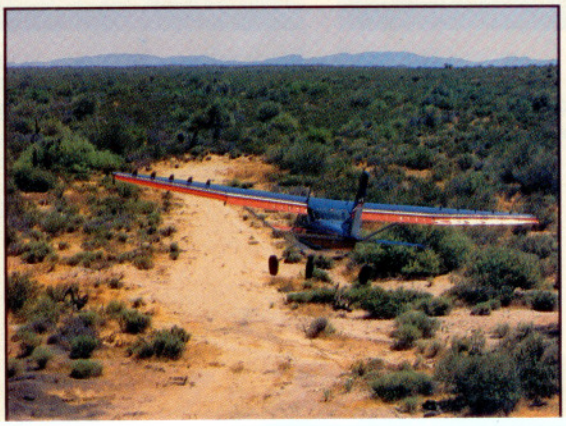
SHORT & SWEET





STOL without pain, courtesy of the Wren 460P.

BY J. JEFFERSON MILLER

When a prospective customer arrives at Wren Aircraft in Buckeye, Arizona, he is treated to a demonstration flight in the Wren 460P at the Buckeye Municipal Airport. Company president J. Todd Peterson will perform takeoffs and landings from a 300-foot pad, demonstrate slow flight at 30 knots and execute a simulated power-off landing after ascending to 50 feet at the best angle of climb and suddenly closing the throttle.

But when an aviation journalist comes to call, Peterson believes a more compelling demonstration of the Wren's abilities is in order. For such special demonstrations, he has constructed a bush strip near a small gold mine in the Arizona desert.

The miners' construction equipment was used to pull shrubs and cacti from an overgrown jeep trail. Only a minimal effort was made at filling in the resulting divots. The strip's rough surface and its 300-foot length, however, are not what make it such a challenge for a STOL airplane. It is The Obstacle—a 100-foot-high hill that peaks a scant 100 yards past the west end of the strip. You cannot climb over it; you have to fly around it. But that is easy in a Wren. The hard part is landing to the east, over The Obstacle.

On the second day of my visit to Wren Aircraft, Peterson and I flew out to the gold mine. Circling overhead, I had trouble spotting the landing area. The strip, when I found it, did not look like much of a strip at all. It seemed to be just a small clearing among the cacti. We lined up on final with full-span Fowler flaps down; approach speed was pegged on 43 knots. We passed over the hill by at least a few feet. To touch down at the end of the strip required a 1,400-fpm rate of descent. From my vantage point it seemed that we were dropping almost straight down in a nose-level mush. A sudden shot of power slowed our descent so that we hit with a tolerable crunch. The Wren skittered to a halt with about 50 feet to spare.

Peterson gave a no-sweat grin and said, "You really can beat the soup out of the old girl."

Beat the soup out of her we did. Between Peterson's crunchers at the mine and my own hard landings during short-field practice back at Buckeye Municipal, I was surprised we did not leave a trail of aluminum wherever we flew. Whether the wings fell off the airplane the day after I left Buckeye, I do not know. But I doubt it.

Peterson's own Wren, 37RJ, is meticulously maintained, yet it is hardly a typical factory demonstrator. The airframe has accumulated 6,000 hours, most of them bouncing in and out of short strips. Parts of the tail are pitted and scarred from pebbles thrown back by prop blast. The propeller tips are nicked all over. (Buckeye's gravel runways seem to eat up props.)

Even with its new red, white and blue paint job, 37RJ hardly could be described as a pretty airplane. A canard protruding from either side of the cowling gives the Wren, from certain angles, an appearance similar to that of a catfish. Massive flap hinges hang below the wing. On top are mounted 10 drag plates used for directional control at low airspeeds.

But the Wren never will go seeking compliments on its appearance. The beauty of this airplane is all in what it does, not in how it looks.

Loaded to gross weight, the Wren will take off and land within 270 feet. At 43 knots it can complete a 180-degree turn within a radius of 300 feet. It will cruise for 13 hours at 47 knots with no danger of overheating. And it can carry a useful load of up to 1,970 pounds when operated in the Limited category, which restricts the pilot to a 500-fpm rate of descent on landing and lowers the maximum flap-extension speed from 78 knots to 69 knots.

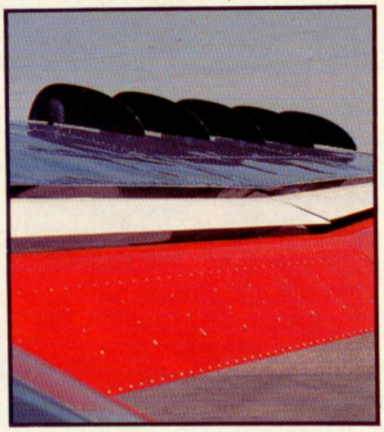
The Wren is the only piston single-engine aircraft certified for Category II operations (100-foot decision height, one-quarter mile visibility). The FAA considers the Wren's approach speeds slow enough to allow a sufficient margin of safety when using the lower minimums.

