



FOREWORD

In man's earliest attempts at designing a machine for flight, he emulated the principle of the birds, which could rise up from a given point and land in the same manner. Since the flapping wing principle proved too complex for contemporary technology, pioneers tried rotating the wings. The concept of a running takeoff or landing was apparently not considered, since this was characteristic of only a few bird species.

These imaginative attempts at vertical flight were doomed to failure, however, because many basic aerodynamic principles were yet to be discovered, and because power sources were totally inadequate.

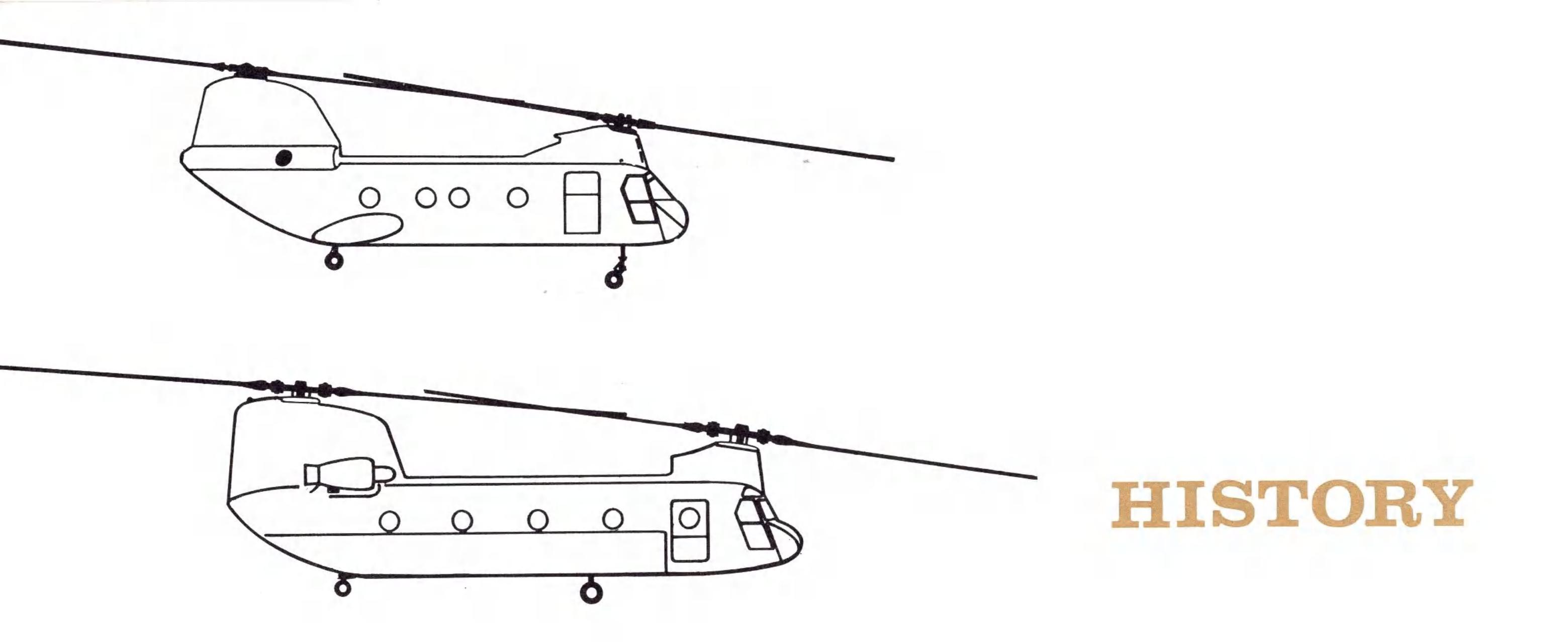
Near the end of the nineteenth century, the glider—a different approach toward emulating the birds—was perfected to the point where it could carry a man. From there it was only a short and logical step to install a power plant, which by then had achieved practicality.

From this small beginning, the fixed-wing aircraft has seen phenomenal growth in size, speed, range, and usefulness as advances in technology snowballed. Since many of the newly discovered aerodynamic principles had direct application to the rotary-wing aircraft, it achieved a renascence—this time with prompt success. In less than three decades, the helicopter has made

tremendous progress in capability and reliability—man finally realized his first ambition, that of true vertical takeoff and landing.

This book is the story of the efforts and accomplishments of the Vertol Division of Boeing in vertical lift technology. The story is told through the evolution of models of aircraft designed, developed, produced, and successfully flown over twenty years.

The missions and milestones that mark Vertol Division's refinement of the helicopter design over the years are presented as a matter of interest to those whose opinions are valued, and as a tribute to those who made these accomplishments possible.



The Boeing Company is composed of an administrative headquarters organization and seven operating divisions of which two are incorporated in a Group administration. Headquarters, the Space Division and Missile and Information Systems Division of the Aerospace Group, the Supersonic Transport Division, the Turbine Division and the Commercial Airplane Division are located in the Seattle, Washington area. The Wichita Division is located in Wichita, Kansas, and the Vertol Division is in the Philadelphia, Pennsylvania area.

The Space Division's Launch Systems Branch conducts its principal operations in New Orleans, Louisiana and Huntsville, Alabama, with the division's Space Craft Programs operation in Seattle. The Boeing Atlantic Test Center is a Space Division operation at Cape Kennedy, Florida.

The Company has two wholly owned subsidiaries—Boeing of Canada, Limited, located in Arnprior, Ontario, and Boeing International Corporation with principal offices in Seattle.

Since its original incorporation in 1943 by a group of young helicopter-

minded engineers, the Vertol Division of the Boeing Company has been engaged in research, design, and manufacture of vertical takeoff-and-landing aircraft. Although the Company's initial effort was one of the first successful helicopters in America, it was the only small single-place, single-rotor helicopter ever built by the Company, and it soon gave way to the tandem configuration design philosophy which has prevailed since that time. Based on this development in the state-of-the-art, the firm received its initial contract in 1945 from the U. S. Navy for the

world's first tandem-rotor transport helicopter, the ten place XHRP-1.

The year 1946 brought a name change from P-V Engineering Forum to the Piasecki Helicopter Corporation, plus a Navy contract for a fleet utility helicopter, the HUP, and a United States Air Force contract for a helicopter capable of accomplishing long-range rescue missions. The Company expanded rapidly and it became necessary to move out of rented quarters and build a facility which is now the division's Fabrication Center.

