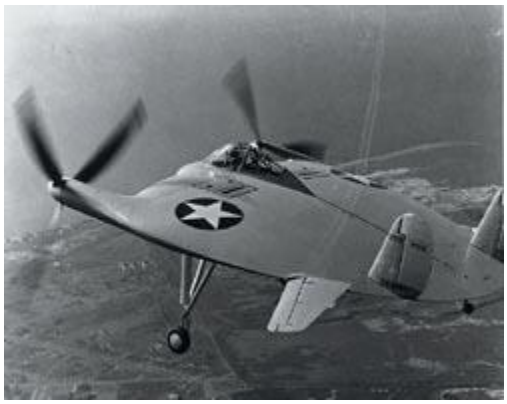
Model Number : V-173
Model Name : Flying Pancake
Model Type: Proof of Concept, Fighter

Charles H. Zimmerman promoted his “Flying Pancake” design from 1933 to 1937 while working for the

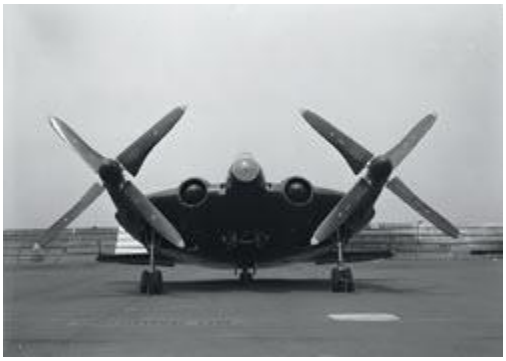


National Advisory Committee for Aeronautics (NACA) at Langley Field, Virginia. He filed for a design patent on April 30, 1935 and was granted patent #2,108,093 on February 14, 1938. With the concurrence of NACA, Zimmerman approached United Aircraft Corporation with his novel design in 1937 and joined United’s Chance Vought Aircraft Division in that year as project engineer. By August 15, 1939, drafting, engineering design, and aerodynamic studies were far enough along for Vought to submit a proposal to the U.S. Navy for a full-scale prototype of the V-173. The U.S. Navy placed a contract for one V-173 on May 4, 1940. First flight of the airplane was on November 23, 1942. Success!!

Dimensions	
Wingspan	23.33 ft
Overall Langth	26.66 ft
Height	12.92 ft
Weights and Capacities	
Empty Weight	2258 lb
Gross Weight	3050 lb
Useful Load	
Fuel Capacity	
Oil Capacity	
Powerplant Characteristics	
Type: Two Continental A-80 engines.	
Rating	80 hp
Displacement	
Weight	
Size (length X diameter)	
Performance	
Maximum Speed, Sea Level	138 mph

Landing Speed, Sea Leavel	22 mph
Stall Speed, Sea Level	
Initial Rate-of-Climb	714 ft/min
Cruise Speed, Sea Level	
Range at Cruise Speed	
Service Ceiling	
Absolute Ceiling	
Crew: 1	
Armament:	

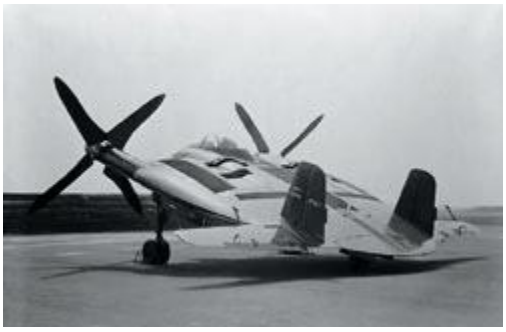
Model Number : XF5U-1
Model Name : Flying Pancake
Model Type: V/STOL Fighter



Front view. The propeller blades were black from the root with white stenciling, then varnished mahogany with yellow tips. The right propeller had Hamilton Standard oval decals and both propellers had small white "tracking" diamonds on them.

The letter of intent for the Vought VS-315 (XF5U-1) was issued September 17, 1942. The XF5U-1 was a twin-engine, single-seat, low aspect ratio flying wing type of airplane, manufactured by the Chance Vought Division, United Aircraft Corporation, Stratford, Connecticut.