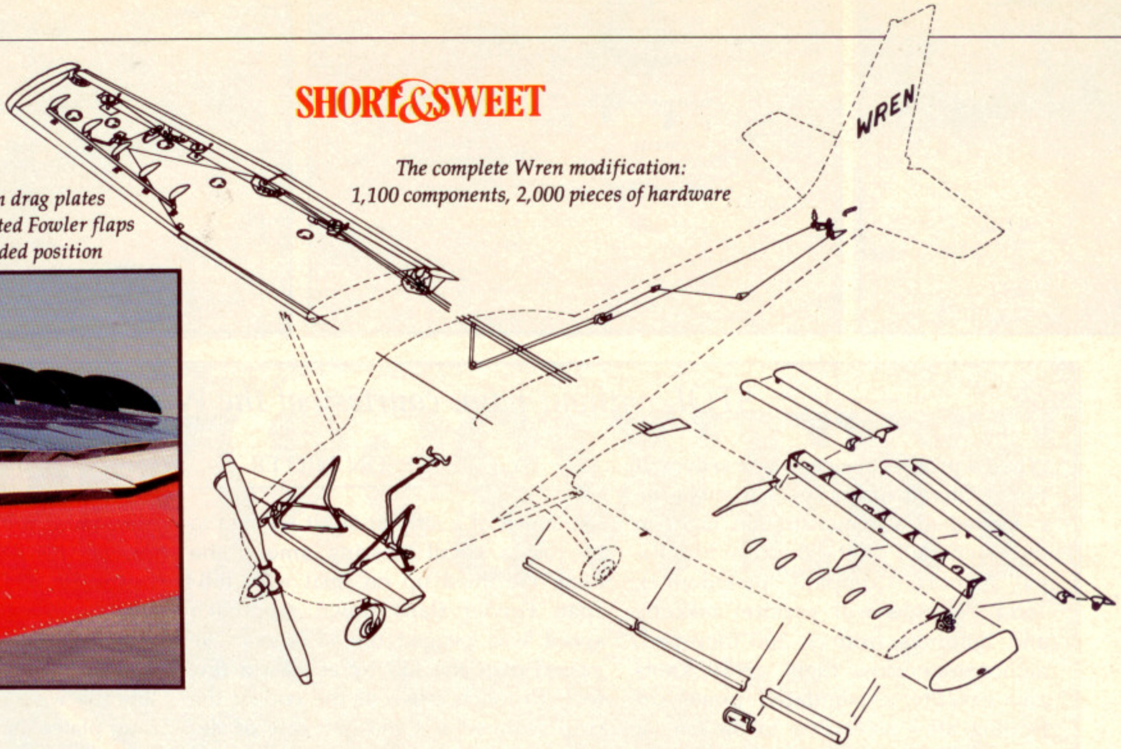
What impressed me most about the Wren, however, was the relative ease with which I learned to land the air-



SHORT&SWEET

Below: Wren drag plates and double-slotted Fowler flaps in the extended position





The complete Wren modification: 1,100 components, 2,000 pieces of hardware

plane in its minimum distance. Though I rarely land an airplane on runways less than half-a-mile long, after a few hours practice I was consistently landing the Wren within 300 feet.

To modify an airplane into a 460P (460 is twice the horsepower of the engine; the P stands for Peterson) you have to start with a stock Cessna 182, which is no slug when it comes to short-field performance. At 68°F at sea level, a 182 weighing 2,800 pounds can take off in 660 feet. It can land in 600 feet. To halve those figures requires the addition of 1,100 Wren Aircraft-manufactured components, 2,000 pieces of hardware (nuts, bolts and so forth) and between 800 and 1,000 man-hours of labor.

Wren Aircraft buys 182s manufactured between 1966 and 1969 (the last year designated under the Wren STCs). The Continental 230-hp O-470-R engine is exchanged for a factory remanufactured one. The propeller is replaced. A new interior, new fuel cells and a new windshield are installed. All cables, pulleys and stressed bolts are replaced. The airframe is inspected and any damage is repaired. The hydraulic and electrical systems are inspected, and parts are replaced as necessary. The airplane is repainted.

Skylane owners can have their aircraft modified by Wren Aircraft without having a complete rebuild, but Peterson says he will not perform the modification if he considers the aircraft only marginally airworthy.

The bulk of the Wren modifications involve the 182 wing. Everything after the rear spar is cut away. The rear spar is removed and replaced with a new one that is five times heavier than the original. The heavier and stronger structure is needed to handle the greater loads placed on the rear spar by the addition of the Wren's larger flap system. The new spar allows the aircraft's maximum gross weight to be raised.