During the following decade the Company designed, developed, and produced the six-place HUP, now designated UH-25, for the Navy; the 14- to 22-place H-21 Work Horse, now the CH-21 for the Air Force, as well as the 40-passenger YH-16, the largest helicopter in the world at the time. HUP's were delivered to the United States, Canadian, and export military services. The H-21 joined the military forces of the United States, Canada, West Germany, France, Sweden, Japan, and the Union of Burma.

From the highly successful H-21 evolved the tandem-rotor Vertol 42, 43 and 44, which have seen service on

the Mid-Canada Line, the Arctic, in Europe and Asia, as well as in the petroleum and construction industries. New York Airways replaced its entire helicopter fleet with the Airliner version of the Vertol 44 in 1958.

In March 1956, the company name was changed to the Vertol Aircraft Corporation to reflect a broader interest in the field of Vertical Take-Off-and-Landing aircraft.

After producing more than 1,000 tandem-rotor helicopters which accumulated over 800,000 hours of flying time, Vertol initiated, in 1956, an eighteen-month program of research and design for a twin-turbine transport helicopter to meet military and civilian requirements. This program first led to the 107 Prototype and eventually to the new generation of turbine-powered aircraft, the 107 and the U. S. Army CH-47A Chinook.

The 107 represented a significant advance in the art of helicopter design. This aircraft has been delivered to the United States Marine Corps, United States Navy, Royal Canadian Air Force, Canadian Army, the Royal Swedish Navy and Air Force, New York Airways, Pan American Airways,

and—under licensee agreement—to Kawasaki Aircraft Company in Japan. Kawasaki-built 107's have been delivered to Kanki Airlines, Thailand Government, the Japanese Navy, Army, and Air Force.

U. S. Navy and U. S. Marine Corps versions of the 107, designated UH-46A and CH-46A respectively, are now in accelerated production at the Vertol Division. Both aircraft are fully operational. The UH-46A has been deployed aboard fast combat supply ships of the Atlantic and Pacific Fleets as a major part of the Navy's Vertical Replenishment (Vert Rep) Program. A number of these ships are operating in the South China Sea area in support of United States Forces in the Southeast Asia conflict. The CH-46A is operational with squadrons of the Fleet Marine Forces, Atlantic and Pacific Fleets, as well as squadrons in the United States. In March 1966, the CH-46A was deployed to Vietnam in support of United States Forces in the Southeast Asia combat zone.

The CH-47A Chinook was ordered by the United States Army for use as a tactical transport helicopter. The primary mission of the Chinook

is rapid deployment of tactical units in combat areas. The Chinook, now fully operational, is also in accelerated production at the Vertol Division. This aircraft has been delivered to U. S. Army air assault units, and is now serving in Vietnam with the First Cavalry Division where it is earning an impressive reputation for its role in support of United States Forces in the combat zone.

Stemming from the Chinook is a new armed/armored version of the CH-47A. This Armed/Armored Chinook, the first of which was rolled out in 1965, mounts a formidable array of armament and has armor protection for the crew and vital aircraft components. This Chinook carries a ton of expendable munitions and over a ton of armor plating.

In 1957, the Company embarked on a pioneering venture in tilt-wing technology. The result of this venture was the Vertol 76 (VZ-2). In July 1958, the Vertol 76 was the first tilt-wing to successfully convert from vertical to horizontal flight and back. Following this first successful flight this aircraft underwent extensive test programs to further advance tilt-wing technology. This research and devel-

opment led to state-of-the-art breakthroughs in tilt-wing control systems and lifting devices.

In March 1960, Vertol Aircraft Corporation became the Vertol Division of the Boeing Company. Since that time, the Boeing Company has expanded Vertol Division facilities by over 400 percent to meet increased production needs and to retain the Division's position as a leader in vertical-takeoff-and-landing aircraft technology. The Division's employment level has grown in this period from about 2,000 to over 12,000.

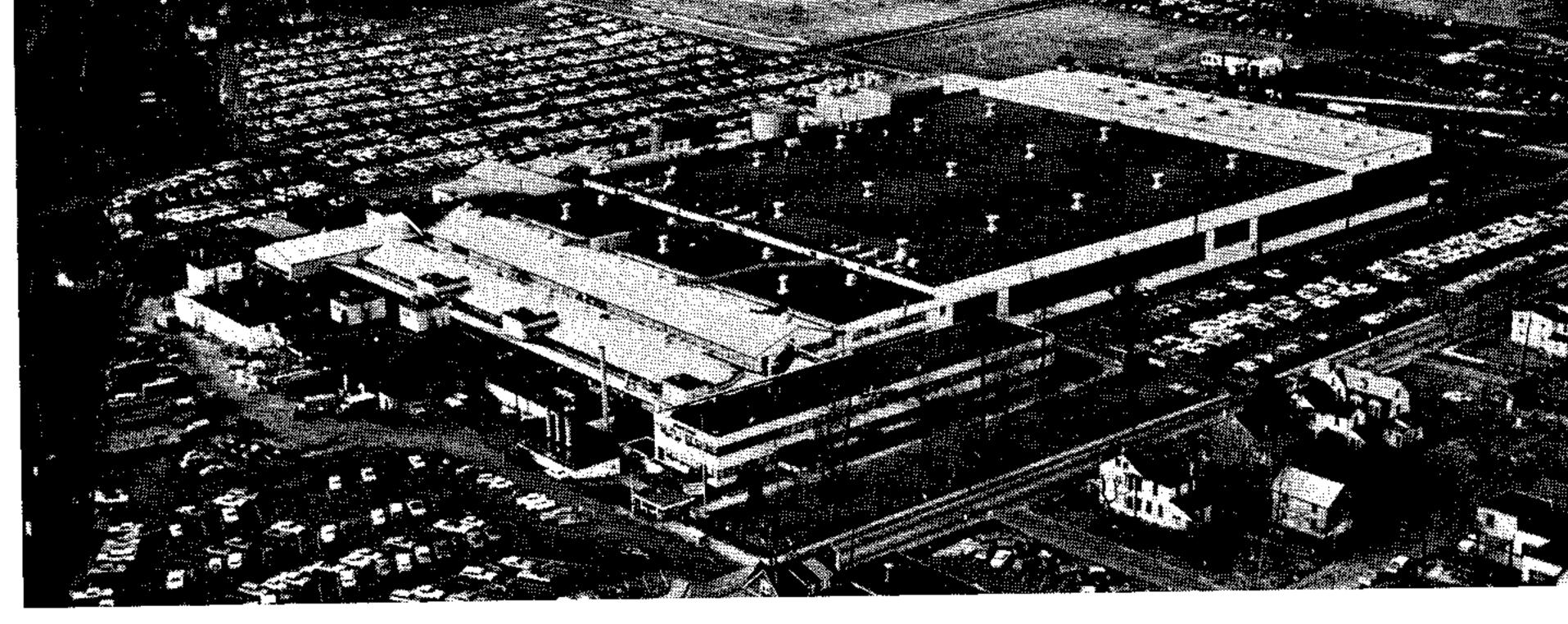
In 1962 the first phase of a complex was constructed and occupied on 290 acres of land located in Ridley Township. This facility, the Engineering and Dynamics Center, includes a Blade Plant and a Transmission Assembly Building. The Engineering and Dynamics Center is now the site of construction of the world's most advanced Wind Tunnel for helicopter and VTOL research, and a new Engineering Laboratory with the most modern and sophisticated equipment available. The Blade Plant has been expanded to increase rotor blade production capacity and to include an R & D Blade Shop for manufacturing rotor blades for research and development.

