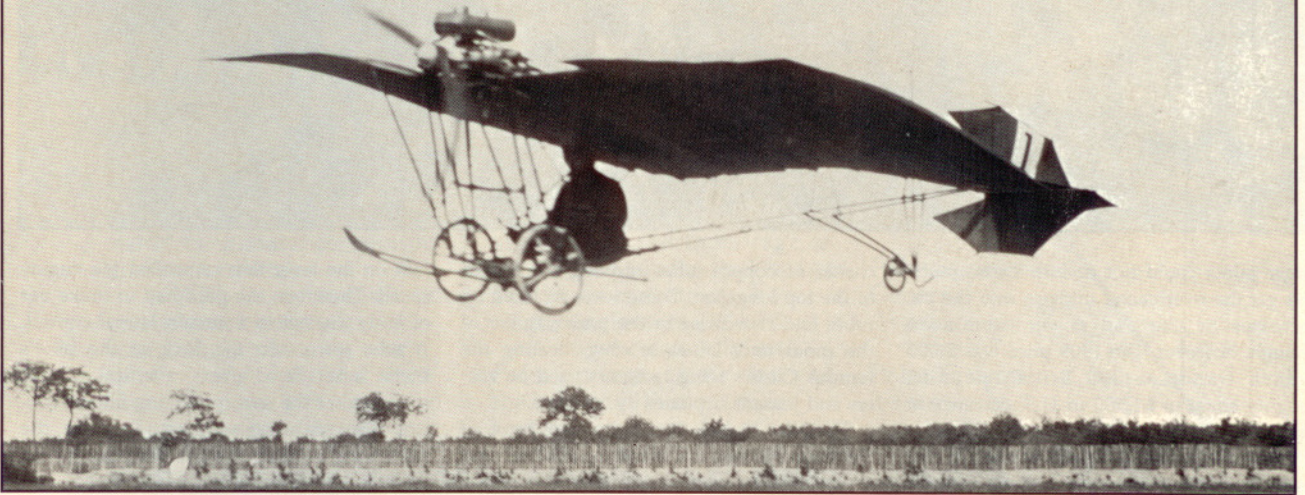


# Heritage of the Demoiselle



*What Santos-Dumont started with his Infuriated Grasshopper has yet to end.*

BY PETER M. BOWERS

The current boom in ultralight aviation has produced several aircraft designs that bear a remarkable resemblance to the world's earliest production lightplane—the Santos-Dumont Demoiselle of 1909 to 1913.

The design actually originated in 1907 as Alberto Santos-Dumont's Model 19. His earlier efforts, through Number 14, were small, one-man dirigibles, which brought him world-wide fame for his flights in and near Paris between 1899 and 1906. His 14bis was an airplane, so numbered because its first trip into the air was made while suspended from his Number 14 dirigible. On November 12, 1906, this large and ungainly boxkite achieved further fame for Santos-Dumont, the little expatriate Brazilian, by becoming the first airplane to fly in Europe.

Number 19 pioneered a daring new concept—a simple, lightweight and low-cost single-seater designed strictly for fun flying. It also introduced a new configuration, which soon was to become the world standard—a tractor with the engine at the front of the structure driving the propeller directly, two main wheels forward of the center of gravity and a smaller wheel or skid aft. That it also was a monoplane was a further innovation in the opening years of the boxkite pusher era. Another unique feature of the aircraft, which was not adopted by the industry, was the empennage, or tail assembly. This was cruciform shaped, a single unit combining rudder and elevator

pivoted at the end of a wire-braced bamboo tail boom. The whole assembly moved at once; up and down for elevator and side-to-side for rudder action.

Unfortunately, Number 19, with a two-cylinder, 18-hp, water-cooled Dutheil-Chalmers engine, was overweight and underpowered. It managed to make only three straight-ahead hops, with distances of 623 feet, 656 feet and 492 feet, respectively, in November 1907. So, Santos-Dumont went back to the drawing board for a redesign.

The 19bis (for second version of the Number 19) was a great improvement struc-

turally. The same cruciform tail now was supported by three bamboo booms, which formed a true fuselage and became a basic feature of the design. The quest for more power resulted in the use of a 24-hp, water-cooled engine, which made the 19bis so overweight that it could not fly, either.

Santos-Dumont's first successful monoplane and the first to carry the name Demoiselle (French for both dragonfly and young lady; the former applying to the airplane) was the Model 20, which flew on March 6, 1909. It had a wingspan of 18 feet, a wing area of 107 square feet and a gross weight of 538 pounds. The powerplant was a 20-hp, water-cooled Dutheil-Chalmers. Those numbers would seem to put the Demoiselle in line with some of today's ultralights; however, with the exception of their basic configurations, with the pilot in the open under the high wing and the tractor engine just ahead of the wing leading edge, the two have little in common.