The first XF5U-1 airplane (Bureau Number 33958) was used for static tests; proof loads, extended to ultimate, largely confirmed structural design predictions. The second XF5U-1 airplane (Bureau Number 33959) was used for experimental flight test and concept validation. It was never flown because many hours of engine run-up showed excessive mechanical vibration between the engine-propeller shafting, gear boxes, and airframe structure. The airplane was taxi tested on February 3, 1947 at Stratford, Connecticut, but, again, vibration levels were considered excessive. The airplane was being readied for shipment by sea through the Panama Canal to Edwards AFB, California, when the contract was canceled (March 17, 1947) because of still unsolved technical problems and the lack of Navy R&D money.



The jet age had arrived, but V/STOL had not.

Dimensions	
Wingspan	32.50 ft
Overall Langth	28.62 ft
Height	16.96 ft
Aspect ratio of basic wing	1.275
Wing airfoil section (NACA)	0016
Wing aera less ailavators (48) sq ft	427
Weights and Capacities	
Empty Weight	13107 lb
Gross Weight	* 16758 lb
Useful Load	
Fuel Capacity	261 gal
Oil Capacity	
Powerplant Characteristics	
Type: Two Pratt & Whitney R-2800-7	
Rating	1350 hp
Displacement	
Weight	
Size (length X diameter)	
Performance	
Maximum Speed, Sea Level	** 425 mph
Landing Speed, Sea Leavel	490 mph
Stall Speed, Sea Level	
Initial Rate-of-Climb	*** 3000 ft/min
Cruise Speed, Sea Level	
Range at Cruise Speed	**** 1152 miles
Service Ceiling	
Absolute Ceiling	30700 ft
Crew: 1	
Armament: Provisions for six 50-caliber Browning Machine Guns	

NOTES:

* Empty weight plus 261-gallons internal fuel, pilot, ammo,two

150-gallon drop tanks. Overload gross weight equals 18,931 pounds with two 1,000-pound bombs.

** Max speed, 425 mph at sea level (501 mph with advanced engine)

*** Rate of Climb

fpm	at mph EAS	at alt, ft
3,000	175	Sea Level
2,500	175	10,000
1,000	165	20,000

**** Max range, 597 statute miles at 10,000 ft altitude with 261 gallons of internal fuel (less 50 gallons for warm-up, take-off and climb) with high blower, 1700 engine rpm, 31 inches Hg M.P., auto lean mixture, 280 mph TAS, prop gear ratio 0.1763:1. With two 150-gallon drop tanks, max range, 1,152 statute miles.

V-173 Flying Pancake - Advanced Design Concept

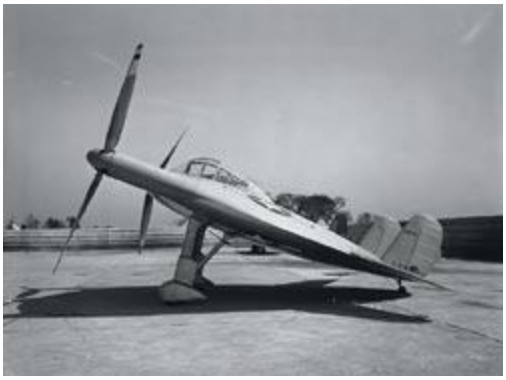
To best appreciate the very-advanced V-173 design concept, one must go back to 1930 when Charles Zimmerman graduated from the University of Kansas with a degree in electrical engineering and an introductory course in aerodynamics that helped him secure a job with NACA. Initially, Zimmerman made a name for himself by designing a free-spinning wind tunnel and then a free-flight wind tunnel.

What made airplanes fly was the stuff that young NACA engineers lived and breathed. This fascination led Zimmerman to design the V-173 as a flying wing, to minimize wetted area and parasite drag, and to put the propellers at the wing tips, rotating so as to oppose induced drag. It was known that a finite aspect ratio wing had a bound lifting vortex along the quarter chord line which, when viewed from the rear, rotates clockwise at the port (left) wing tip, and counterclockwise at the starboard (right) wing tip, causing downwash aft and rotates the lift vector back to cause induced drag such that:

CDi = CL2/pe Aspect Ratio

Where “e” is the airplane efficiency factor determined by wind tunnel test.