The Division's new Assembly Center adjacent to the Engineering and Dynamics Center was acquired in 1965 as a result of production acceleration to double the output of CH-46's and Chinooks simultaneously and to meet future production requirements. This major factory complex, located on 112 acres of land, has over one million square feet of covered manufacturing area. Of the one million square feet, over 700,000 square feet are high bay area. This facility provides not only for presently programmed production needs, but also provides considerable plant capacity for future production growth.

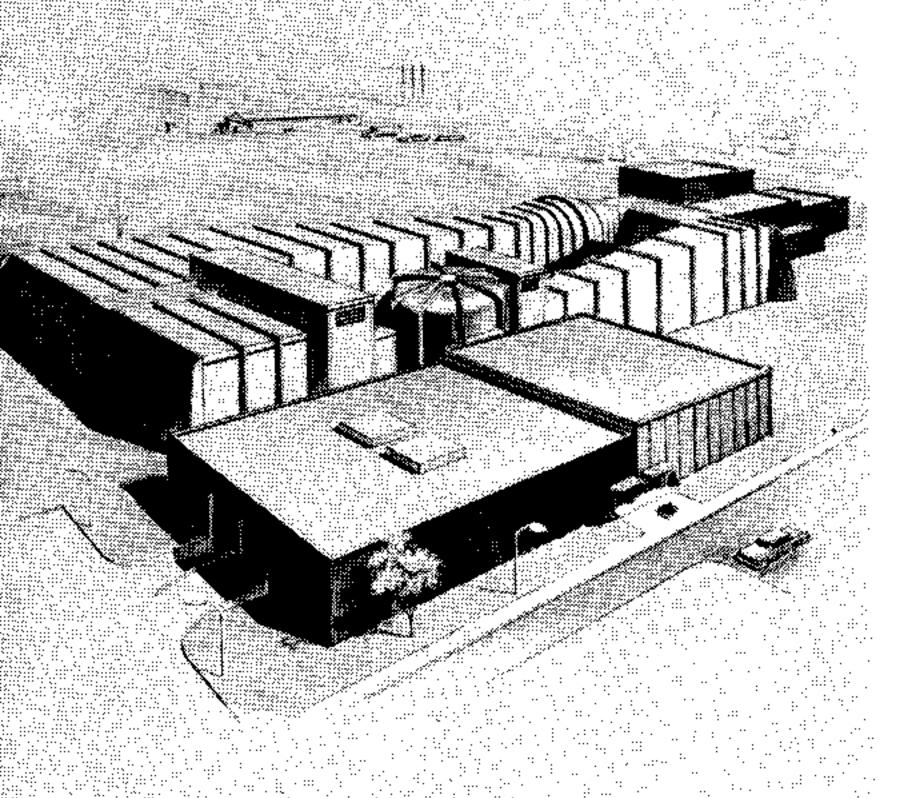
In its expansion program, the Vertol Division has followed a concept of totally balanced capability. In the interest of integrated capability in all areas, the Division has expanded manufacturing, engineering, and support facilities in relative proportion. This concept of balanced expansion and balanced increase in capability ensures the means to satisfy total customer requirements from concept formulation through the acquisition and operational phases of a product's lifespan.

However, mere facilities and equipment, regardless of how up to date and how sophisticated they are, do not assure product success. To conceive, design, build, service and support products, skilled people are a mandatory asset. Therefore, the Division has sought out and acquired many highly competent personnel in both the professional and non-professional fields. These personnel assure program continuity, impetus, and capability necessary to support product programs throughout the product's life cycle, starting from birth of the concept and continuing through retirement of the hardware.

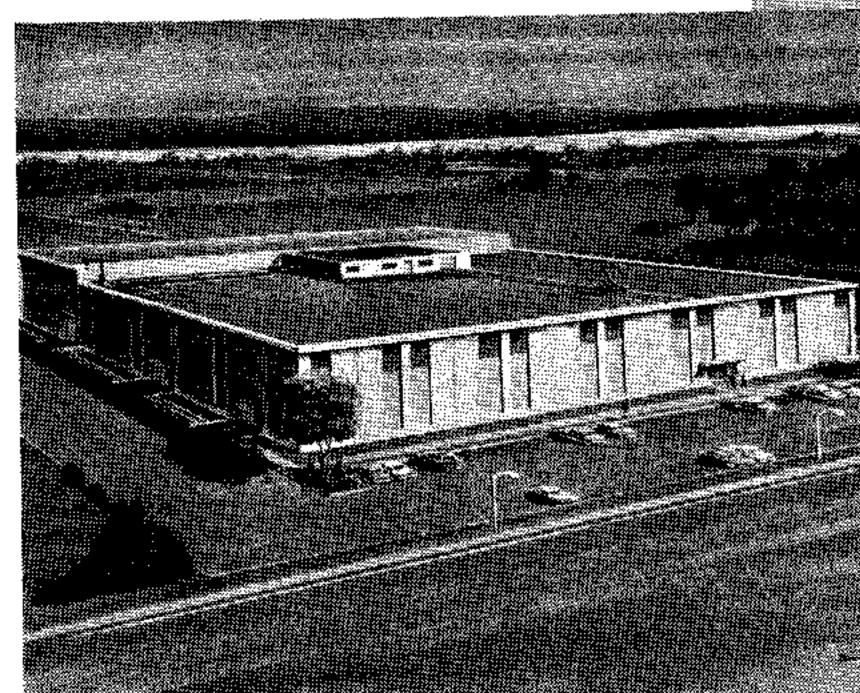
Fabrication Center



Engineering & Dynamics
Center



Wind Tunnel (Artist's Concept)