The little Demoiselle caught on. Santos-Dumont, wealthy from his Brazilian coffee plantations, had no desire to make money from his inventions. He allowed others to use his designs freely and encouraged the Clement-Bayard Motor Company to manufacture and market the Demoiselle. This was done, and the little monoplane, called The Infuriated Grasshopper by Swiss exhibition pilot Edmond Audmars, soon became world-famous through its air-show performances. Its size was a major drawback to its wide use, however; the originals had been built for Santos-Dumont's small frame, so



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larger pilots could not fit into them, much less get the overloaded midgets into the air. Increases in size and power came soon enough, however. The 1909 price was 5,000 French francs or 300 British pounds, roughly equal to \$1,500 in U.S. currency at the time.

Some design details of the Model 20 and early derivatives are notable. The radiator for the water-cooled engine originally was a

cluster of copper tubes running the length of the top longeron. These were replaced by tubes laid chordwise in the undercamber of the inner ends of each wing, beating the famous Curtiss wing radiators used on racers and pursuit airplanes by 13 years.

The pilot had his hands and feet busy all the time: He had one hand on a wheel that controlled the rudder and the other on a wheel that controlled the elevator plus one

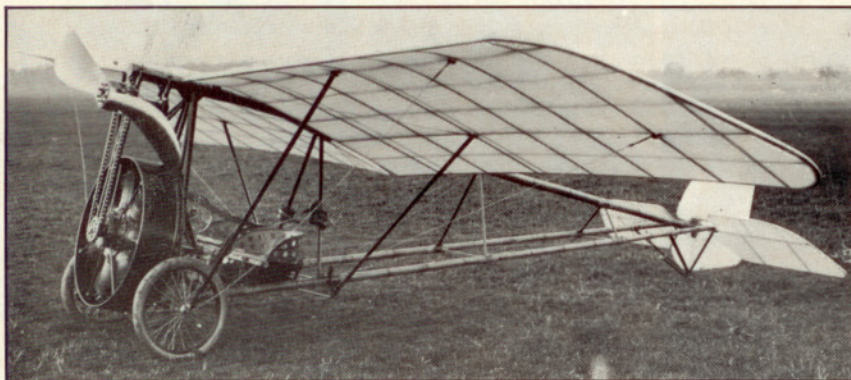
foot on the lever that controlled the engine speed. Therefore, the pilot had to make use of body English to maintain lateral control. A tube sewn into the back of the pilot's flight jacket fitted over a vertical control stick behind the seat, providing lateral control through wing-warping. To raise the right wing or lower the left, the pilot leaned to the left. This warping was not equal, with one wing being warped upward and the other down. Only the trailing edge of the wing on the outside of the turn was pulled down. Plenty of rudder displacement was necessary to overcome the terrific adverse yaw generated by the outside wing.

The Demoiselle had brakes—of sorts—long before other aircraft adopted them. The pilot wore heavy wire-reinforced gloves and simply grasped one or both of the front wheels when he wanted to slow down or keep from rolling. Some of today's ultralights have mechanical brakes; in others, the pilots either use Santos-Dumont's technique or put their feet on the ground.

Other designs adopted the general configuration of the Demoiselle and of course improved on it in succeeding years. Some remained in production right up to the outbreak of World War I in 1914. The first German-built airplane to fly, the 1910 Grade, owed much to the Demoiselle.

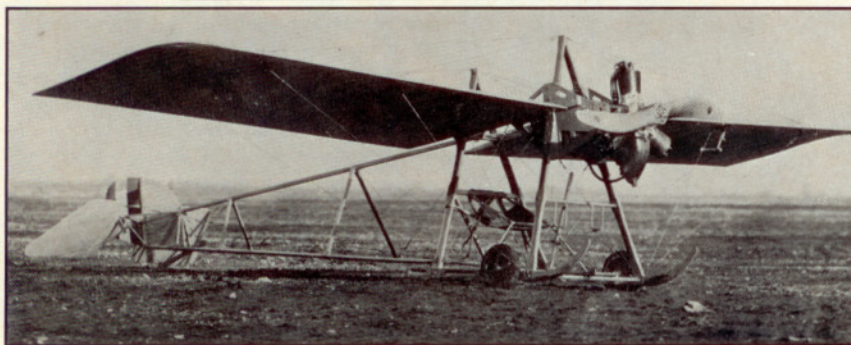
The war did not end the Demoiselle concept as it did some other prewar oddities. The basic configuration reappeared almost intact in late 1918 when the U.S. Naval Aircraft Factory built two small, lightweight scout airplanes that could take off from platforms built over the forward turret guns of battleships. Powered with a 55-hp Lawrence air-cooled radial engine, this Demoiselle derivative had the official Navy designation of SA-1 for ship's aircraft. For structural simplicity, the naval design even reverted to wing-warping for lateral control but with the improvement of equal up and down displacement and up-to-date manual stick controls and rudder pedals.