Zimmerman knew that a right-hand propeller generates a strong right rotational component to the slipstream. Hence, a right-hand propeller on the starboard wing tip and a left-hand propeller on the port wing tip should reduce induced drag. The theory of wing lift and induced drag, together with experimental data available for propeller slipstream rotation lead to:



CDi = CL2/pe (1-FOO) Aspect Ratio

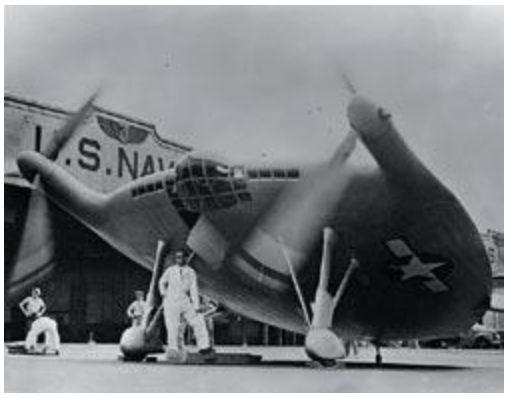
That's right, it was called "FOO Factor" or FQ , and had theoretical values from 0 to 1 or more, depending on shaft horsepower. With power off, FOO=0 and induced drag was proportional to lift coefficient squared and inversely proportional to wing aspect ratio. In a high-powered climb, FOO could be greater than one and induced drag became induced thrust. This was true not only theoretically, but actually, as shown by powered tests of a 1/3-scale V-173 model in the Langley full-scale wind tunnel (December 1941). Numerous free-flight (rubber-band and electricpowered) and captive wind tunnel tests were conducted between 1933 and 1943. These tests showed that:

1. Symmetrical trailing edge flaps provided insufficient roll and pitch control. Therefore, "ailevators" were added to the basic design. (Ailevator was coined from aileron plus elevator and the spelling was later changed to ailavator.)
2. Propeller cross-shafting was required for safety of flight with one or both engines out.

Twin fins and rudders were always part of the design for directional stability and control.

V-173 Flying Pancake - The Aircraft

The basic wing area (427 sq ft.) and planform (less ailevators and propeller nacelles) of the V-173 and XF5U-1 were identical. The airfoil was the NACA 0015 section on the V-173 and the NACA 0018 section on the XF5U-1. Two Continental A-80 engines, rated at 80-horsepower each, turned two 16.5-foot three-bladed propellers on the V-173. The aircraft had long fixed main landing gear and a 22-degree nose-high static ground angle. Wheel fairings were added after the first flight. The pilot cockpit enclosure had a windowed leading edge ahead of the pilot for down vision, and four segmented leading edge inlets (left and right) for engine air.



For light weight, the airframe structure was made of wood with fabric covering. With a wing loading of only 5 lbs/sq ft, the V-173 could lift off in 200 feet in a calm, and with a zero run against a 25-knot headwind. However, with a power loading of 14-lbs/hp maximum, level flight speed was only 138 mph.

The pilot could enter or egress from the cockpit through a hatch in the cockpit floor or through a sliding canopy.

The first flight was of only 13 minutes duration because of very heavy longitudinal stick forces, and having only 20 gallons of fuel aboard. The stick forces were subsequently lightened by adding the trailing-edge stability flaps and ailevator trim tabs. The airplane accumulated 131 hours in several hundred flights, many of which were flown to exhibit the outstanding STOL characteristics. Vought's Chief experimental pilot, Boone T. Guyton, made 54 flights.

Guyton summed up his observations as:

- *I was able to apply full power, raise the nose as high as it could be held, and have control about all three axes without stalling.*
- *The aircraft could not be completely stalled or even approach a spin condition.*
- *A notable characteristic was high deceleration in a tight turn due to the aspect ratio (drag due to lift), and low power loading.*
- *Engine- and propeller- related vibration showed the need for articulated (i.e., flapping) propellers.*

Today, with its vertical tails and ailevators removed, the V-173 is in storage at the Smithsonian Institution's Air Museum warehouse in Silver Hill, Maryland