Engineering Laboratory (Artist's Concept)

Assembly Center





XHRP-X...1946



XHRP-1...1945

HRP SERIES

The XHRP-X "Dogship" was the first helicopter produced under military contract. Designed and built in record time for the U.S. Navy in March 1945, it not only was the first successful tandem-rotor helicopter but also the largest helicopter to fly successfully at the time. Two XHRP-1's quickly followed and served as static/dynamic and flight test articles. From these helicopters the basic principles of control were developed for the subsequent HRP-1, on which an extensive flight test program was conducted.

The HRP-1 was a ten-place helicopter powered by a 600 horse-power Pratt & Whitney R-1340 engine. Twenty aircraft were constructed under a Navy contract, and deliveries were completed in 1948. These helicopters performed numerous rescue missions with both the Navy and the Coast Guard. Using the HRP-1, rescues and medical missions up to 90 miles at sea were successfully completed by the U.S. Coast Guard.

The HRP-2, five of which were produced, was an all-metal fuselage version of the HRP-1, with a number of refinements and modifications.

The HRP series helicopters were the first to demonstrate the towing capability of VTOL aircraft, and to establish the superiority of the tandem-rotor configuration for this operation. As mine sweepers their speed was comparable with that of surface vessels, without the inherent danger of striking mines. Their ten-passenger capacity ushered in the era of transport helicopter operations. Six HRP's are currently licensed by the Federal Aviation Agency.



Designation—HRP-2

MISSION
CREW
PASSENGERS
ENGINE MAKE
H.P.
ROTOR DIAMETER
FUSELAGE LENGTH
WEIGHT EMPTY
USEFUL LOAD
MAX. SPEED
CRUISING SPEED
RANGE
CEILING WITH
NORMAL LOAD

Rescue & transport 2 10 (1) P & W R-1340-AN-1 600 41 ft 54 ft 5,301 lb 1,924 lb 91 kt 80 kt 300+ n. mi 9,840 ft

7



XHJP-1...1946

Designation-HUP-2 Retriever

MISSION
CREW
PASSENGERS
ENGINE MAKE
H.P.
ROTOR DIAMETER
FUSELAGE LENGTH
WEIGHT EMPTY
USEFUL LOAD
MAX. SPEED
CRUISING SPEED
RANGE
CEILING WITH
NORMAL LOAD

Rescue & utility
2
4
(1) Continental R-975-34
550
35 ft
32 ft
4,236 lb
1,514 lb
94 kt
73 kt
310+ n. mi
10,200 ft

HUP SERIES

The Navy Bureau of Aeronautics wrote requirements in 1945 for a high-performance utility helicopter to operate from aircraft carriers, battleships, and cruisers. The competition for this type was won by the tandem-rotor HUP, or as it was then known, the XHJP-1.

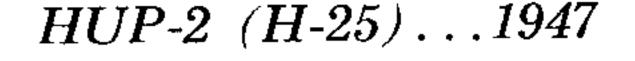
The prototype XHJP-1 had won a Navy production contract in competition with a single-rotor helicopter built to identical operational specifications. It was the first helicopter to incorporate overlapping tandemrotor blades and prove the all-around advantages of this configuration.

The HUP, now designated the UH-25 "Retriever" by the Navy, is a six-place, single-engine rescue and utility helicopter. The fuselage is of all-metal, semimonocoque construction with a conventional fixed landing gear. The overlapped tandem design provides a compact fuselage and rotor system, permitting the HUP to be handled on any aircraft carrier elevator without folding the blades and

on any cruiser elevator with blades folded. The mission of the HUP is ship-based rescue, observation and utility, personnel and cargo transport.

The HUP-2 was the first production helicopter to be equipped with an auto-pilot which permits "hands off" flying. A total of 339 HUP type helicopters were delivered to the U.S. Navy, the U.S. Army (H-25's), the Royal Canadian Navy, and the French Navy. The Army's H-25 was known as "Army Mule" and doubled as a troop carrier and flying ambulance.

An example of the HUP's versatility was the performance of a single U.S. Navy squadron of twelve HUP-2's during rescue and relief operations at Tampico, Mexico, after the area had been badly damaged by a hurricane. In 2,298 day sorties and 88 night sorties, a total of 184,037 pounds of food was delivered to Mexican flood victims; 81 medical teams were transported together with 1,867 pounds of medical supplies. In a single day 2,280 persons were evacuated-1,425 of them rescued by hoist. One pilot transported 21 persons-a remarkable achievement for a six-place helicopter.





HUP-1...1948

FEBRUARY, 1962

A U.S. Navy UH-25 played a typically useful role in the sea operation following Lt. Colonel John Glenn's history-making orbital flight in space, air-lifting the astronaut from the pick-up destroyer the U.S.S. Noa to the carrier U.S.S. Randolph.



H-16 SERIES

Originally selected by the United States Air Force as a long-range transport helicopter, the YH-16 also incorporated the United States Marine Corps and United States Army Field Force characteristics for an assault transport helicopter capable of transporting large quantities of troops and equipment into critical combat areas. It was the largest helicopter in the world at the time, with space provisions for 40 troops or seven tons of cargo in its 2,250-cubic foot cabin.

Two of these big experimental helicopters were built for the USAF: the YH-16 "Transporter," test flown in 1953, and powered with two reciprocating engines delivering a total of 3,600 horsepower, and the YH-16A "Turbo Transporter," powered with two Allison YT38 turbines geared directly to the 82-foot diameter rotors. The first public showing of the latter took place at Philadelphia's International Airport on December 1955.



The YH-16A unofficially broke the existing helicopter record in 1956 with a speed of 166 miles per hour. Its service ceiling was over 18,000 feet. Data gathered from ground and flight tests of the YH-16A were instrumental in the further development of large turbine-powered, tandem-rotor helicopters.

