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Skycrane-Igor Sikorsky's Vision Of The Perfect External Lift Aircraft

During the early helicopter development years of the 1940s and 1950s, the helicopter's maximum lift capability was limited by the piston engines and rotor systems available at the time. The development of the shaft turbine engines in the early 1960s made it possible for Igor Sikorsky's vision and his team to develop more efficient external lift helicopters. Sikorsky realized that for operations that were primarily to lift heavy external loads, the unused cabin structure was heavy and very inefficient. He concluded that a helicopter without a cabin would be a major solution for this mission. The S-64 Sikorsky Skycrane was created to solve this problem, and was the last helicopter initiated by Igor Sikorsky. The data for this issue was obtained from the "Skycrane, Igor Sikorsky's Last Vision" written by John A. McKenna, who was responsible for building the first S-64 in 1961, and for supporting the Army and commercial programs as the Executive Vice President of Sikorsky Aircraft. This newsletter supplements the July, 2007 issue, "Evolution of the Sikorsky Skycrane".

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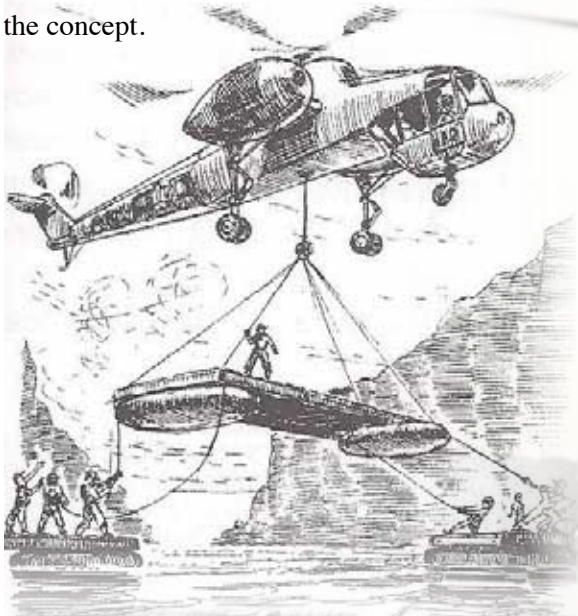
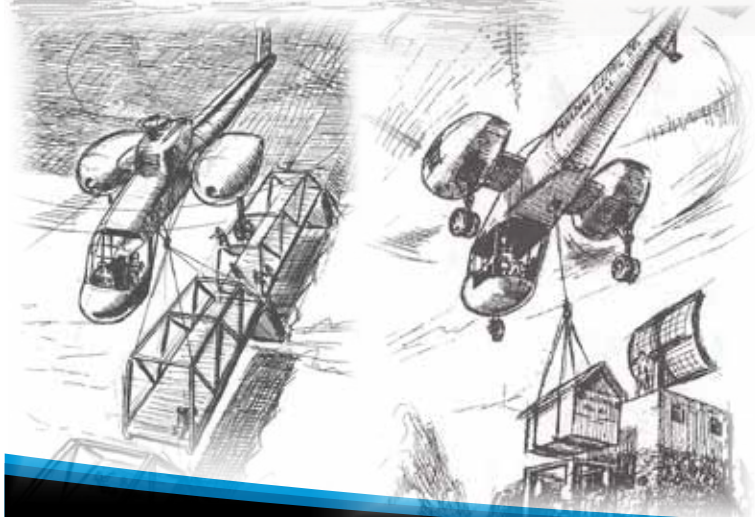
Igor Sikorsky's Last Vision

Sikorsky Aircraft had become one of the leading manufacturers of helicopters in the world during the 1950s. Igor Sikorsky focused his attention on his vision for the perfect external lift helicopter in 1953. His vision was to design a helicopter with an external cargo hook and without a cabin. Elimination of the heavy cabin increased the external lift capability, and provided the capability to carry loads regardless of the shape within the load capability of the aircraft. The cockpit would be modified to have a rear facing pilot seat as well as front facing seats. The rear facing seat would be used to monitor the cargo load during pick up and release operations. The fuselage weight reduction would enhance the external lift capabilities and provide the first practical helicopter in the world with this unique feature. The conceptual drawings shown were prepared by Sergei I. Sikorsky in 1957, and were used to sell the concept.

