



Sikorsky Archives News

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The Conceptual and Preliminary Design Process Creates Advanced Technology Aircraft for the Future



TVX Tilt Rotor



CARA Tilt Rotor



ABC with Turbo Fans



Compound Helicopter



Tilt Wing



ABC Skycrane



X Wing



ABC



Navy Super Skycrane

This issue is a sequel to the January 2009 newsletter covering the "Sikorsky Quest for Speed", and is devoted to the creative talents of all the individuals at Sikorsky Aircraft who created the many concepts and preliminary designs for current and future aircraft, including aircraft

configurations that never made it to the development and production phases. The paintings shown in this issue illustrate the engineering and artistic talents of Andy Whyte. Historical details have been taken from Art Linden's paper, "Fifty Years of Sikorsky High Speed Concepts".

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Vertical Lift Flight Explorations at Sikorsky

The preliminary designs for Igor Sikorsky's first helicopters, the H-1 and H-2 were conceived and designed in 1909 through 1910. His first practical helicopter, the VS-300 was created in 1939. He summarized his early helicopter experience with the following quote:

"I started my activities in aviation by building a helicopter in 1909 with a small Anzani 25 horsepower engine with two crude propellers rotating in opposite directions on concentric shafts. This first machine achieved little results except mainly to teach me how things should not be done. My first two

machines were built between 1909 and 1910 and were helicopters. The first of these ships refused to leave the ground while the second could lift itself, but refused to lift me."

After designing and building over 27 different fixed wing aircraft in Russia and over 15 different land and sea aircraft in the United States, at the age of 50 Igor Sikorsky returned to his first love, the helicopter. He succeeded in achieving first flight with the VS300 in 1939. Since then, Sikorsky Aircraft conceptual and preliminary design engineers evaluated aircraft configurations that combined the benefits of vertical lift with high speed capabilities beyond that achievable with the basic helicopter.



H-2



VS-300



Stowed Rotors and Compound Helicopters



Tilt Rotor



Tilt Wing

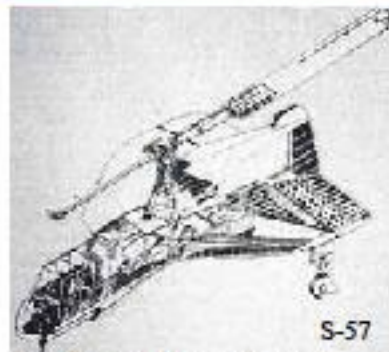


ABC

Convertiplanes and Stowed Rotors

The S-57 was designed in the early 1950s with the goal of combining the vertical lift capabilities of the helicopter with the higher speeds of the fixed wing aircraft. The configurations evaluated included the single blade counterbalanced pressure jet, and the delta wing versions.

During the early 1960s the two bladed stowable version was designed and wind tunnel tested. Design studies were performed on four bladed stowed rotor configurations in the early 1960s with the goal of winning the Air Force Combat Aircrew Recovery Aircraft (CARA) program. The program was subsequently terminated due to a change in customer priorities.



Single Blade Convertiplane



Single Blade Stowed Rotor



Two Blade Stowed Rotor



4 Blade Stowed Rotor



CARA



Telescoping Rotor Aircraft (TRAC)



Variable Diameter Tilt Rotor

During the mid 1960s variable diameter rotor systems were being evaluated to change the rotor diameter for maximum aerodynamic efficiency when transitioning from vertical to horizontal flight conditions. The Telescoping Rotor Concept (TRAC) varies the rotor diameter via a jackscrew mechanism shown in Figure (1).

The rotor diameter was reduced for forward flight, and increased for hover and vertical lift conditions. Wind tunnel tests were performed to prove the mechanism and concept feasibility. The complexity and weight of the required mechanism had to be traded off against the advantages obtained. The system was never implemented on an actual aircraft.

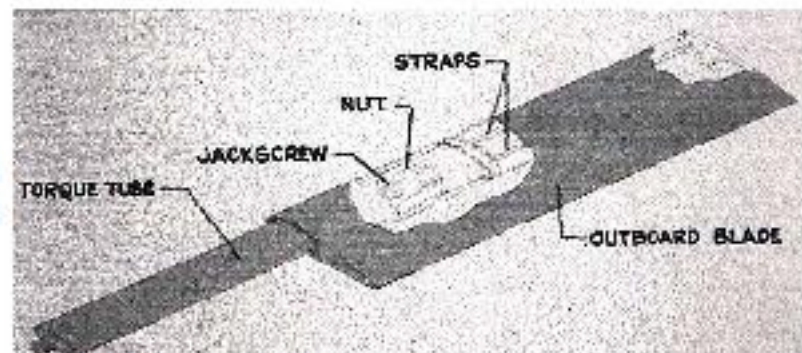


Figure (1) Telescoping Rotor Blade

Compound Helicopters

During the mid 1960s, the U.S. Army developed a need for a higher speed aircraft to replace the Bell AH-1 series. The aircraft was designated the Advanced Aerial Fire Support System (AAFSS). The design speed was 260 knots (299 mph). Based on an extensive development program of the NH-3/S-61F compound helicopter for the U.S. Navy, Sikorsky proposed the S-66 compound helicopter. Lockheed won the contract with their Rigid Rotor aircraft. Lockheed's aircraft was built and flight tested. The contract was subsequently terminated due to technical issues.