Designation-YH-16A Turbo-transporter

MISSION
CREW
TROOPS
ENGINE MAKE
H.P.
ROTOR DIAMETER
FUSELAGE LENGTH
WEIGHT EMPTY
USEFUL LOAD
MAX. SPEED
CRUISING SPEED
RANGE
CEILING WITH
NORMAL LOAD

Long Range Rescue & transport 3
40 or 32 litters
(2) Allison YT38-A-10
1,800 hp @ 14,300 rpm (each)
82 ft
77 ft 7 in
22,506 lb
11,071 lb
127 kt
122 kt
200 n. mi
19,100 ft

11

CH-21 SERIES

When the first YH-21, now designated CH-21, was delivered to the United States Air Force in 1953 it was immediately placed into rescue service in the Arctic without the benefit of any formal service evaluation of its performance. This "beefed up" version of the HRP-2, which had won the USAF competition for a long-range rescue helicopter, had to prove its reliability and ruggedness under the severest conditions as an operational aircraft.

Because of its excellent performance, its winterization features which permitted operation at temperatures as low as minus 65° F., and its capability of being routinely maintained under the same severe conditions, the CH-21A was given additional duties by the Air Force as a cargo and personnel transport in the most northern areas of Alaska, Canada, and Greenland, and in support of the DEW Line, CH-21B's were used as the prime support of the Texas Tower radar stations situated out in the Atlantic, off the coast of the United States.

The Royal Canadian Air Force employed CH-21 type helicopters in active support of the Mid-Canada





R.C.A.F. VERTOL 44A...1958

Radar Line before turning the job and the helicopters over to Spartan Air Service. The U.S. Army uses the CH-21C "Shawnee" as a tactical and logistical support vehicle.

The CH-21C and an export model designated the Vertol 43 have both received their baptism under fire, serving with distinction in combat with the French Army in Algeria and, more recently, achieved a notable combat record with U.S. Army Military Assistance Groups serving with Government forces fighting Communist Viet Cong guerrillas in the jungles, mountains, and rice paddies of South Vietnam. These helicopters have proven to be surprisingly invulnerable

to small arms ground fire, suffering as many as eight bullet hits in a single blade without causing the mission to be aborted.

An experimental model, powered with twin T53 turbine engines, was the forerunner of the turbine-powered transports. This was designated the Vertol 105. Another twin-turbine installation, using T58s, was developed and flown under a U.S. Navy contract. This helicopter was designated the CH-21D.

The Vertol 44 is an improved, FAA-certificated CH-21 type helicopter for military and commercial operations. Some of the prime differences between the 44 and the H-21C are:



H-21C and 44A in combat in Vietnam and Algeria



VERTOL 44B...1958

all-metal rotor blades, increased power, reduced drag, and a roll rate damper stability device which resulted in improved flying qualities.

The CH-21's have served as air rescue helicopters with the RCAF and USAF, as utility transports with the U.S. Army and German Army, on ASW and minesweeping operations with the Royal Swedish Navy and the French Navy.

The commercial version, the 44B, was operated by New York Airways, Sabena Belgian World Airlines, and Spartan Air Service, as well as in the petroleum and construction industry.

This outstanding series of helicopters has amassed a truly remarkable record of service and versatility since the first CH-21 was delivered to the USAF in 1953.



Designation—CH-21B (& C) Work Horse (& Shawnee)

MISSION
CREW
TROOPS
ENGINE MAKE
H.P.
ROTOR DIAMETER
FUSELAGE LENGTH
WEIGHT EMPTY
USEFUL LOAD
MAX. SPEED
CRUISING SPEED
RANGE
CEILING WITH
NORMAL LOAD

Transport & rescue 2 20 or 12 litters (1) Wright R-1820-103 1,425 44 ft 52.6 ft 9,148 lb 5,556 lb 109 kt 88 kt 350 n. mi 7,750 ft

Designation-44A (& 44B)

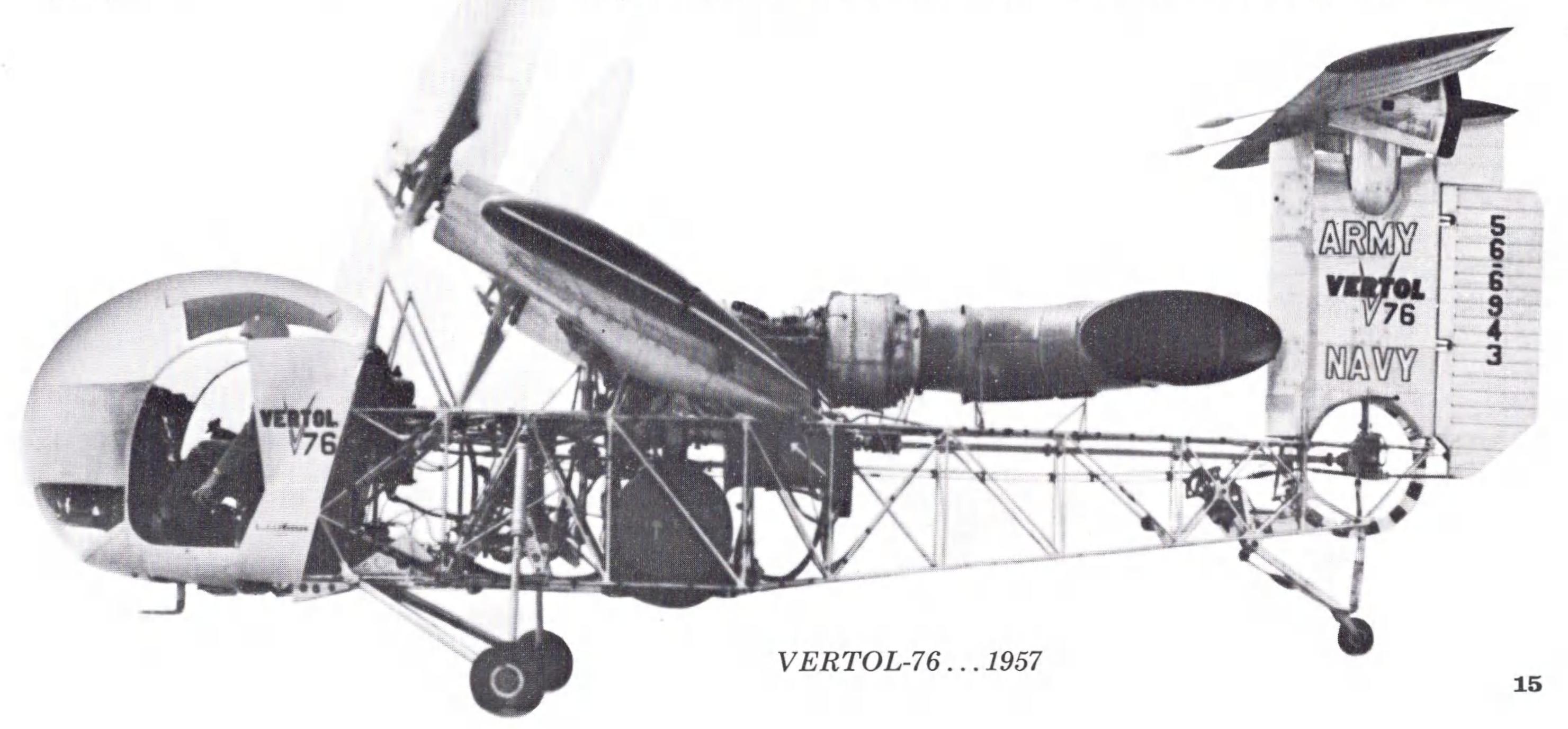
Utility (& airliner) MISSION CREW 19 (15) **PASSENGERS** (1) Wright Cyclone 977C9HD2 ENGINE MAKE 1,425 (takeoff) H.P. ROTOR DIAMETER 44 ft FUSELAGE LENGTH 52.6 ft WEIGHT EMPTY 8,990 lb (9,786 lb) 5,360 lb (4,564 lb) USEFUL LOAD 110 kt MAX. SPEED CRUISING SPEED 88 kt 250 n. mi RANGE CEILING WITH NORMAL LOAD 8,900 ft