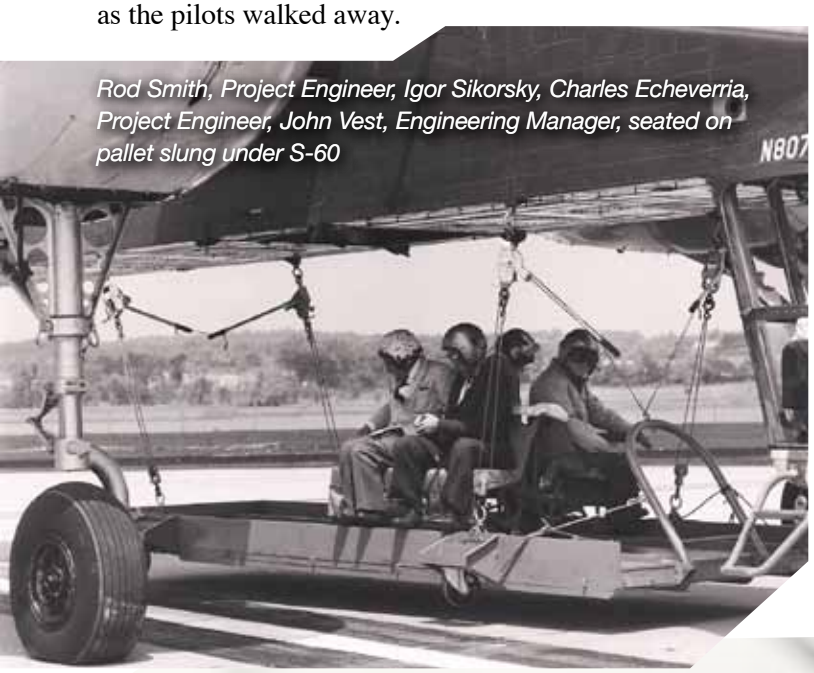


S-56 *(HR2S-1)*



The S-60 project was started in May 1958. The design approach for the flying crane was to modify the S-56 aircraft, which was the largest cabin helicopter in use in the United States at the time. The S-60 flying crane design retained the S-56 engines, propulsion drive, transmissions and rotor systems. The S-60 experimental flying crane design was started in early 1959 by Lewis Knapp , Chief of Preliminary Design at Sikorsky Aircraft. Igor Sikorsky was constantly hovering over Lew's shoulder making suggestions relative to the evolving configuration. Igor Sikorsky was a polite and gentle man who would never give an authoritative direct order. He would listen patiently to reasons for the design approach, and with quiet persistence he would steer the design to the configuration he instinctively knew was correct.

The twin engine U.S. Marine HR2S-1 and Army H-37 were troop transport helicopters. External loads were carried via a cargo sling under the cabin. The total potential external load was limited due to the weight of the empty cabin during these missions. The S-60 crane design replaced the S-56 cabin structure with a reinforced boom structure. This resulted in higher external load capabilities. The major helicopter configuration difference was that the cockpit is suspended in space forward and below the fuselage boom structure as shown in the sketches and photos. In the event of a hard landing and gear collapse, the cockpit was designed to swivel up without hitting the rotor to protect the pilots. This feature was successfully demonstrated at the completion of program under a NASA contract simulating a fighter takeoff and landing sequence. A severe landing during these tests resulted in the landing gear collapsing. The cockpit swivel feature was successfully demonstrated as the pilots walked away.



Rod Smith, Project Engineer, Igor Sikorsky, Charles Echeverria, Project Engineer, John Vest, Engineering Manager, seated on pallet slung under S-60

Igor Sikorsky was actively involved in the design and development phases of the experimental S-60 program to the extent of being a flight test engineer in July of 1959. Mr. Sikorsky and members of the Engineering Team are shown seated on airline chairs bolted to a flat wooden structural floor supported on cables slung under the aircraft boom structure. The evaluation flight occurred as high as 1500 feet and 70 knots. At one point in the flight, Igor Sikorsky stood up and walked to the edge and around the platform to evaluate the vibration and stability characteristics of the external load. When he was satisfied with the aircraft performance he returned to his seat.

