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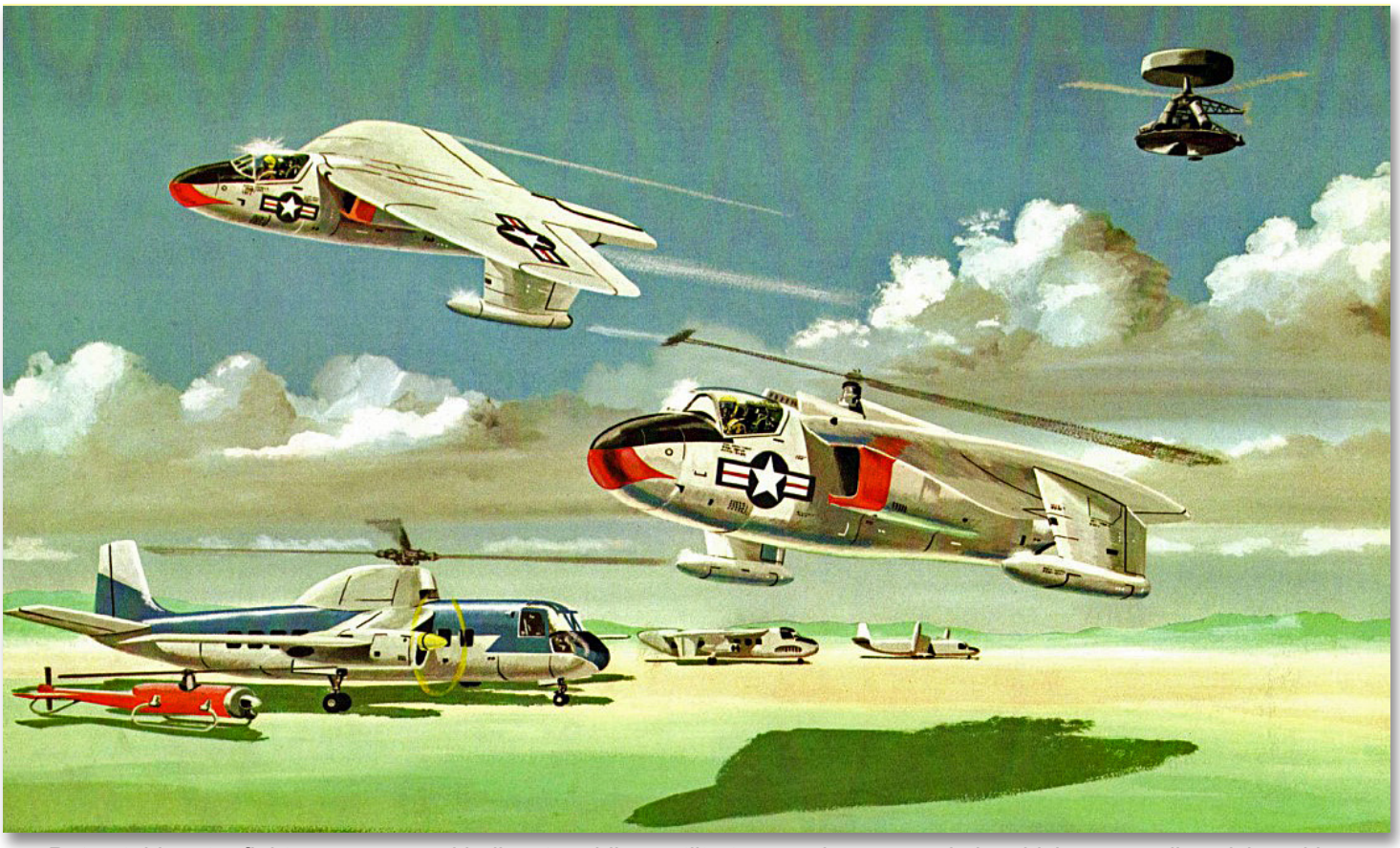
Sikorsky Art: The "Might-Have-Beens"