The Demoiselle configuration then disappeared for a while, but the basic fuselage,

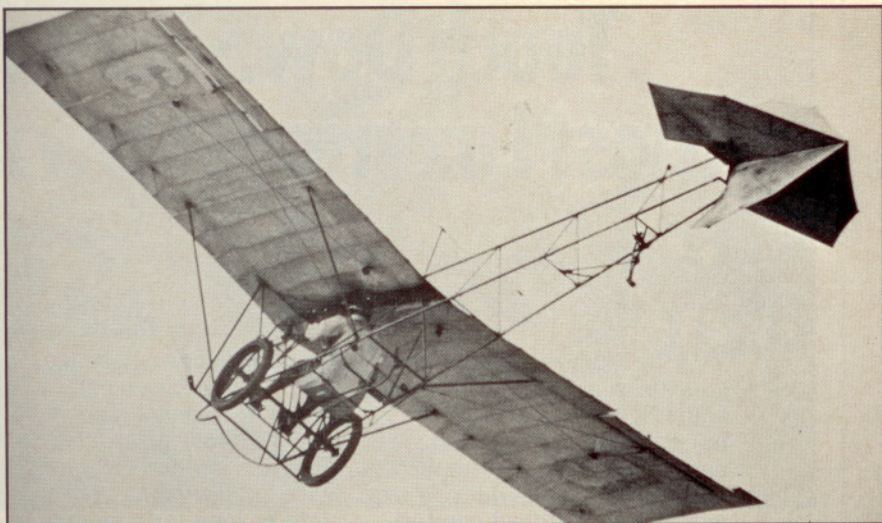


*On this 1913 version of the Demoiselle, a 50-hp Gnome engine is mounted low, and it drives the aircraft's high-mounted propeller through a chain. Although this Demoiselle's tail surfaces are more modern, it retains bamboo longerons. Its wings are braced with struts and wires from beneath as on earlier versions.*

#### YESTERDAYS • WINGS



*The U.S. Naval Aircraft Factory built two SA-1s (ship's aircraft) in 1918, using the Demoiselle configuration. The lightweight scout aircraft could take off from a battleship's gun turrets. The SA-1 had a fixed vertical fin but no horizontal stabilizer.*



The British movie *Those Magnificent Men in Their Flying Machines* revived interest in the Demoiselle by featuring a full-scale replica (above, top). Soon, designers in the homebuilt movement had developed their own Demoiselle derivatives. Earl Adkisson's Flying Barn Door (above, bottom) was the first. It had a modern thick-section airfoil and a 65-hp Continental engine, but it retained the Demoiselle's cruciform tail.

#### YESTERDAYS • WINGS

Another Demoiselle derivative, Ken Flaglor's Scooter (below), originally was powered with an 18-hp Cushman golf-cart engine, but soon switched to a 30-hp VW engine. Several Scooters have been built from Flaglor's plans.



with fabric covering, up-to-date tail surfaces and the engine lowered into a structure ahead of the pilot, reappeared in the 28-hp Roché-designed homebuilt of 1925. This was redesigned to use a steel-tube fuselage and went into production in 1929 as the Aeronca C-2.

The renaissance of the Demoiselle came soon after the design received publicity with the release of the movie *Those Magnificent Men and their Flying Machines* in 1965. This film wrote a chapter of aviation history by itself. Full-scale flying replicas of five distinctly different 1910 airplanes (aeroplanes then) were built, with backup duplicates for each. The story was about a fictional 1910 air race from London to Paris, and a Demoiselle was one of the replicas.

The replica Demoiselle originally was built to true 1910 dimensions, with steel tubing instead of bamboo for the fuselage. Also, the wing-warping was replaced by many more bracing wires both below and above the wing and small ailerons. The powerplant was a 30-hp Volkswagen automobile engine of the type then becoming popular for smaller airplanes in the homebuilt movement. Unfortunately, all the improvements and the heavy engine made the replica too heavy to fly. It was sent back to the shop for new wings with two feet more span and a more efficient airfoil. Also, a more powerful VW engine was fitted.

The most significant improvement, however, was a change of pilots (not that the first two were not sufficiently skillful). The final pilot was a young lady who weighed 110 pounds. Even with her lesser weight, the revamped replica would barely fly, so it went back to the shop again for still more wingspan and a 50-hp VW engine.