Jack McKenna stated in his book, that this was not the first time Igor Sikorsky flew on an open platform under a helicopter. When Jack first interviewed for a job at Sikorsky Aircraft in 1956, he saw a simple wooden platform supported underneath an older helicopter with a test engineer seated. Jack was informed that the test engineer was Igor Sikorsky evaluating the aircraft's vibration characteristics. Jack decided at that moment, that if the inventor and founder of the helicopter industry was still performing flight tests, that he would take any reasonable job to work in Igor Sikorsky's company.

Development of the S-64 Production Skycrane

The experience and lessons learned with the S-60 crane helicopter led to corporate approval in April, 1961 for Sikorsky Aircraft to design and develop a new crane helicopter called the S-64 Skycrane. The major physical changes that define the S-64 include the following:

- Replaced piston engines with more powerful Pratt & Whitney JFTD12 gas turbine engines increasing power available from 2100 to 4500 shp per engine for the S-64E (CH-54A) and 4800 for the S-64F (CH-54B).
- New main gearbox with increased power capability.
- Increased number of main rotor blades to 6 with increased chord and other improvements.
- Added a nose wheel in place of the S-60 tail gear
- Redesigned the aft pilot cockpit to include additional instruments and controls to allow precise control of the aircraft for quicker access to and delivery of loads.
- Increased cockpit size to include a pilot, copilot, aft pilot, and two mechanics to facilitate flying 10 hours per day in remote areas with no on-site support.
- Increased hoist capacity to 20,000 pounds for the CH-54A and 25,000 for the CH-54B.
- Added a load leveling system to facilitate rapid securing and balancing loads evenly.
- Added a hydraulic accummulator start auxiliary power unit so that the S-64 could be started anywhere.
- Eliminated all of the cowlings and work platforms on the up per deck of the fuselage, reducing weight, cost and maintenance.
- Added kneeling landing gear on S-64E to accelerate the attachment of vehicles, pods and other loads.
- Added 3 axis fly-by-wire side arm controller in rear facing cockpit seat.

The unique approach to the design improved the maintenance and accessibility to all components, reduced weight and enhanced the basic mission for heavy load delivery at required speeds, including precise placement of loads at delivery. The improved productivity of the Skycrane demonstrated its effectiveness for its external load missions relative to cabin helicopters performing the same mission.

After two years of successful demonstration with two S-64s in West Germany and more than a year of successful demonstrations at several United States bases, the U.S. Army ordered six YCH-54As in June 1963. The first flew in twelve months and four were delivered four months later to the Army at Fort Benning. After two months of testing by the Army, the four were sent to Vietnam in December 1964, where they were rapidly deployed in combat and logistics support operations. The remaining two were used by the Army to complete its testing and obtain FAA certification in mid 1965 for the CH-54A configuration. Sikorsky obtained FAA certification for the commercial version of the S-64 in 1969.

S-64 at Fort Benning With Howitzer in foreground

S-64 Receiving FAA Type Certification, Harry Jensen, Jack Mckenna, and FAA representative

The CH-54 U.S. Army Skycranes Were Mission Ready When They Arrived In Vietnam in 1966 as reported by Frank J. Delear Public Relations Manager at Sikorsky Aircraft in the May 1966 issue of Vertiflite Magazine:

It did not take long for the CH-54s to prove their versatility and attract attention in Southeast Asia. A New York Times correspondence reported from An Khe, South Vietnam, "Of the 434 aircraft in First Cavalry Air Mobile Division, these are the favorites. The flying cranes can do astonishing things and in the few weeks they have been here they have impressed everyone."