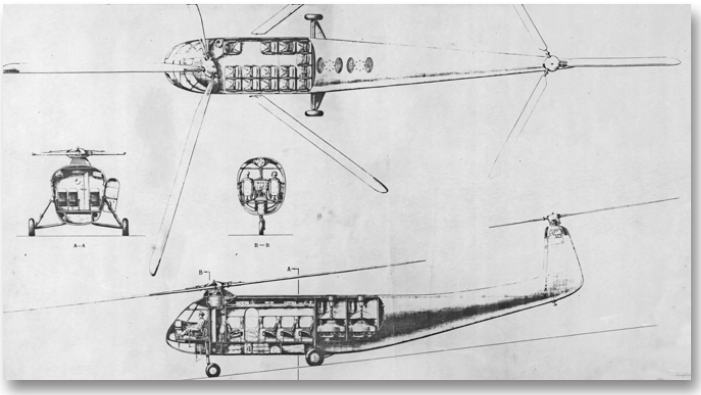
Retractable rotor fighters, compound helicopter airliners, tiltrotors, and unmanned air vehicles were all envisioned by the Sikorsky Advanced Concepts Group. (All images property Sikorsky Archives.)

Sikorsky engineers have long drawn or painted concept aircraft that never flew, but their art revealed ideas that advanced real-world flight. Trans-oceanic flying boats, helicopter airliners, fast coaxial compound helicopters, and convertiplanes with folding, tilting, or stopping rotors all appeared before technology, money, and political will could make them fly. Vaughan Askue joined the Sikorsky Advanced Concepts Group in Bridgeport in 1978. He cautioned, "I suspect a lot of this was a public relations effort to show how forward-thinking Sikorsky was and to keep our competitors off balance." However, some of the bold concepts fly today in the civil-certified S-92, the three-engined S-95 (CH-53K) King Stallion, and

the coaxial compound S-97 Raider. Sikorsky Innovations is the descendent of the Advanced Concepts Group and still engineers new solutions to customer needs.

S-45 Flying Boat

Igor Sikorsky's fixed-wing flying boats peaked with the four-engine, 40-passenger VS-44A, but in 1935 the aviation pioneer told the Royal Aeronautical Society of a 100-passenger S-45 meant to fly from New York to London or Paris non-stop. In *The Story of the Winged-S*, he wrote, ". . . it appears probable that the large, palatial airliner of the future will still consist of a relatively narrow wing, a streamlined body resembling a dirigible, and a small tail surface." Sikorsky S-model numbers identified engineering drawings and were usually assigned only to aircraft in detail design. Outclassed by land-based aircraft in a world covered by post-war runways, the six-engine S-45 never came to be, but jetliners with hundreds of seats span global routes today.



Sesqui-Tandem Helicopter

The VS-300 in 1939 promised Sikorsky Aircraft new markets in Vertical Takeoff and Landing (VTOL), but the agile, compact helicopter with lifting rotor overhead and anti-torque rotor at the tail competed with designs less sensitive to center-of-gravity (cg). In 1946, Sikorsky engineer Nick Glad drew this helicopter bus with tandem rotors of different sizes. The S-54 tested a "sesqui-tandem" layout in 1948, but engineer Ed Kastenberger gave the single-rotor S-55 an expanded cg in 1949 by placing the heavy engine in the nose and a large cabin under the rotor. Igor Sikorsky had predicted, "During the first and second decades of flying, it was frequently taken for granted that several lifting surfaces were necessary, particularly for planes designed for carrying heavy loads. . . As time went on, triplanes and tandems disappeared rapidly. At a later date even the biplanes nearly disappeared from the air. . . I believed that in the development of the helicopter the same sequence would be followed, and the craft with a large single main rotor and one or more small auxiliary rotors furnishing stability and control, would remain the best configuration." Like most modern helicopters, today's powerful S-95 (CH-53K) follows his plan.

