YESTERDAY'S WINGS

The Boeing Monomail

by PETER M. BOWERS / AOPA 54408

THROUGHOUT aviation history there have been many examples of new airplane designs that failed to live up to their potential because the airplanes got ahead of the available powerplants. In many cases, an airplane would be designed to use a promising new powerplant that was then on the drawing board or even in the development stage. All too often, the engine was delayed for various reasons and the new airplane had to fly with a lower-powered, or otherwise unsatisfactory, substitute engine.

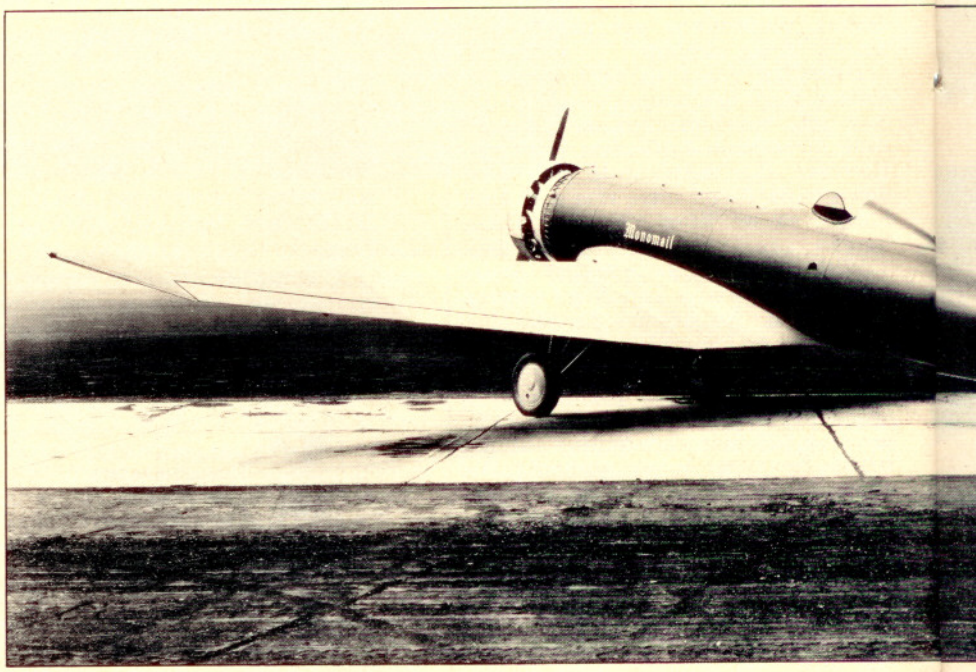
What at first appears to be an example of the airplane getting ahead of the engine can be found in the Boeing Monomail of 1930. However, this was not really the case. The powerplant was the Pratt & Whitney Hornet, a well-proven air-cooled radial with extensive military and civil operation dating from 1927.

Taken by itself, the Model 200, which the builder named Monomail for being a single-wing mailplane at a time when traditional biplanes dominated the airmail routes, was a truly revolutionary airplane. In spite of the heavy influence it exerted on subsequent designs, the Monomail is virtually forgotten today because of the greater fame of its descendants and the fact that the design itself was not a commercial success and did not establish a reputation on the mail routes.

No single feature of the design was new—the revolution came about by putting several different preexisting features together in one airplane for the first time.

From a distance, the most notable feature of the Monomail was that it was a clean low-wing monoplane at a time when most commercial single-engine monoplanes were high-wings with strut bracing. Cantilever wings themselves were not new, going back to World War I and being conspicuous on the contemporary Fokker and Ford trimotor transports and the famous wooden Lockheeds.

The reason for the wing being in the low position was most significant—it was down there so that it could support and house a retractable landing gear. This tripod assembly rotated backward about the front spar and into a wheel well just ahead of the rear spar. Since the wing at this point was not thick enough to house the full diameter of the wheel vertically, the lower half of

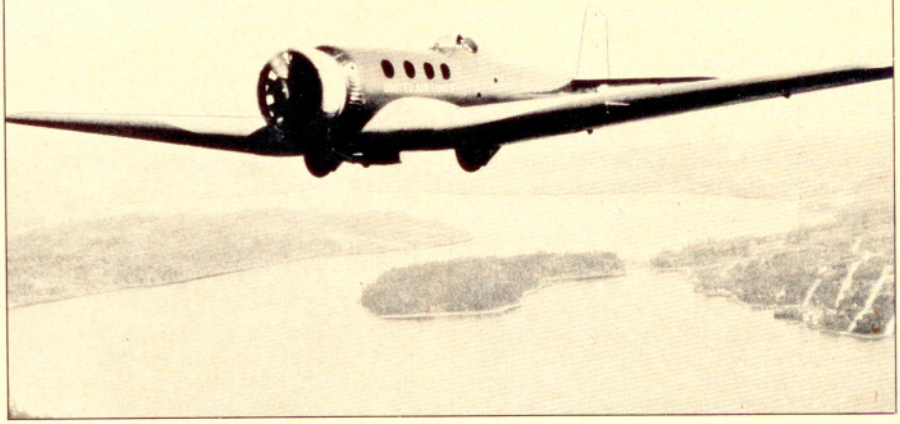


BOEING 200/221

Specifications		Performance	
Powerplant	Pratt & Whitney Hornet B 575 hp @ 1,950 rpm	High speed	158 mph **
		Cruise speed (60% power)	135 mph
Span	59 ft 1½ in	Landing speed	56 mph
Length	41 ft 2½ in *	Initial climb	850 fpm
Area	535 sq ft	Service ceiling	14,000 ft
Empty weight	4,758 lb	Range	530 sm
Gross weight	8,000 lb		

* stretched 27 in for Model 221A

** compromise fixed-pitch propeller



Flight view of the Model 200 shows the incompletely retracted wheels and the streamlined fairings behind them. Boeing retouched this photo, adding windows to show what the unfinished passenger-carrying model, the 221, would look like.