These shortcomings do not detract from the capabilities of the designers and builders of the replicas—the other replicas built for the movie had pretty much the same problems as the Demoiselle. And their greater sizes and flexible structures caused even more problems. The 1910 originals were highly successful in their day if they could merely get off the ground in perfect weather for a trip around the field or a short hop to another a few miles away. The movie airplanes had to be able to stay up longer, maneuver with other aircraft, hold position for the camera in turbulence that would have kept the originals on the ground, plus meet modern safety criteria unheard of in the originals' day.

Since the Demoiselle was by far the cutest airplane in the movie and of an economical size, it had an impact on designers in the homebuilt movement; a number of modernized Demoiselle derivatives soon appeared. Most of these derivatives were developed for the enjoyment of their particular builders, and only one model was made. But the plans for one, Ken Flaglor's all-wood VW-powered Scooter, were put on the market, and several have been built by others. The

Scooter initially was powered by an 18-hp Cushman golf-cart engine but quickly switched to a 30-hp VW for improved performance.

The birth of the current ultralight movement came in the early 1970s, when small, two-stroke-cycle engines were adapted to existing hang gliders to permit flat-land launching and a short hop to the soaring site. Since these worked, other designs quickly were developed to fly entirely independently of the slope-soaring sites. Several of these adopted the basic Demoiselle configuration of pilot beneath the wing, engine at the wing leading edge and a conventional tail, supported by three longerons that are now aluminum tubing instead of bamboo.

There are several reasons for the success of the modern Demoiselle derivatives. One, of course, is the lightweight, glider-inspired, aluminum-tube structure covered with undoped ripstop sailcloth. The other is the availability of a variety of two-cycle engines in the 10- to 40-hp range adapted from chain saws, go-carts, lawnmowers and snowmobiles. In years past, similar engines in the 20-hp range had been taken from military radio-controlled anti-aircraft target

aircraft and fitted to established gliders and sailplanes as auxiliary launching devices—but with little success. The overall size and weight of the gliders, no matter how slick, was too much for the small, direct-drive propeller turning at a very inefficient high speed. The early hang-glider conversions got by on small, direct-drive engines primarily because of their lighter weights and much lower flying speeds.

The big performance breakthrough for powered ultralights came with the development of practical reduction drives, either rubber belts or hard gears, that reduced the engine's high speed, by half or even one third, to more efficient propeller speeds. Reduction gearing had been tried on small airplane engines in the late 1920s and 1930s but was not notably successful; it now is nearly universal with ultralights.

Ultralights are booming today, and many of them owe much to the concepts that Alberto Santos-Dumont introduced in 1907 and perfected in 1909. □

*Intrigued by airplanes long before his first ride in a Travel Air at age 10, Peter Bowers, AOPA 54408, has since logged more than 4,200 hours.*



Today's ultralights, represented by the Robertson B1-RD (above), are improvements on the Demoiselle. Reduction-drive gearing, conventional pilot controls and tail surfaces and ailerons for lateral control are some of the B1-RD's innovations.

	Demoiselle (1909)	Naval Aircraft Factory SA-1 (1918)	Flaglor Scooter (1967)	Robertson B1-RD (1982)
<b>Specifications</b>				
Powerplant	Dutheil-Chalmers 20 hp @ 1,200 rpm	Lawrence L-3 55 hp @ 1,800 rpm	1,500cc VW 36 hp @ 3,200 rpm	Cuyuna 430R 35 hp @ 6,500 rpm; 3.2:1 reduction
Wingspan	18 ft	27 ft 8 <sup>3</sup> / <sub>4</sub> in	28 ft	32 ft
Length	20 ft	21 ft 8 in	15 ft 8 in	18 ft 7 in
Wing area	107 sq ft	144 sq ft	115 sq ft	162 sq ft
Empty weight	242 lb	425 lb	390 lb	251 lb
Gross weight	538 lb	695 lb	650 lb	530 lb
Wing loading	5.02 lb/sq ft	4.9 lb/sq ft	5.6 lb/sq ft	3.2 lb/sq ft
Power loading	26.9 lb/hp	12.6 lb/hp	18 lb/sq ft	15.1 lb/sq ft
<b>Performance</b>				
High speed	56 mph	65 mph	90 mph	50 mph
Cruising speed	—	—	80 mph	38 mph
Landing speed	—	37 mph	—	15-18 mph*
Initial climb	—	—	600 ft/min	800 ft/min † 550 ft/min ‡
Range	—	2.4 hr	175 sm	2.17 hr on 3.75 gal; 82.5 sm, no wind

\* Depending on pilot weight; † 180-lb pilot;

‡ Gross weight; — not obtained.