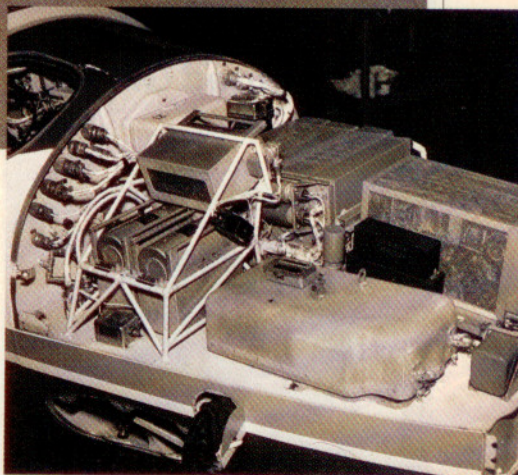




The Morane-Saulnier MS-760 Paris Jet was the first very light jet (above and left, circa 1959). The aircraft's avionics bay is pictured below. Beech Aircraft marketed the MS-760 in the United States.



VLJ déjà vu

Is the very light jet really something new?

BY JOHN W. OLCOTT

More than 50 years ago, before Eclipse Aviation President and Chief Executive Officer Vern Raburn was born—and obviously decades before he envisioned the Eclipse 500 and well before media and government officials

worried about very light jets (VLJs) flying the skies—the concept of relatively light aircraft powered by jet engines and flown by a single pilot emerged.

Advancements in jet technology following World War II indicated that this form of propulsion was sufficiently reliable to be used in public and private transport. Jets flew well above most weather. They were fast, and even early turbine powerplants were relatively easy to operate compared with sophisticated

reciprocating engines of similar power. (If you have doubts, ask a pilot who flew a Lockheed Super Constellation with its R-3350 Wright turbo-compounded radial engines, which produced as much as 3,700 horsepower from 18 cylinders packed in a twin-row configuration and featuring three separate power recovery turbines attached to the exhaust system associated with each group of six jugs.) Jet power for general aviation was an obvious progression.

The first VLJ

With the introduction of the Morane-Saulnier MS-760 Paris Jet, concept became reality in the late 1950s. Like other jet designs of that era, which found their way into the civilian marketplace, the MS-760 began life as a twin-engine military trainer and liaison aircraft. First flight of the four-place, pressurized aircraft took place in July 1954.

Although production models of the Paris I were sold to the French air force and navy as well as the governments of the Netherlands, Brazil, and Argentina, the civilian market became an obvious target. In early 1958, several months before our nation's Civil Aeronautics Administration (CAA) morphed into the Federal Aviation Agency (predecessor to the Federal Aviation Administra-

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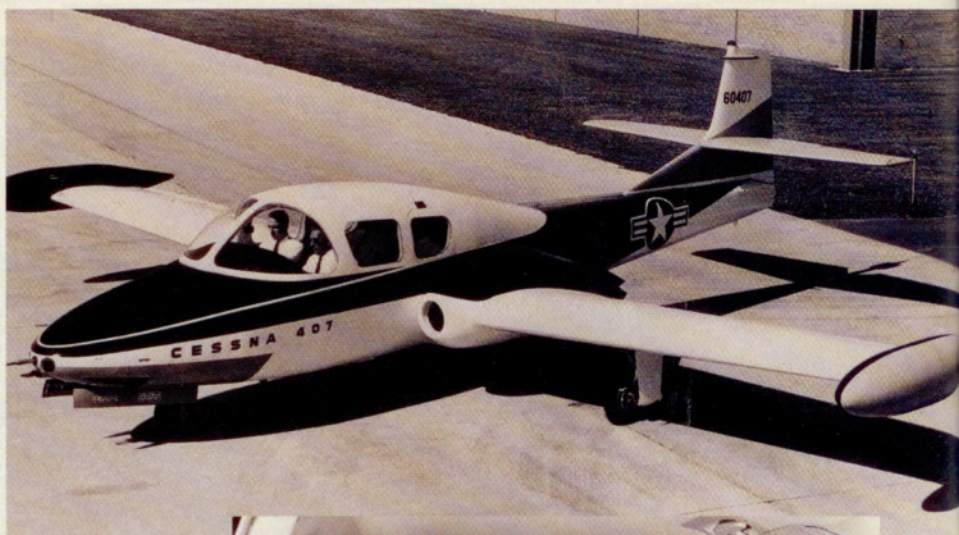