VERTOL 76

This experimental aircraft, pioneered in 1957, was the first tilt-wing VTOL ever built. It was developed for the U. S. Army and the Office of Naval Research as the Vertol 76 (VZ-2), the first tilt-wing to go through conversion from vertical flight to horizontal and back again. The first successful complete conversion flight was July 15, 1958.

The entire wing and both rotorpropellers can be tilted to a vertical position, thus enabling the 76 to take off and land like a helicopter. The aircraft transitions from hover to forward flight as the wing and rotor-propellers are tilted forward to the horizontal position. The 76 then flies like a fixedwing aircraft. Consequently, it has unusual potential for close support under terrain conditions that would nullify the effectiveness of a less versatile aircraft.

The Vertol 76 successfully completed an extensive three-year flight test program and underwent flight tests of an advanced wing configuration. These and similar test programs led to a number of state-of-the-art breakthroughs in tilt-wing technology. In 1965, the Vertol 76 was retired to take its place in history with the other aviation firsts at the Smithsonian Institute Museum in Washington, D.C.



107 SERIES

The Boeing-Vertol 107 was the result of foresight, investigation, and research.

Early in 1956, Vertol initiated a program to determine the optimum configuration for a twin-turbine-powered transport helicopter to meet the world-wide requirements of the coming turbine-engine era of the 1960's. This program, which lasted eighteen months, resulted in the 107 prototype design which made its initial flight in April 1958. The aircraft was widely and successfully demonstrated in the United States, Canada, Europe, and Asia.

By 1958, when the prototype first flew, Vertol had developed a successful interchangeable steel-spar rotor blade which had reduced vibration significantly. Another important advancement introduced in the 107 design was a flight control system that had been simplified by the elimination of longitudinal cyclic pitch. Differential collective pitch, for which the control components were already included, was used to effect longitudinal control. As a result, vibration actually decreased at speeds from 100 to 140 knots.



Emphasis was placed upon the compactness of the 107 design to minimize the amount of space occupied by aircraft aboard ship, and to reduce the vulnerability and camouflage problems under combat conditions. Ease of maintenance and low maintenance cost were stressed throughout the design phase, and each design detail by part, component, and installation was reviewed with these goals in mind. Whenever warranted, a "packaging" concept was adopted for removing and replacing assemblies, thereby simplifying and speeding maintenance on the 107. As many parts as possible were made interchangeable, and the number of parts was reduced because of the unusual simplification of design, resulting in low-cost production.

Refinements to the basic design resulted in the YHC-1A, developed for the U.S. Army, and first flown in August 1959.

Flight evaluations in both the YHC-1A and the 107 prototype were carried out by seven foreign military agencies, in addition to the U.S. Air Force and the U.S. Navy which concurred in the opinion that this aircraft represented a marked advance in design development.

The fuselages of these twinturbine-powered helicopters (redesignated by Dept. of Defense as CH-46Cs) are sealed at the factory, giving them flotation capability—able to land and take off on water without special equipment. The landing-gear/fuel cell stubs are also sealed, providing the helicopter with good stability when afloat.

The Boeing-Vertol 107-II was certificated in early 1962 by the Federal Aviation Agency as a transport helicopter, and received approval for vertical-takeoff-and-landing operations and emergency water landings the same year.

The 107-II entered commercial airline service with New York Airways in 1962 in a 25-seat Airliner configuration, replacing the older Vertol Model 44's. Upon return of their last Vertol 44 to the Vertol Division, New York Airways became the first all turbine-powered helicopter airline.

In mid-1965, New York Airways received approval for rooftop landings on the Pan Am Building in Midtown Manhattan. Scheduled operations from the Pan Am roof were begun in December, 1965. As of April 14, 1966, New York Airways had car-



CH-46C...1959

ried a total of over 1,058,100 passengers, and had flown over 20,500 hours. On January 5, 1966, New York Airways carried a record number of 2,927 passengers in one day, and during January, 1966 set a helicopter airline record by carrying 44,026 passengers in one month.¹

Kawasaki Aircraft Company of Japan also ordered the 107-II for passenger and cargo service in Japan. Under a license agreement Kawasaki has delivered 107's to Kanki Airlines, Thailand Government, and the Japanese Army, and Navy.

¹Numbers of passengers include those carried by two Pan American Airways 107's operated by New York Airways.



Designation-CH-46A Sea Knight

13,000 ft

MISSION
CREW
TROOPS

ENGINE MAKE
H.P.
ROTOR DIAMETER
FUSELAGE LENGTH
WEIGHT EMPTY
USEFUL LOAD
MAX. SPEED
CRUISING SPEED
RANGE
CEILING WITH NORMAL LOAD

Assault & transport 3 25 troop seats or 15 litters and 2 attendants (2) T58-GE-8B 1,250 hp @ 19,500 rpm (each) 50 ft 44 ft 10 in 12,406 6,823 lb 138 kts 130 kt 200 n. mi.