Among the Skycranes earliest combat area activities were the airlift of enough C-rations to feed a battalion for three days, and handling a 105 mm Howitzer, its crew and ammunition into battle. Each operation required only hours. Shortly after the First Cavalry Division reached Vietnam, a Skycrane carried a bulldozer to the top of a 1200 foot mountain where slopes were covered with a dense rain forest. The bulldozer was needed to clear the mountain top and position all the equipment necessary to build a radio relay station. The total work was done in one day instead of two weeks. Major T. J. Clark, in charge of the 478th heavy lift outfit commented, "The Army ordered six flying Cranes from Sikorsky Aircraft, which developed the big helicopters in the hope that someone would recognize its utility".

Utility Pod

Bridge repair in Vietnam

CH-54 is shown with Engine Air Particle Separators to extend engine life from 8 to beyond 600 hours Time Between Overhaul in abrasive environments

Army vehicle transport

The Army rapidly demonstrated the versatility of the Skycrane capabilities for bridge construction, transporting pods for maintenance, hospital, storage, command centers, sleeping quarters, transporting 90 passengers or 87 combat ready troops, and aircraft recovery. The Skycrane demonstrated its capability for ship to shore cargo off loading, and numerous other capabilities for military as well as commercial use.

The structural integrity of the Skycrane was demonstrated during overload hovering tests at Sikorsky carrying a General Sheridan track vehicle with concreate blocks. Numerous overload battle field occasions occurred where the aircraft was loaded beyond its published design capabilities when success of the mission required over loading to meet the battle field situations that were encountered. A total of 99 Skycranes were built and delivered. After more than 30 years of service to Army Aviation, the Sikorsky CH-54 Skycranes were retired from military service.

Sikorsky Develops Commercial Markets For The Skycrane

During the 1966 to 1967 time period a Sikorsky Commercial Operations Team demonstrated the capabilities of the S-64 Skycrane in North and South America. The missions included cargo unloading from ship to shore; construction site support; offshore drilling support; power line tower placement at inaccessible sites; placement of ocean barriers; bridge construction and fire fighting. Rowan Drilling Company, Erickson Logging, Evergreen Logging, and Tri-Eagle were the first commercial companies that leased S-64 Skycranes for their operations.

Power transmission line support

Erickson's successful operations in the 1980s opened new markets, and led to significant growth when Sikorsky agreed to sell him the design and production rights. He changed the Skycrane name to AirCrane. Erickson expanded his fleet with army surplus CH-54 aircraft and parts.

Removing Columbia Statue from Capital Building for repair

Cargo container ship offloading

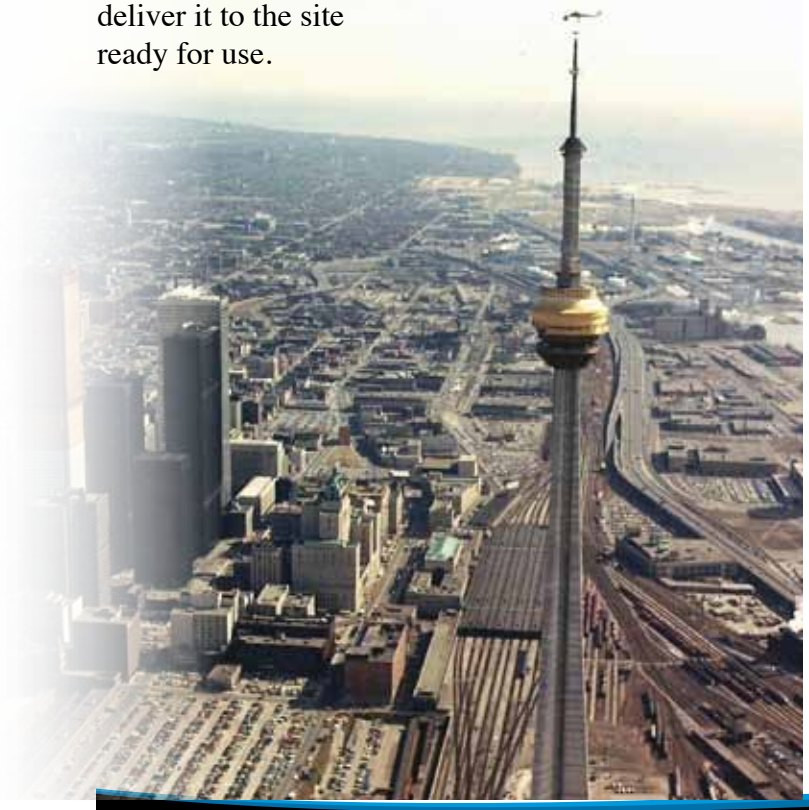
Erickson was logging in Canada and Malaysia with his fleet, and rapidly advancing the AirCrane's capability to fight fires. Erickson developed a 2650 gallon tank to accurately spread a water, foam mix, or retardant in various delivery streams. The tank can be filled by snorkel or ram scoop in 45 seconds over water only 18 inches deep.

