by the thought that the flying machine might have military uses.

Military potential might not have been in the mind of Leonardo da Vinci, the Renaissance genius, when he sketched a version of the helicopter, but he had more than a slight interest in weapons. Before turning his attention to flight, he had designed cannons, mortars, finned bombs, and a tank-like armored vehicle.

Leonardo designed a helicopter featuring a screw-like propeller driven by a clockwork mechanism. From all appearances, it may have been airworthy. But Leonardo evidently never produced a working model. Like many inventors, he became sidetracked, wasting his ener-

—Photo bv Paul Kenned

gy on complicated wing-flapping machines that had no chance of working.

Probing the Top's Secret

Others continued to probe the secret of the Chinese top. In 1784, a French naturalist named Launoy and an artisan named Bienvenu made a model containing a novel powerplant—a steel bow whose string was wrapped around the shaft.

They wound it up and released it at a meeting of the French Academy of Sciences. The scientists are said to have been amazed, but nobody seemed to know where to take the idea from there. A bow big enough to power a man-carrying vehicle clearly would be too heavy to lift itself. Anyway, other Frenchmen a year earlier had invented the hot-air balloon, a simpler means of vertical flight.

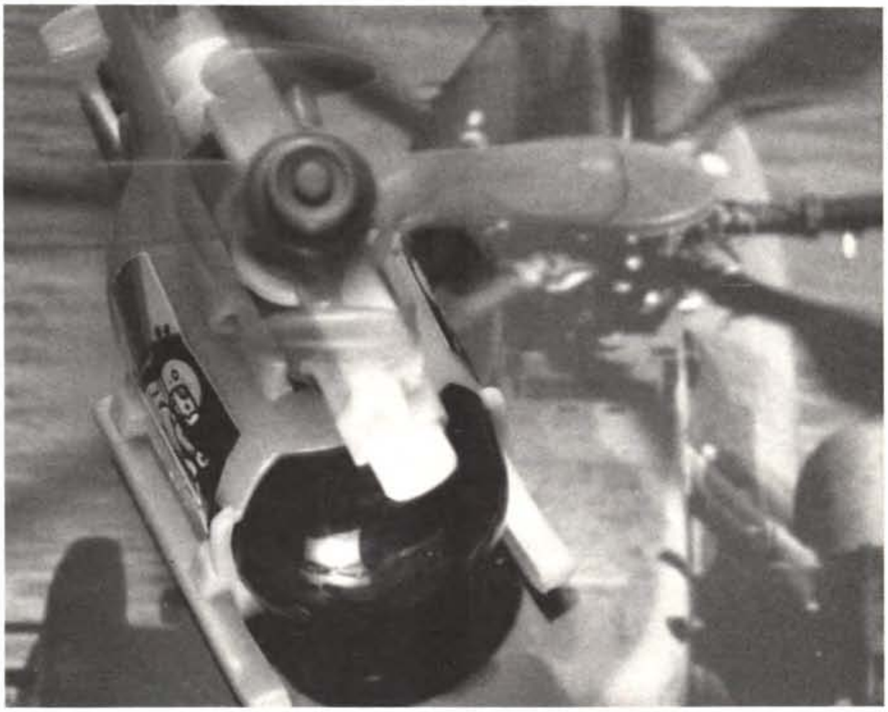
Sixty years later, an English inventor came up with a different kind of power. W. H. Phillips used a kind of slow-burning gunpowder to heat water in a tiny boiler. The steam passed through a hollow shaft and was let out through small nozzles at the tips of the rotor blades. The force set them rotating like the arms of a lawn-sprayer. Although his model weighed about forty pounds, it lifted off and flew some distance before crashing in a neighbor's field. Phillips never went beyond the model stage. In effect, however, he had invented jet propulsion.

Like earlier inventors, Phillips was so absorbed with getting his machine off the ground that he hadn't thought much about what he would do with it once it did become airborne. Britain's Sir George Cayley, however, thought about the problem of forward propulsion.

In his youth, Cayley had been fascinated by the Chinese top. He too was frustrated by the lack of a suitable engine and gave his primary attention to fixed-wing machines. In 1843, however, he built a string-powered version of the top with tin blades. He envisioned, but never built, an "aerial carriage" with contrarotating blades to make it rise, plus two pusher propellers for forward flight. He planned to use friction plates in a kind of clutch to put both sets of propellers into motion gradually as needed to convert from vertical to horizontal flight. Cayley died before making his craft a reality.