The Airliner version not only provides a high degree of passenger comfort and safety, it also features a removable baggage bin which rolls out of the rear of the helicopter like a drawer, on overhead tracks. It can be replaced with a preloaded bin at terminal points, thus reducing baggage loading time to less than five minutes.

In 1961, the Royal Canadian

Air Force and Royal Swedish Navy and Air Force ordered 107-II's for their military forces. The Royal Canadian Air Force 107's were designated the CH-113 Labrador. Both Swedish versions were designed HKP-4.

The primary mission of the Royal Canadian Air Force CH-113 Labrador is search and rescue missions over land and water, and the transport

CH-46A SEA KNIGHT . . . 1961

of troops, supplies and support equipment to unprepared areas under all weather conditions, day or night.

The Royal Swedish Navy HKP-4 is primarily an antisubmarine hunt and kill aircraft, but is also suited to transport, and rescue missions. The Royal Swedish Air Force HKP-4's primary mission is search and rescue over land and water, and it is also suited to transport and medical evacuation missions.

Also in 1961, a special version of the 107-II won a U. S. Navy design competition for an assault transport helicopter for the United States Marine Corps, and production orders followed. This model is designated the CH-46A Sea Knight.

The primary mission of the Sea Knight is to rapidly deploy large numbers of combat-equipped Marines to remote areas. It has blade folding for aircraft carrier compatibility, de-icing, an auxiliary power unit, and an integral rapid cargo-handling system. A straight-in rear loading ramp facilitates loading and unloading.

The CH-46A is now fully operational with squadrons of the Fleet Marine Forces, Atlantic and Pacific Fleets, and is in service with the U. S. Marine Corps in Vietnam.

In September, 1965, the Defense Department notified the Vertol Division to accelerate the CH-46A Sea Knight production schedule by 100 percent over the previously planned production rate. The CH-46A is now in quantity production at the Vertol Division.

In February of 1963, the 107 was ordered by the Canadian Army. The first CH-113A Voyageur was accepted by the Canadian Army in November, 1964. The mission of the CH-113A is the transportation of troops, weapons, supplies and equipment in tactical and logistic operations.

The CH-113A Voyageur has undergone several highly successful exercises with the Canadian Army, including the "Keep Safe" exercise at Camp Gagetown, New Brunswick, Canada in mid-1965 and the NATO "Winter Express" exercise in Northern Norway in early 1966. It has also per-

RCAF CH-113 LABRADOR . . . 1961



ROYAL SWEDISH AIR FORCE HKP-4 . . . 1961



CANADIAN ARMY CH-113A VOYAGEUR . . . 1963



ROYAL SWEDISH NAVY HKP-4 . . . 1961









New York Airways...1962

PAN AM ... 1964

UH-46A SEA KNIGHT . . . 1964

Designation-107-II

MISSION
CREW
PASSENGERS
ENGINE MAKE
H.P.
ROTOR DIAMETER
FUSELAGE LENGTH
WEIGHT EMPTY
USEFUL LOAD
MAX. SPEED
CRUISING SPEED
RANGE
HOVER CEILING
IN GROUND-EFFECT

Airliner 3 25 (2) GE CT58-110 1,250 hp (each) 50 ft 44 ft 7 in 10,764 lb 8,236 lb 148 kt 135 kt 215 n. mi. 10,700 ft formed well in various exercises as a tactical vehicle. The "Keep Safe" exercise was a large-scale Canadian Army counter-insurgency maneuver to test tactics used by Canadian Forces in combating uprisings and guerrilla warfare. The "Winter Express" exercise was held within the Arctic Circle at temperatures as low as 45 degrees below zero Fahrenheit.

In January of 1964 Pan American Airways ordered two Boeing-Vertol 107 Airliners. These Airliners were delivered in 1965 and are now operated for Pan Am by New York Airways.

Also in January 1964, the U. S. Navy placed an order for versions of the CH-46A. The Navy version was designated the UH-46A and the first aircraft was delivered in June, 1964. The UH-46A's primary mission is the vertical replenishment of combatant ships while underway from combat support ships. The UH-46A is now operational with the Atlantic and Pacific Fleets, and is operating from fast combat supply ships in the South China Sea. The UH-46A is a major component of the U. S. Navy's Vert Rep Program.



CH-47A "CHINOOK" . . . 1961

In September, 1958, following a design competition, the joint U. S. Army/U. S. Air Force Source Selection Board recommended to the Army that Vertol be selected to design and develop a new medium transport helicopter called the Chinook as a replacement for its obsolescent piston-engine powered transport helicopters. By May, 1959, the model specifications were approved and a contract issued. Now designated the CH-47A, the Chinook immediately went into design and development testing, and the first flight took place in September, 1961.

The Chinook, a twin-turbine tandem-rotor transport, is proving to be an effective and efficient infantry assault platoon carrier—having transported, repeatedly, a complete infantry platoon consisting of 44 combat-equipped soldiers. The Chinook has lifted a useful load of over 10½ tons. The first production Chinooks were powered by twin Lycoming T55-L-5 gas turbine engines, each with a military rating of 2,200 horsepower. The more powerful T55-L-7 engine, with a rating of 2,650 horsepower, has superseded the L-5, thereby increasing significantly the lifting capability of the Chinook.

The Chinook is now in accelerated production for the U. S. Army. In 1965, in conjunction with deployment of the Chinook to Vietnam, the Defense Department ordered Chinook production doubled.

As of March 31, 1965, the Chinook had accumulated 50,000 flight hours; 14,000 of these hours flown in combat in Southeast Asia. The 90 Chinooks in Vietnam have flown approximately 40,000 combat sorties, and have retrieved over 100 downed aircraft.

The Chinook incorporates features which give it excellent instrument flight characteristics as well as flotation capability. A rear ramp permits rapid straight-in loading and unloading of troops, vehicles, and cargo. It is fitted with an external cargo hook, enabling it to carry objects too bulky to fit within its payload compartment. Seats are provided for 33 combat-equipped



troops, and a jump seat for either the crew chief or a troop commander. In combat operations, additional troops can be seated on the floor—as they were in Algerian operations and as they are being transported in South Vietnam. With seats folded against the compartment walls, there are provisions for 24 standard pole-type litters.