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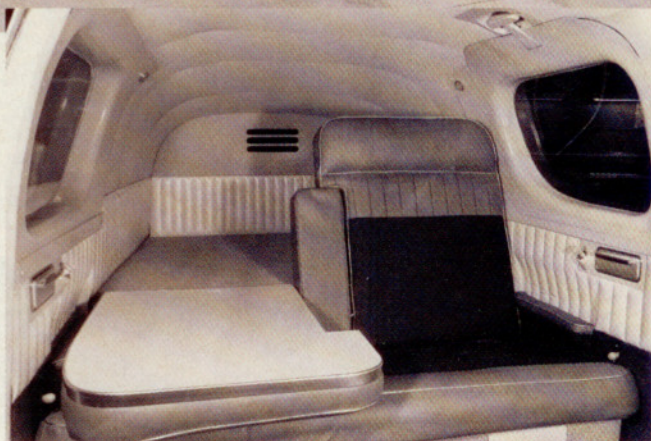
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The Cessna 407 (above) was unveiled in September 1959. It featured a pressurized cabin that could accommodate four people (right).



tion), the Paris I received its U.S. type approval, becoming the first very light jet. From its onset, the MS-760 required only a single pilot.

The aircraft's two Turbomeca Marbore II engines, each producing 880 pounds of thrust, were replaced with Marbore VI turbojets capable of providing 1,058 pounds of thrust for the Paris II. The final version of the aircraft, first flown in February 1964 and known as the Paris III, was capable of carrying a pilot plus five passengers, even though it retained the Turbomeca powerplants of its Paris II predecessor.

Unlike the Paris I and II, which required occupants to enter the cabin by sliding the aircraft's canopy aft, stepping over the fuselage sidewall, and lowering themselves into seats in a fashion similar to a crew entering a fighter jet, the Paris III, which never made it to production, featured a conventional door on the aircraft's left side. The more popular version of the aircraft, however, was the four-place Paris IIB, with a claimed maximum speed of about 375 knots and a ceiling of slightly more than 39,000 feet—performance numbers nearly identical to the VLJ de-

signs about to be certified this year (see "Turbine Pilot: The Year of the Very Light Jet," February *Pilot*).

The MS-760 offers other similarities to current VLJ designs, particularly with respect to size. Its 33.25-foot wingspan is about four feet shorter than the Eclipse 500's and nine feet shorter than the Cessna Mustang's. Although the fuselage lengths of the Paris and the Eclipse are nearly identical at 33.25 and 33.1 feet, respectively, the MS-760 is more than six feet shorter than the Mustang.

Beech Aircraft marketed the MS-760 in the United States, and the Timken Co. operated the Paris for executive transportation in 1959 and the early 1960s. However, Beech suspended its marketing arrangement after a few years because of a lack of customer demand.

Other early VLJs

In the late 1950s Cessna also eyed the civilian jet market, with a modified version of its highly popular T-37 twinjet trainer. Unveiled in September 1959 and known as the Cessna Model 407, the aircraft featured a pressurized cabin that could accommodate four occupants. Its wingspan measured 37.8

feet, and the aircraft's overall length was slightly shorter than 32 feet. With a projected cruise speed of 404 knots and ceiling of 46,400 feet, the Cessna 407 was then expected to exceed the performance of today's VLJs. The aircraft never got past the mock-up stage, however, apparently because of limited customer interest. The general aviation community would wait until October 1968 before learning about the FanJet 500, Cessna Aircraft's first civilian jet.