Cayley inspired Vicomte de Ponton d'Amécourte of France, who built a model similar to the aerial carriage. It also had contrarotating blades, one above the other on separate shafts, one shaft inside the other. Power came from a small aluminum engine that generated steam in a boiler. The idea caught the imagination of science-fiction writer Jules Verne, who used the idea in a novel. While the steam engine worked fine in fiction, it was too heavy to get aloft when tried in the real world.

Early inventors were up against basic physics. The top worked because it was small and light. However, the mass and weight of an object increase by a factor of four every time its volume doubles. Cayley, having done these basic calculations, concluded that helicopter flight could be achieved only after the development of a new power source—the internal combustion engine.


—Photo by Paul Kennedy

The War Between the States

Meanwhile, in the New World, the bloody American Civil War was bringing hardheaded military men face-to-face with the child's magic flying top. By 1864, a variety of problems had forced the Northern Army to disband its balloon corps. That left Maj. Gen. B. F. Butler, commander of the Union Army of the James, without air-observation support for his assault on Petersburg, Va. When the queer little hovering toy was demonstrated, Butler was intrigued. He ordered an engineer, Edward W. Serrell, to design a man-carrying version.

Serrell sketched a machine resembling Cayley's carriage, with four fans for lift and two more for propulsion and steering. It was to have wings for gliding, moving weights for balance, and a steam engine for power. Each sheet-iron airscrew weighed 500 pounds, but tests showed that it could lift more than its own weight, given enough power. A New York firm set to work on a high-pressure engine.

It's interesting to speculate that, had the Civil War lasted a few years longer, it might be remembered not only for the first clash of ironclad warships but also for the first contest of military flying machines.

In the South, the pain inflicted by the Union blockade of Confederate ports inspired William C. Powers of Alabama to propose a similar flying machine, one that could bombard US warships from the air. Powers made a model with four vaned screws that looked like long worm gears. Two were for lift and two were to drive the machine forward. Like the Union helicopter, however, the Confederate machine was never completed.

In 1870, France's Alphonse Pénaud skirted the power question by giving his Chinese tops motors made of twisted rubber bands. He made promising models, but ultimate failure made Pénaud so despondent that the Frenchman, at age thirty, committed suicide. In 1878, Italian Enrico Forlanini again tried steam power. To eliminate the heavy firebox and boiler, he employed a metal sphere into which he forced superheated steam just before takeoff. This drove a small piston engine that kept his model helicopter in the air for thirty seconds. Although it worked, the problem of endurance was obvious.

In 1880, American inventor Thomas A. Edison decided it was time to find out exactly how much power it would take to lift a helicopter. After a series of tests, Edison came to a conclusion: No helicopter would fly until engines weighed less than four pounds per horsepower. Edison decided that the answer was an internal combustion engine and made one using guncotton as fuel. It worked a few times, then blew up, singeing the inventor's hair.

By the turn of the century, Charles Manley had built a gasoline engine that fit Edison's specifications. It weighed only 125 pounds and developed 52.4 horsepower. However, Manley was working for aviation pioneer Samuel P. Langley, whose interests focused on fixed-wing aircraft rather than on helicopters. The Wright brothers, too, built an aluminum-block engine that met requirements; it was used not on a helicopter but on the aircraft that made history's first powered flight, on December 17, 1903.

One Foot for Twenty Seconds

Emphasis shifted strongly to winged planes, but a few inventors continued to find helicopters more promising. In 1906, Frenchman Paul Cornu—like the Wrights, a bicycle-maker—built and tested a model with contrarotating blades and a two-horsepower engine. A full-scale version, sporting a twenty-four-horsepower engine, came a year later. On November 13, 1907, Cornu climbed aboard his machine, fired up the engine, and rose to a height of one foot for twenty seconds. Brief though his flight was, Cornu was aloft long enough to discern a problem that would plague designers for decades. His fragile machine was almost uncontrollable.

World War I, though it focused even greater attention on fixed-wing airplanes, helped bring the helicopter to life by stimulating development of light, powerful, inexpensive new powerplants. One rotary engine that became popular with helicopter designers was the Le Rhône, used on Nieuport trainers bought by the US Army.