S-57 Retractable Rotor

New ideas were generally committed to a painting after aerodynamicists and weight experts determined their feasibility. Engineer Andy Whyte started with the Sikorsky Transmission Group in

1951 but later created most Advanced Concepts images. “In his mind he was a preliminary design engineer,” recalled Advanced Design Engineer and Comanche Program Manager Art Linden. “He was also an artist. It was interesting to watch him develop his talent. Early-on, the paintings were pretty crude. He was a guy learning, but you can watch him over the years get better and better.” Whyte’s 1960s painting of the single-blade, stowed-rotor S-57 captured a VTOL jet fighter able to stop and fold its rotor to attain jet speeds in cruising flight. In response to an Air Force contract in 1956, the counterbalanced single-blade rotor was tested in wind tunnels and flew once on a Sikorsky R-4. Linden observed, “The technical issue that never got resolved was how would you stop that rotor in flight and what kinds of loads would it generate as it slowed down.”

Light Observation Helicopter

Piston-engine S-55s, S-56s, and S-58s in the 1950s established Sikorsky Aircraft as maker of large single-main-rotor helicopters in the 1950s. However, when the U.S. Army solicited proposals for a turbine-engine Light Observation Helicopter (LOH) in 1960, the company drew this clean-sheet design as one of 12 bidders offering 22 different LOH configurations. The three-bladed, two-seat LOH proposal failed to make the final selection, and the Army took the four-bladed Cayuse and two-bladed Kiowa to war in Vietnam. Based on combat experience, Sikorsky engineers in 1970 drew an Advanced Armored Reconnaissance Vehicle with a single T53 turboshaft and no tail rotor.

S-66 AAFSS

Vietnam drove the Army’s development of fast attack helicopters, and Sikorsky S-66 compound helicopter was a contender for the Advanced Aerial Fire Support System (AAFSS). The winged, tandem-seat design proposal submitted in 1965 incorporated a ‘rotoprop’ that would swing to the side to counter torque in a hover and turn to the rear for high-speed thrust. The S-66 used a proven articulated rotor, but the Army chose the rigid-rotor Cheyenne for AAFSS development. When the Cheyenne was canceled, Sikorsky built the tandem-seat S-67 around S-61 dynamics but found no launch customer.

CARA

Vietnam also drove requirements for Combat Search And Rescue (CSAR). The Sikorsky S-61s and S-65s (HH-3Es and HH-53B/Cs) that saved pilots from North Vietnam were slow and vulnerable. In the late 1960s, the Air Force defined a Combat Aircrew Recovery Aircraft (CARA) smaller than the HH-53 and capable of

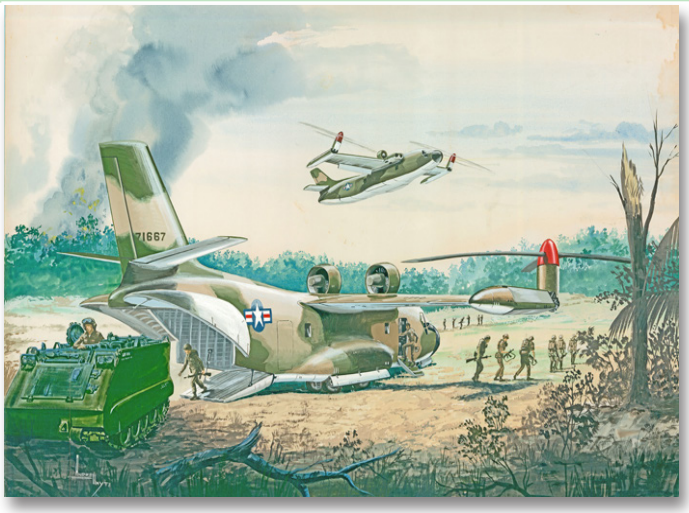
fixed-wing speeds from 360 to 450 kt. Sikorsky pictured two- and three-blade stowed-rotor configurations that would transition from hover to fast flight with rotors folded and convertible engines switching from turboshaft power to jet thrust. The Air Force ultimately lost interest in CARA but today sponsors High-Speed VTOL (HSVTOL) studies with CSAR in mind.