When launched, Cessna's FanJet 500 indeed met today's informal definition of a very light jet, since it weighed 500 pounds less than the artificial VLJ limit of 10,000 pounds maximum gross take-off weight (MGTOW). Its designers also sought to have the aircraft certified for single-pilot operations from the time of its entry into the marketplace. Subsequently modified and introduced to the world as the Citation, the aircraft's weight increased to 10,350 pounds, nudging it beyond what now identifies an aircraft in the very-light-jet arena. Furthermore, the FAA was very cautious about single-pilot certification even though Cessna wanted its first civilian jet to be approved for a one-person crew. Reflecting a growing conservatism that may not have existed in the days of the CAA, the government

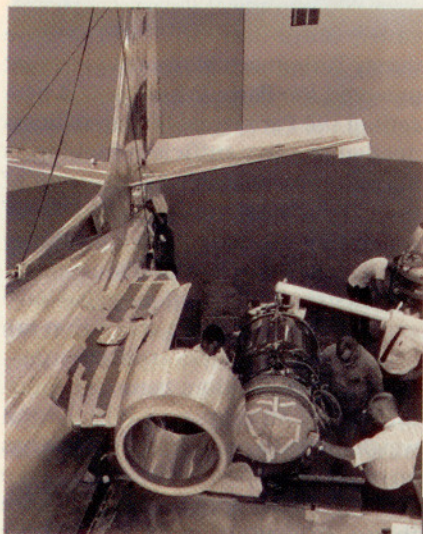
wanted more operational experience before approving single-pilot certification for the Citation.

American Jet Industries, an aircraft modification firm founded in 1951 and led by Allen Paulson before his acquisition of Grumman American, introduced the Hustler 400 in 1975. One might say the Hustler was a VLJ of sorts since it was powered by one Pratt & Whitney PT6A-41 turboprop mounted in the aircraft's nose and a Pratt & Whitney JT15D-1 turbofan in the tail. The aircraft, which initially flew in January 1978, was designed with a maximum gross weight of 9,500 pounds and an anticipated maximum cruising speed of 400 knots at 23,000 feet. The aircraft never progressed beyond the prototype stage.

Paulson subsequently absorbed the Hustler program into Gulfstream American (which he renamed Gulfstream Aerospace because he said potential investors were more likely to purchase stock in an aerospace company) and redesigned the aircraft as the Gulfstream Aerospace FanJet 1500. The Hustler's PT6A-41 was replaced with a single tail-mounted PWC JT15D-1, which delivered 2,200 pounds of thrust, and the new aircraft's maximum weight was reduced to 7,500 pounds. A subsequent version of the FanJet 1500, weighing a maximum of 8,800 pounds, was powered by a single JT15D-5 that produced 2,900 pounds of thrust and was expected to propel the Hustler to a maximum speed of 360 knots.

When the FanJet 1500 took flight for the first time in January 1983, it was the only single-engine business jet in flight test. The program was terminated in 1985 because of difficulties in achieving the FAA-mandated maximum stalling speed of 61 knots for a single-engine aircraft, as well as a lack of buyer interest in the design as the expected sales price increased during development.

Continued



In 1968, Cessna launched the first civilian jet, the FanJet 500 (right). Its 2,200-pound thrust JT15D-1 twin-spool front fan engines were lauded for their efficiency (above).





American Jet Industries introduced the Hustler 400 in 1975 (above). The Hustler program was absorbed into Gulfstream Aerospace, which produced the Peregrine business jet (left).

New technology

Although the dream of a high-performance jet that can be purchased without forfeiting a king's ransom and flown by a single pilot is not new, the enabling technologies for achieving that goal are. Jet engines designed in the 1950s had enormous appetites for fuel, structures were heavy, and avionics were far from integrated. Thus, the first generation of designs to embrace the VLJ dream had operational limitations.

Although the Morane-Saulnier MS-760 Paris Jet was easy to fly and it found a home as a primary training aircraft for the French military, its operational profile as a transport was limited. Maximum range without reserves was advertised as 1,156 nautical miles, which consumed the aircraft's total fuel capacity of 484 gallons. With a maximum gross takeoff weight of 8,650 pounds and an empty weight of about 4,850 pounds, most of the MS-760 IIB's useful load of 3,800 pounds was consumed by the 3,243 pounds of jet fuel it carried. A mere 557 pounds were available for pilot, passengers, and baggage. Today's VLJs should be significantly more suitable for typical operations, in large part because of engine technology.