George de Bothezat, a Russian émigré working for the Army, designed a new helicopter that was tested at McCook Field (now Wright-Patterson AFB) in Ohio. Its four, huge, six-blade rotors were driven by a 180-horsepower Le Rhône. Steering was provided by two other propellers. In late 1922, de Bothezat got it about six feet off the ground for more than a minute. The next year, it carried two persons. One who flew it, Col. Thurman Bane, declared the contraption the "biggest aeronautical achievement since the first flight of the Wright brothers." But the Army decided the design was too complicated and gave up on it.

The Army also had invested in the efforts of a Washington, D. C., inventor, Emile Berliner, and his son Henry, who sought to combine the best features of fixed- and rotary-wing aircraft. They mounted twin rotors atop monoplanes, biplanes, and even triplanes, adding a smaller rotor to lift the tail. While the Berliners achieved modest successes, they never licked the control problem. The Army lost interest.

Birth of the Autogyro

Another inventor piqued the Army's curiosity. Juan de la Cierva, a young Spanish aristocrat, also had been drawn to the Chinese top. He became convinced that helicopters held more promise than fixed-wing aircraft, but he sought a new solution to the control problem. He found it in the action of the Chinese top.

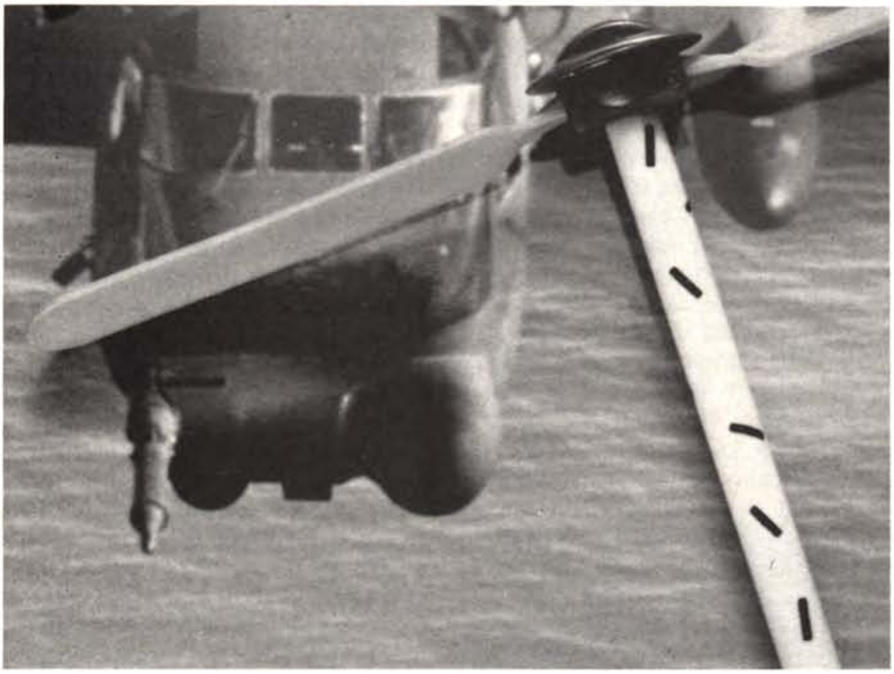
De la Cierva observed that the toy, though its propeller lost power as it reached the top of its climb, nevertheless floated to earth as the propeller continued to windmill on its own. The rotor itself did not necessarily need to be powered, he realized. So long as it was moving through the air, it could provide lift the same way as a conventional wing does.

Like the Berliners, de la Cierva fitted his rotor to a conventional fuselage with a propeller for forward motion. He removed the wings and added an unpowered rotor in their place. In its early tests, the machine left the ground but then threatened to tip over. De la Cierva added stubby wings fitted with ailerons. When his machine still tipped to one side, he was baffled. Finally, it struck him that the models he flew had flexible rattan rotors, which flattened and twisted again as they rotated and thus gained and then lost lift. On his next machine, he hinged each blade of the rotor so it could rise or fall naturally and reach its own best angle. By January 1923, his machine worked smoothly, and de la Cierva spent the next two years refining his design.