Tilt Prop Convertiplane

Tilting wings and tilting rotors to take-off and land like a helicopter yet cruise like an efficient fixed-wing airplane were tested in the 1950s. In the mid-1960s, Sikorsky proposed a Tilt-Prop Convertiplane to achieve the same result without the complexity of variable rotor speeds for vertical takeoff and efficient cruise. Advanced Design paintings subsequently put the same concept on single- and two-seat gunships. In the 1990s, the company would test variable diameter tiltrotor (VDTR) mechanisms to extend and retract blades for takeoff and cruising efficiency.

Lift Fan Transport

Andy Whyte drew this high-speed lift-fan transport around 1960. The lift fans in louvered pods under each wing would require convertible engines able to switch from shaft drive for vertical lift to turbofan thrust for high-speed flight. NASA Lewis Research Center and the Defense Advanced Research Projects Agency funded a program to demonstrate a convertible TF34 engine in the early 1980s, but plans to fly the convertible engine on the S-72 Rotor System Research Aircraft were abandoned.



Tri-Vertiplane

Sikorsky artwork in the 1960s pictured a range of high-speed VTOL solutions with fixed wings and tilting or folding rotors. The 450 kt Tri-Vertiplane imagined around 1967 would take off and land vertically on tilting proprotors, accelerate to fixed-wing flight with thrust from overwing turbofans, and stop its outrigger turboshaft proprotors in flight to fold along wingtip nacelles. Other less ambitious compound concepts used helicopter rotors to lift off like a helicopter and propellers to sustain fixed-wing flight.

By the mid-1960s, stretched S-61s were flying with helicopter airlines, and Sikorsky engineer Al Wolf led studies of faster compound helicopters

Compound Airliner

aimed at commercial and military applications. *Sikorsky News* in November 1968 described an S-65-based compound with fixed wings, outrigger propellers, and a tail rotor to carry 86 passengers at cruising speeds of 265 mph on short intercity routes. *Sikorsky News* in December 1968 reported the company had invested $18 million over 15 years in the compound helicopter and quoted the company's Vice President for Air Transportation Systems John McKenna saying much of the hardware for an S-65 compound was available, and production design could begin. Most helicopter airlines succumbed to business pressures, and the compound airliners never took shape.

Coaxial Crane Helicopter

Early in rotorcraft development, Igor Sikorsky saw value in crane helicopters dedicated to external loads. "As a rule, the crew of the crane can attach any object to the crane helicopter, and even if there is no room for the helicopter to land, the object can be picked up via a hoist and delivered in the same manner to any spot. . . It would be difficult to over-estimate the volume, diversity and value of the service which such a vehicle could render." By 1968, the S-64 Skycrane (Army CH-54) was in production, and Sikorsky engineers were considering growth cranes. This coaxial crane with stacked S-64 rotors and three T64 engines promised to lift heavy loads yet fit a constrained footprint. Counter-rotating articulated rotors would cancel torque, but another drawing suggested greater main rotor separation and a shrouded fan for directional control.

S-64B

Though the coaxial crane found a dead-end, Sikorsky engineers proposed an S-64B crane helicopter with three engines turning a single main rotor 79 ft in diameter. The company lost the U.S. Army competition for an even larger Heavy Lift Helicopter in 1971, but the Department of Defense authorized a U.S. Navy Marine Corps program to develop a new heavy-lifter more powerful than the downed aircraft recovery. The S-64B drivetrain became the starting point for the Super Stallion still in service today pending deliveries of the even more powerful S-95 (CH-53K) King Stallion.