The Eclipse, for example, projects a range of 1,280 nm under instrument

flight rules with a payload that includes a 200-pound pilot and three 170-pound passengers. Its Pratt & Whitney Canada PW610F turboprops, which produce 900 pounds of thrust, are significantly more fuel efficient than the thirsty Turbomeca Marbore VI jets that powered the Paris. Whereas 37.4 percent of the Paris' total lift capability is needed to carry sufficient fuel for its maximum range, only 27.3 percent of the Eclipse's maximum gross takeoff weight is allocated for fuel to achieve more range than the MS-760's.

Construction techniques also have evolved, resulting in aircraft that are lighter overall and less expensive (relative to inflation) than their VLJ counterparts of 50 years ago. With a total weight of 5,640 pounds, the Eclipse has an operational profile that exceeds the MS-760 Paris', which weighed more than 3,000 pounds more. Friction stir welding used on the Eclipse reduces weight somewhat, and noticeably cuts construction time. Sophisticated tooling enables Eclipse to project significantly higher rates of production than typical for a general aviation jet, thereby promising sufficiently high volume to offer the aircraft at a lower cost.

The all-composite Adam A700, a larger aircraft than the Paris, has a maximum gross takeoff weight of 7,600

pounds, 1,050 pounds less than the Paris'. Although impressive, the promise of significantly lighter structures using composites has yet to be realized fully. Perhaps using composites as unique materials—such as in the design of another VLJ in development, the Spectrum 33—and not simply as a replacement for aluminum will yield even lighter aircraft.

In addition to the significant role of new jet powerplants, today's advanced avionics enable the VLJ concept to be realized. Relatively low cost and highly integrated cockpit displays that include primary flight instruments and communications and navigation radios, as well as safety systems such as weather radar, terrain, and traffic avoidance sys-

certification. Required equipment on both single-pilot aircraft included a functioning autopilot, a boom mic, and a transponder activation switch on the pilot's control yoke.

Combining dreams and technologies

For pilots who wish to experience the VLJ phenomenon now, California Flight Academy, located in El Cajon, California, offers type ratings in the MS-760 Paris Jet and will modify an MS-760 with glass cockpits and GPS flight management systems. Currently there are 41 MS-760 Paris aircraft listed on the FAA registry, and several more are available in Canada. According to Greg Webster, who has been flying and



The all-composite, seven-place Adam A700 is not yet certified. But Adam has taken more than 60 orders for its very light jet.

tems, are the result of technologies that place single-pilot operations within the operational skill set of many more pilots than did VLJs of yesteryear.

The role of avionics in reducing pilot workload and enabling single-pilot approval for jets is by no means new. Cessna's aim was to obtain single-pilot approval for the FanJet 500, but the aircraft's avionics suite was deemed unable to provide a sufficiently low workload to convince federal officials that Cessna's objective was feasible. The first Citation, which evolved during development from the FanJet 500, was certified in 1971 under FAR Part 25 for a minimum crew of two. In 1978 Cessna eventually achieved FAA certification for single-pilot operations for two new aircraft, the Citation I SP and the Citation II SP. Both SP Citations, however, were approved under FAR Part 23. With its maximum gross takeoff weight of 11,850 pounds, the Citation I SP suffered no reduction in loading, but the Citation II SP had its maximum gross takeoff weight artificially reduced to 12,500 pounds to be eligible for Part 23

instructing in MS-760s for nearly 30 years, the aircraft presents minimal, if any, challenge for the average pilot.

"I have been responsible [for] training about 100 pilots who obtained MS-760 type ratings," said Webster. "Everyone loves the machine from the first moment they move the throttles forward. It's an easy aircraft to fly from takeoff to landing, which is to be expected since the

French used the Paris to train pilots with no previous experience."

The dream of owning a jet aircraft certified for normal use and flown legally by one pilot has been

achievable for nearly half a century. But it takes today's technology to make the promise of very light jets real. **AOPA**

John W. Olcott, past president of the National Business Aviation Association, leads General Aero Co., consultant for the business aviation community.

i Links to additional information about very-light-jet technology may be found on AOPA Online (www.aopa.org/pilot/links.shtml).