In 1925, Britain's Air Ministry said it would be interested in what de la Cierva was calling his "autogyro," provided it could do more than a conventional plane. De la Cierva recruited British test pilot Frank Courtney. The autogyro was able to meet most of the Air Ministry's tests, but came to grief on the most demanding one—an almost vertical descent from 1,500 feet. The rotors slowed the fall, but not enough. Courtney hit hard, the landing gear crumpled, and the seat gave way. Even so, Courtney walked away from the crash, and the Ministry bought the autogyro.

After resolving several other problems, de la Cierva took his autogyro into volume production. He built more than ninety himself and licensed firms in Japan, Germany, Russia, and France to do the same. He sold a franchise in the United States, where by the 1930s the radically new flying machine was causing a sensation. Newsreels were filled with images of the new wonder, and futurists predicted that, in no time, average Americans would have these flying automobiles. In 1935, the US Army bought a commercial autogyro, the KD-1, renaming it the YG-1. When the US entered World War II, its fleet numbered sixteen.

Widespread use of the autogyro was not to be, however. The cost of owning and operating the aircraft was too great for commercial users, much less for the common man. Moreover, the Army, having concluded that the autogyro had insufficient range and lifting power, was starting to put its money into another, more promising machine developed by yet another Russian émigré.



—Photo by Paul Kennedy

Igor Ivanovich Sikorsky, like so many others, found boyhood fascination in the Chinese top. One story is that he swiped whalebone stays from his sister's corsets to make bowstring engines for his own versions of the top. By 1909, he had studied engineering and built his first helicopter, which, though powered by a twenty-five-horsepower motorcycle engine, obstinately refused to rise. When his second model also failed to get off the ground, Sikorsky gave up vertical flight—temporarily—and focused his attention on fixed-wing planes. In 1913, he built the world's first four-engine airplane and, during World War I, made bombers for the Russian Army. When the revolution broke out in 1917, Sikorsky left Russia and settled in the United States.

Not until the late 1930s did Sikorsky return to his work on helicopters. This time, he designed one with a single lifting rotor and a smaller vertical rotor at the rear. The tail rotor solved the torque problem, the downfall of many other inventors. As the rotor turned in one direction, the machine tended to turn in the opposite direction. Sikorsky and others had used two contrarotating rotors in earlier machines to counter the effect, but these required a more complicated set of shafts and gears. The single rotor was simpler, and the smaller tail rotor canceled out torque and provided some steering capability as well.

On September 14, 1939, Sikorsky got his VS-300 helicopter off the ground. Two years later, the Army gave him a contract to build another experimental model, the XR-4, with a 165-horsepower engine. Later versions were fitted with more powerful engines.

Sikorsky had solved not only the problem of getting his machine to fly, but also the far more difficult one of controlling it once it was airborne. His system of flight controls remains standard in many of today's helicopters. It included a stick and rudder like that of a conventional plane and one additional lever. With his left hand, the pilot operated the "collective pitch lever." Moving it backward or forward changed the pitch of all the rotors at the same time, increasing or decreasing their lift and making the helicopter rise or descend. The top of the lever twisted like the throttle of a motorcycle to control power.

With his right hand, the pilot ran a second, "cyclic pitch lever" forward, backward, or sideways. It changed the pitch of each rotor at a specific point in its rotation to move the helicopter forward, backward, or sideways. The pilot's feet changed the pitch of the blades in the tail rotor. The system was more complex than the controls of a fixed-wing plane and required better coordination—but it worked.

Four decades after the Wrights gave the world its first heavier-than-air flying machine, Sikorsky had given it the means for practical vertical flight. In their own ways, both inventions changed the nature of human travel and of warfare.

Sikorsky produced fewer than 200 helicopters over the course of World War II. They were used mainly by the Army's Air Rescue Service and the US Coast Guard, but some went to Britain's RAF. In Korea and later in Vietnam, the helicopter became as familiar as the ubiquitous Jeep—and remains so today. Vietnam-era helicopters still could not fly as fast or as far as airplanes or lift as much weight. But they could operate from small clearings, hover over battlefields, and drop into jungles. They became flying scout cars, observation posts, ambulances, troop transports, airborne cranes, and lethal gunships.

In the civilian world, helicopters serve the police, hospitals, firefighters, newspapers, construction workers, aerial taxi services, mountain climbers, shipping firms, and movie producers, among others. The toy that delighted children and baffled scientists for at least sixteen centuries has blossomed into one of the most versatile vehicles of the modern world. ■

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