Fire fighting support

Skycranes Of The Future

Igor Sikorsky's vision for the Skycrane was a stroke of genius. There is no other aircraft that can pick up any part or assembly and precisely relocate it to a new location without major disassembly. The S-64 Skycrane's gross weight and payload capability was limited by the engine power available at the time. Conceptual designs for larger and more powerful Skycranes were created in the mid 1960s. The era for larger and more powerful Skycranes is now within our reach with the current U.S. Marine CH-53K helicopter development program.

History has shown that the primary drivers for improved helicopter productivity has been a function of the improvements in rotor system technology and engine power available. Sikorsky Aircraft's experience has also shown that the basic empty weight to gross weight ratio comparison between a crane and a cabin version helicopter greatly favors the Skycrane for lift capability and delivery, regardless of the size and shape of the item being transported. The CH-53K helicopter in a crane configuration will be able to meet the military's current maximum lift requirement of 25 tons, and deliver it to the site ready for use.



The S-64 Skycrane operated by the Erickson Air-Crane Company was used to construct the Canadian National telecommunications tower in Toronto, Canada in 1976. On June 26, 2006, a celebration ceremony was conducted in Toronto to mark the 30th anniversary of the engineering feat by re-enacting history. The S-64 is shown hovering over the tower in the left photo simulating the topping of the tower.

During the construction of the tower, the Skycrane made 40 separate lifts to deliver material and sections required to complete the topping of the telecommunication antenna. The total height of the building and tower is 1,815 feet and 5 inches, making it the tallest free standing tower and building in the world at the time. This architectural triumph is a Wonder of the Modern World.

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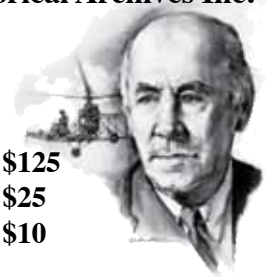

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Sikorsky's CH-54B Skycrane World Altitude Records

MAX ALTITUDE FEET	MAX PAYLOAD POUNDS	PILOT
36,122	NO PAYLOAD	CW3 JAMES CHURCH
31,165	2,205	CAPT B. BLACKWELL
31,480	4,410	CW4 EUGENE PRICE
25,518	11,025	CW4 EUGENE PRICE
17,212	22,050	CW3 JAMES CHURCH
10,850	33,075	CW3 DAVID SPIVEY
TIME TO CLIMB:		
9,843 FT IN 1 MIN 22.2 SEC		MAJ J. HENDERSON
19,686 FT IN 2 MIN 58.9 SEC		MAJ J. HENDERSON
29,529 FT IN 5 MIN 57.7 SEC		CW3 DELBERT HUNT

Newsletter designed and edited by Lee Jacobson and Sikorsky Archive Members with graphic assistance by Edgar Guzman

"At this time there is no program to develop a more capable crane helicopter to replace the Skycrane. What may be required is a person or company with the vision and passion to lead the effort to build on Igor Sikorsky's vision". — ***Jack Mckenna***

"The list of impossibles, for aviation could go on and on, and only as time and the unexpectedly brilliant development of flying progressed, was it finally recognized that the most dangerous forecast in aviation is to predict the impossibility of something". — ***Igor Sikorsky***

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