The first Boeing Monomail, Model 200. Note the three separate mail compartments ahead of the cockpit, the transition from a circular fuselage cross section forward to a vertical knife edge aft, and the large fillet between the wing and the fuselage.

the wheel projected into the slipstream. While this arrangement did not realize the full drag-reducing potential of the retractable gear, it was still a big step forward, since no other designs were using anything like it at the time.

Retractables had been around since before World War I, but were used mostly on amphibians with no consideration of drag reduction. The airplanes of the time weren't fast enough to benefit significantly from such a feature; the handicap of the added weight and machinery outweighed the benefits until speeds approached 150 mph.

The low cantilever wing and retractable gear of the Monomail resulted in a very clean airplane, which was further enhanced by two other innovative features. One was a ring cowling around the radial engine, which was actually the newest feature of all while also being an oldie. The apparent contradiction comes from different applications at different times.

Back in World War I, many air-

planes were powered with rotary engines, which threw off great quantities of unburned castor oil. On pushers, with the engine behind the crew, this was no problem. With the engine up front, such devices had to be shielded. As the speed of the planes increased, these shields, or cowlings, took on a more streamlined form to reduce airplane drag. When the rotary engine went out of production after the Armistice, the cowling disappeared with it. The static radial engines that replaced the rotaries operated entirely in the open to get maximum exposure to the cooling airstream.

As radial engines became more powerful, their high drag became a serious handicap to high-performance aircraft. The National Advisory Committee for Aeronautics (NACA, now NASA, for National Air and Space Administration) went to work on the problem and developed a new cowling that at first glance looked like the old rotary cowling of 1918. However, it did much more than contain oil spray and streamline the nose of the airplane. It did smooth out the flow of air past the engine, which was a significant drag reduction in itself, but it also accomplished the seemingly bootstrap operation of adding thrust.

By careful contouring, the NACA cowling acted in effect as a small wing bent into a circle, a wing that had a significant forward vector of thrust. This was borne out when designers, expecting a rearward load to be applied against the cowling, found the cowling actually pulling forward against the attach fittings and hitting the propeller. The performance gains possible with the new cowling were demonstrated very spectacularly at the 1929 National Air Races and designers hastened to adapt it to existing radial-engine models and to design it into new ones. Many designs merely cut the forward portion of the full NACA cowling back to form a ring—and this was widely used as the "Townend Ring;" the Monomail used Boeing's own version of the latter.

The final "new" feature of the Monomail was its structure—all-metal semi-monocoque, with smooth skin in place of the traditional corrugations, and flush riveting. The wing had the two bolted, square, aluminum tube spars used on some previous Boeing designs, but the torsional stiffness was provided by the metal skin, which substituted for the fabric used previously. The fuselage had longerons to take the major bending loads but the torsion

The speed range of the Monomail (right) was seriously hampered by the need to use a fixed-pitch propeller. Here the Model 200 is tested with a special geared Hornet engine that drives a more efficient slow-turning, three-blade propeller. The Model 221 (below) was completed with a six-passenger cabin in place of the two forward mail compartments. Later, it was stretched 27 inches to add a seventh passenger seat and the original Model 200 was reworked to become a duplicate Model 221A. Note that the wheel fairings have been removed.

was again taken by the smooth metal skin. The fuselage cross section was an oval, which further improved the streamlining but required an elaborate fillet between the fuselage and the wing.

For all its advanced features, however, the Monomail retained one real anachronism—the open cockpit behind the wing for the pilot. Established airmail pilots had a say in the design of the new ship and insisted on this particular detail. In further keeping with old design concepts, the wing loading of the Monomail was light enough to avoid the need for wing flaps.

The Model 200 Monomail was a single-seater with three separate mail and express compartments totaling 220 cubic feet. It was awarded Approved Type Certificate A-330 on June 24, 1930. A sister ship, the Model 221, which differed only in having a six-passenger cabin in place of two of the mail compartments, received ATC-366 on September 16, 1930. After brief use on Boeing Air Transport routes, the Model 221 was stretched 27 inches to increase the passenger capacity to seven as the Model 221A, and the Model 200 was converted to a duplicate 221A.

Since the two Monomails were a ton heavier than the Boeing Model 40B-4 biplanes, had double the passenger and mail capacity and were over 20 mph faster with the same engine, why didn't they enjoy commercial success commensurate with their advanced configurations?

It wasn't a case of the airplane being ahead of the engine this time, but a case of being unable to take full advantage of what should have been a fully compatible powerplant at both ends of the performance scale. The Monomails needed something that was not available at the time—a good controllable-pitch propeller. The ground-adjustable models of the period could be set for the most effective takeoff and climb performance, but the high-speed performance then suffered. If the blades were set for efficient cruising, the takeoff suffered, particularly at places like 6,000-foot-high Cheyenne on the San Francisco-Chicago route.

Boeing had the same trouble with its 247 twin-engine model of 1933 until Hamilton-Standard perfected a controllable-pitch model, which went into service on the improved 247D model of late 1934. The Monomails eventually got controllable propellers, but by that time other designers had caught up with and improved on the revolutionary Boeing, so there was no point in perpetuating the 1930 model.

The Monomails left their mark, however, by contributing their aerodynamic and structural features to the Boeing B-9 that revolutionized the Army bomber business and the 247 transport that itself inspired and was quickly surpassed by the Douglas DC-1, -2 and -3 models. □