Sikorsky flew the S-69 Advancing Blade Concept (ABC) in 1973 and offered the rigid coaxial rotor

ABC LAMPS

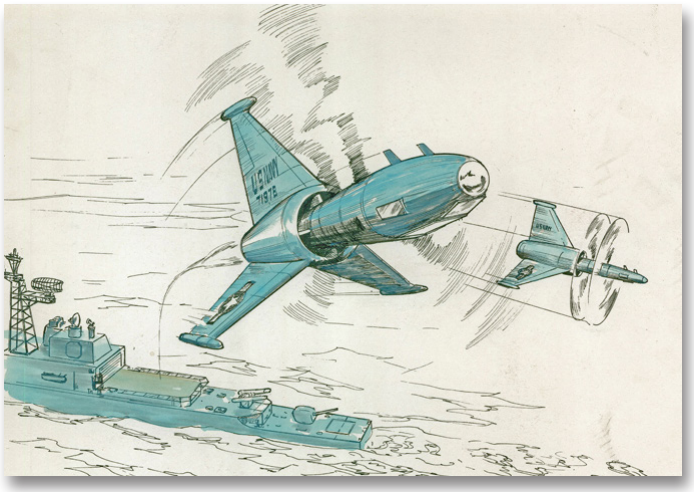
helicopter as an alternative to tiltrotors. Art Linden observed, "We lost that research battle. The research money went to the tiltrotor." Andy Whyte nevertheless drew ABC technology on a range of military and civil helicopter concepts. The naval ABC shown here is sized to the Light Airborne Multi-Purpose System (LAMPS) MK III mission ultimately filled by the Sikorsky S-70B Seahawk. Paradoxically, the notional ABC LAMPS has no auxiliary propulsion. "You don't need the ABC rotors if you're not going to go faster than 180 kt," noted Linden.

Black Hawk Airliner

The S-70 Black Hawk entered the U.S. Army competition for a Utility Tactical Transport System (UTTAS) in 1974, but Advanced Design was already applying S-70 dynamics and structures to commercial applications. The S-70C-29 airliner shown here was envisioned to carry 29 passengers and baggage 250 miles. Black Hawk airliners never materialized, but the civil-certified, 19-passenger S-92 airliner unveiled in 1992 was certified in 2002 with a purpose-designed airframe, rotor system, transmission, and digital cockpit. It has found notable success in scheduled operations for the oil industry.

S-71 AAH

The U.S. Army began its Advanced Attack Helicopter (AAH) competition in 1973, and Sikorsky offered the S-71 based on ballistically-tolerant S-70 dynamics. "Our proposal was to put a gunship around the UTTAS components, and it would be cheap and easy," recalled to Art Linden, "The basic concept was probably 60 to 65% all-UTTAS components. The new part was the fuselage and the cockpit, and all the armament." Two AAH contenders built flying prototypes, but the S-71 advanced no further than a mockup. "The Army did not want to buy all its gunship helicopters and utility helicopters from the same company."