The Chinook can accommodate any helicopter mode component of the Pershing Missile Weapons Systems. Capable of carrying modern artillery and missile systems, the Chinook provides tactical mobility for the fire support required by air assault infantry units.

This versatile medium assault transport was designed with a minimum of maintenance requirements to be independent of elaborate ground support equipment in order to operate efficiently in forward combat areas with the troops. An installed APU permits ground operation of all utility and starting systems, thereby eliminating the need for external power sources, No special tools are required for maintenance at the operating level.

In late 1965, the first Armed/ Armored Chinook was officially rolled out and testing was begun. The Armed



/Armored Chinook uses its payload capability to advantage by mounting an extensive array of armament, as well as armor to protect the crew and vital parts of the aircraft against heavy caliber ground fire.

Mounted on the nose is an M-5 40mm Automatic Grenade Launcher. This turret-mounted weapon is controlled by the copilot, who is able to cover an extensive area on either side of the flight path. Complementing this nose turret, pylons on each side of the aircraft carry fixed forward-firing weapons including a 20mm gun and either a 19-round 2.75-inch rocket pod, or a 7.62mm high-rate-of-fire Gatling machine gun.

The flanks of the aircraft are protected by four gunners stationed two to either side of the cabin. Each



CH-47A ARMED/ARMORED "CHINOOK" . . . 1965



of these gunners is provided with either a 7.62mm or 50 caliber machine gun on flexible mounts. Another gunner is stationed aft with the same type weapon mounted on the rear loading ramp. From this vantage point, the gunner can protect the aircraft from ground fire after the aircraft has passed, a capability not present in previous armed helicopters. This aircraft carries a ton of expendable munitions.

The Armed/Armored Chinook is provided with a new type of steel armor plate which is built into the crew seats and protects their torsos. Other steel plates protect components of the aircraft. The rugged components of the Chinook and extensive dualization of systems, combined with over a ton of armor plate, assures a high degree of survivability for the aircraft.



MISSION
CREW
TROOPS
ENGINE MAKE
H.P.
ROTOR DIAMETER
FUSELAGE LENGTH
WEIGHT EMPTY
USEFUL LOAD
MAX. SPEED
CRUISING SPEED
RANGE
CEILING WITH
NORMAL LOAD

Troop and cargo transport
3
A combat-equipped platoon
(2) Lycoming T55-L-7
2,650 hp (each)
59.1 ft
51 ft
17,913 lb
18,000 lb
130 kt
130 kt
210 n. mi. (Normal)
14,500 ft





DISTRIBUTION

MODEL	USER DESIGNATION	CUSTOMER
PV-3	XHRP-X—Dog Ship	U.S. Navy
	XHRP-1	U.S. Navy
	HRP-1	U.S. Navy
PV-14	XHJP-1	U.S. Navy
PV-15	YH-16 Transporter	U.S. Air Force
PV-15	YH-16A Turbo-transporter	U.S. Air Force
PV-17	HRP-2	U.S. Marines
PV-18	HUP-1 Retriever	U.S. Navy
	UH-25B (HUP-2) Retriever	U.S. Navy; French Navy
	UH-25A (H-25A) Army Mule	U.S. Army
	UH-25C (HUP-3)	Royal Canadian Navy
PD-22	YH-21 Work Horse	U.S. Air Force
42	CH-21A (H-21A) Work Horse	U.S. Air Force; Royal Canadian Air Force
42	CH-21B (H-21B) Work Horse	U.S. Air Force; Royal Canadian Air Force
43	CH-21C (H-21C) Shawnee	U.S. Army
63	HUP-4	U.S. Navy
71	H-21D	U.S. Army
76	VZ-T (Tilt-Wing)	U.S. Army-Navy
107	Y/CH-46C(YHC-1A)	U.S. Army
107 M	CH-46A (HRB-1) Sea Knight	U.S. Marines
	UH-46A Sea Knight	U.S. Navy
114	Y/CH-47A(YHC-1B) Chinook	U.S. Army
	CH-47A (HC-1B) Chinook	U.S. Army
	CH-47A Armed/Armored Chinook	U.S. Army

DISTRIBUTION

MODEL	USER DESIGNATION	CUSTOMER
42A	Vertol 42	Royal Canadian Air Force; Rick Helicopter
43	Vertol 43	German Air Force German Army
44A	Boeing-Vertol 44A	French Army U.S. Air Force Royal Canadian Air Force
		Royal Swedish Navy Royal Swedish Air Force
44B	Boeing-Vertol 44B	New York Airways, Atlas, Russia
		German Army Royal Swedish Navy
44C	Boeing-Vertol 44C	Russia
107-II	Boeing-Vertol 107	New York Airways
107-II	CH-113	Royal Canadian Air Force
107-II	HKP-4	Royal Swedish Air Force
107-II	HKP-4	Royal Swedish Navy
107-II	Kawasaki-Vertol 107	Kawasaki
107-II	CH-113A	Canadian Army
107-II	Boeing-Vertol 107	Pan American Airways

SUMMARY

During nearly two decades of continuous design and production of VTOL aircraft, the Division has established itself on the forefront of the industry as a manufacturer of transport helicopters. Vertol Division helicopters have logged over a million and a half flight hours. A notable list of VTOL firsts has been compiled by the Vertol Division since its inception in 1943 by a group of young engineers.

This group designed and built the world's first successful tandemrotor helicopter, the XHRP-X, for the U.S. Navy, and has since exploited to the fullest the inherent advantages of the tandem configuration. The Division successfully demonstrated the towing capability of tandem-rotor VTOL aircraft, the indiscriminate inflight loading afforded by its large allowable center-of-gravity range.

Vertol designed the first successful helicopter autopilot installation, established helicopter world records for speed and altitude, designed and first successfully demonstrated minesweeping by helicopters, successfully demonstrated the first automatic altitude control on a helicopter, and built and successfully flight tested the first tilt-wing VTOL. Vertol also developed the Stability Augmentation System (SAS) which provides a helicop-

ter with flying qualities approaching those of fixed-wing aircraft.

This is but a partial list of technical accomplishments resulting from a continuous and extensive research and development program.

Vertol Division, as a pioneer in the field of vertical flight, with access to the vast resources of the Boeing Company, has become a fully integrated aircraft manufacturing facility, with the experience, technical knowledge, managerial and engineering talent required to meet the problems and challenges in the broad field of VTOL/STOL mechanical and aeronautical technology.