S-66



NH-3/S-61F



S-67

Rear Loading Compound



RSRA Conceptual Design



RSRA Proposed Design



Rotor System Research Aircraft (RSRA)



Tilt Rotors and Tilt Wings

In the 1960s and 1970s Sikorsky Aircraft evaluated other high speed concepts including Tilt Wings, Tilt Rotors, and the Tri-Verti-Plane.



The Tri-Verti-Plane (TVP) combines the features of the tilt rotor and the stowed rotor configuration. The rotors are transitioned from helicopter mode to low speed airplane mode, and to the stowed rotor high speed mode.



TVP Helicopter Mode



TVP Low Speed Airplane Mode



TVP Stowed Rotor High Speed Mode

Ducted Fans and X Wing Aircraft

During the period between 1960 through 1970, Sikorsky Preliminary and Conceptual Design Engineers were prolific in creating vertical lift aircraft configurations that utilized vertical ducted fans and X Wing concepts. The ducted fans produced the vertical thrust for take off, and the jet engines provided the propulsion force for horizontal flight.

The X-Wing configuration relied on the Coanda Effect to generate the aerodynamic pressure differential over an airfoil. Circulation control airfoils allowed the rotor/wing to maintain lift and control vibrations while starting and stopping rotation. A joint NASA/DARPA and Sikorsky program was undertaken between the mid 1970s to mid 1980s to design, fabricate and test an aircraft incorporating the X-Wing principals. The Rotor Systems Research Aircraft (RSRA) Program, which was in process at the time with the U.S. Army and NASA, was utilized to test and develop some of the X-Wing technology.

The results of the X-Wing Design, Test and Development Program demonstrated that the basic scientific principles associated with the technology were valid. However, due to the complexities of the structural, mechanical and pneumatic control design problems yet to be resolved, the program was terminated. The details of this program are documented in Art Linden's report, "Fifty Years of Sikorsky High Speed Concepts".



Ducted Fan Transport Aircraft



Ducted Fan Rear Loading Cargo Aircraft



RSRA with X-Wing Installation



X-Wing Concept 1



X-Wing Concept 2

Advancing Blade Concept (ABC) Aircraft

Approximately 100 years after Sikorsky's first coaxial rotor helicopter is conceived, the high speed helicopter of the future X2 is born. In the mid 1960s Sikorsky created an alternate to the compound helicopter, the ABC aircraft. This configuration eliminates the retreating blade stall problem, so that there are advancing blades on both sides of the aircraft. At this time Igor Sikorsky was retired from management responsibilities providing consulting services to the company. He was very interested in the program and reminded the engineers that his first helicopter experiments in Russia in 1908 were with a coaxial helicopter. Numerous preliminary designs using the ABC technology were created.



CH-54 Skycrane



Super Skycrane



ABC Skycrane

The Super Skycrane

The first turbine engine S-64 Skycrane flew on May 9, 1962. The Army CH-54A Skycranes were rated at 42,000 pounds gross weight with a 10 ton payload. The CH-54B improved Skycrane was rated at 47,000 pounds gross weight and 12.5 ton payload.

The CH/MH-53E helicopters evolved from a Navy S-64B design program for a 3 engine



MH-53E



CH-53K In Development



H2



ABC Scout



ABC Commercial



X2 Test Aircraft



ABC Transport

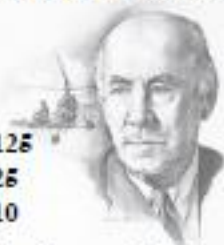


ABC Skycrane

Skycrane. The S-64B dynamic and rotor drive systems formed the basis of the H-53E series. The current CH-53K design rating is 88,000 pounds gross weight. Based on a parametric growth study, it is conceivable that this aircraft can grow to 100,000 pounds gross weight within ten years in service. A future Super Skycrane evolving from the K program with a potential of 100,000 pounds or more gross weight and a 25 ton payload is very feasible.

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Newsletter designed and edited by Lee Jacobson, Art Linden and Andy Whyte



“The list of impossibilities, 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 I. Sikorsky



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