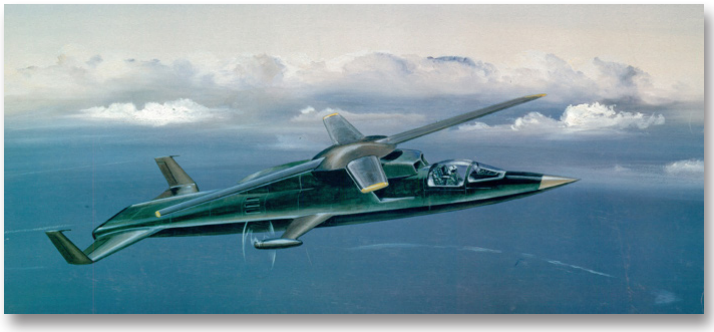


Coaxial Unmanned Aerial Vehicle

Unmanned Air Vehicles (UAVs) today extend the reach of small-ship sensors, but around 1978, Sikorsky engineers considered this ABC UAV. "The concept of a tail-sitter was not unique to us or anyone else," noted Art Linden. Coaxial rigid rotors would lift the vehicle from a deck spot and tip it over for cruising flight. The idea failed to find a sponsor, but the Sikorsky Cypher UAV flew ABC rotors ringed by an aerodynamic shroud in 1997. Ken Rosen was then VP of Research and Engineering and recalled, "It was not a ducted fan. It was a revolution, a dual counter-rotating rotor, a rather stiff one by the way. . . It was basically an X-2 helicopter with a duct around it." Cypher tests logged 400 flight hours, but Sikorsky abandoned the program. "It was a ridiculous error on the part of Sikorsky management not to continue," observed Rosen. "We were ahead of everyone in the world in VTOL UAVs." Cypher control algorithms nevertheless provided the basis for the manned X2 ABC demonstrator.

ABC LHX

U.S. Army studies in 1982 defined a Light Helicopter Experimental (LHX) with greater speed and agility compared to legacy helicopters, and with dramatically reduced radar, infrared, and acoustic signatures. The service initially wanted LHX scout/attack and utility versions, and Sikorsky studied a range of configurations including this tandem-seat attack helicopter based on the Advancing Blade Concept with integrated tail thruster. Technology at the time made the ABC too heavy for the LHX requirement, and the Army saw no need for speeds over 170 kt. Sikorsky and Boeing won the LHX development program with a single-main-rotor helicopter enhanced by a shrouded Fantail. The Army canceled the Comanche scout/attack helicopter in 2004, and the requirement is answered today by the S-102 Raider-X now proposed for the Army's Future Attack Reconnaissance Aircraft.



X-Wing

In the early 1980s, Sikorsky Advanced Design investigated the X-Wing, a circulation-controlled stop-rotor aircraft with VTOL helicopter performance and Mach 0.8 fixed-wing speed. DARPA, NASA, and the Navy sponsored a test program to build, fly, and stop the ultra-stiff composite rotor in flight on the S-72 Rotor System Research Aircraft. RSRA manager Art Linden recalled "The X-Wing program was highly classified, but when we put the RSRA together, it was very public. Andy Whyte was tasked with what an X-Wing might look like." Sikorsky engineers meanwhile built real X-Wing technology for the RSRA. Ken Rosen explained, "We built the entire circulation control system, one of the most complex programs we ever undertook. . . It was like changing a helicopter's cyclic and pitch settings every few milliseconds." NASA cancelled the X-Wing flight test in 1986, but Ken Rosen observed, "The payoff to Sikorsky was people like myself and Art, leaders of Comanche program in the '90s. We learned a huge amount about fly-by-wire and composites."

Lessons in composite structures, compound propulsion, rigid rotors, and fly-by-wire flight controls were not lost on Sikorsky engineers. The technologies are integrated in the S-102 Raider-X now being assembled for the Army's Future Attack Reconnaissance Aircraft (FARA), and they promise the company a new range of products to shape the future of vertical lift.

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Please contact us at iisha@snet.net or see our website www.SikorskyArchives.com for details on how you may help us

Thank You

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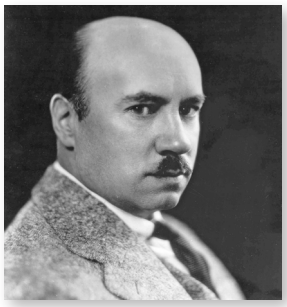
August 28, 2023 — L to R, Sikorsky V.P. Dana Fiatarone, Sikorsky volunteer James Sharretto, Archives V.P. John Bulakowski, Sikorsky volunteer Joe Decker, Archives President Dan Libertino, Sikorsky V.P. John Cerreta, and Sikorsky volunteer Steve Bakonyi at the successful conclusion of the inaugural Sikorsky Archives charity golf tournament at Sacred Heart University's Great River Country Club.

Prepared by Frank Colucci and John Bulakowski
with graphic art and layout by Jodi Buckley.



"I had a feeling that I had begun to learn to develop the ability which is so important for pioneering and inventive work, namely the ability to distinguish between the valuable and the worthless products of imagination."

Igor Sikorsky — *The Story of the Winged-S*