Full-span, double-slotted Fowler flaps are added. The ailerons and flaps droop to 30 degrees when fully extended. In this configuration, the wing produces 87 percent more lift than with the flaps retracted. When making a short-field landing, it is very important to retract the flaps quickly after touching down in order to eliminate the extra lift they generate. A button has been added to the yoke that will retract the flaps in four seconds.

A variable-radius leading-edge cuff has been riveted over the old leading edge. The Wren's leading edge is much more rounded than the Skylane's and must add considerable drag, but it also allows the air to flow smoothly over the wing at extremely slow speeds and high angles of attack. Because the cuff radius narrows and the droop lessens toward the tip, there is very little progression of the stall out from the wing root. Complete roll control is provided throughout the stall.

The drag plates, or "Wren's teeth" as they are called by the company, are both spoilers and rudders. During a turn with flaps down, the plates ahead of the aileron on the downside wing will turn up to 60 degrees diagonally to create drag to counteract the adverse yaw produced by the aileron on the upside and to direct air over the aileron for greater effectiveness. Each tooth is mounted on a steel shaft. The five plates on each side are interconnected and activated by a push rod.

The Wren's canard consists of a stabilizer and elevator sprouting from each side of the cowling. The canard is attached to the control column by a push rod and acts opposite the elevator: When the tail elevator is down, the canard elevator is up. The canard enables the Wren to maintain a flat pitch attitude during short-field takeoffs and landings. It is very effective in the prop blast. Because of the canard, the nosewheel can be lifted off the ground within the first 15 feet of a takeoff run. Without the canard, takeoff and landing distances increase by 40 percent.

The Wren's stabilizer is linked to the flap actuation system: When the flaps are extended, the stabilizer's leading edge tilts down to minimize pitch changes and relieve some of the trim load from the elevator.

The main landing-gear springs are standard Skylane issue, capable of handling a 750-fpm drop onto the surface at gross weight. The wheels are heavy-duty: 8.00 X 6s on the mains; 6.00 X 6s for the nose gear. Wheel fairings are available. As an option you can order extra extra large wheels: 8.50

SHORT WORK

Even with an airplane such as the Wren, it is not easy to land in 300 feet. It requires pilot technique, concentration and, above all, practice.

All pilots learn to make short-field landings in preparation for their private pilot checkride. They are taught to set up a steep approach at a slower-than-normal speed. This allows the pilot to clear obstacles and minimizes the forward travel of the aircraft once it reaches the runway.

Rarely are pilots faced with a situation that requires them to extract maximum landing performance from their aircraft. Since many usually land at airports with runways longer than 2,500 feet, they tend to come in for a landing with excess speed and float a long distance down the runway. This is fine when sufficient runway is available. But a pilot who does not practice landing on a desired spot soon loses the ability (if he ever had it).

Being such a pilot, I had much to relearn when I began my short-field training with J. Todd Peterson, president of Wren Aircraft. First I had to come to terms with the 300-foot patch on which I would be landing. I would have to have the airplane on the ground at one end of the runway and stopped at the other. The airplane could not float so much as 50 feet. I was doubtful I could make such a landing.

At the start, Peterson had me practice takeoffs and landings in order to get a feel for the airplane. He would ask me to taxi almost to the end of a runway and then, instead of pointing the airplane down the length of the runway, he would ask me to take off using the remaining 200 feet. To land, I would concentrate on touching down as near a taxiway as possible. At first I flew my approaches at 47 to 52 knots, which is faster than necessary in the Wren.

Having begun consistently to land near the taxiway, we moved our landing site to one of the corners formed by the airport's triangular runways. This area provided about 500 feet for landing. I would fly a pattern about 400 feet above the ground and reduce power at a point I thought would provide the correct glide angle down to the edge of the landing area. As my rate of sink increased and I dropped below my imaginary glideslope, I would increase power to bring myself back up toward it but inevitably would overshoot. Though my corrections were minimal, they caused the airplane to approach the runway in a series of steps. As I neared the threshold, I would find myself either slightly high or slightly low. If I was low, I would drag it in with power, but the Wren develops so much lift that I would end up floating 100 feet past my touchdown point. If I was too high, I would chop the power and begin to sink in earnest, then try to arrest the sink with a last second shot of power. But I usually would apply the power too late, hit with a bone-jarring thud and then bounce back up a few feet, only to come crashing down a second time. I also had the bad habit of slightly relaxing back pressure on the yoke after touching down.

Peterson had me slow my approach speed to 43 knots. He began talking about a "stabilized approach." In other words, he wanted me to set up a steady rate of descent after turning final, minimizing pitch and power changes, so that I would descend in a straight line to my touchdown point. I lengthened my final approach leg to give myself more time to stabilize the aircraft. Though my approach angle was straighter, I found I still was having problems reaching my touchdown point at the right speed.

Peterson, fortunately, had determined my problem (I was chasing the airspeed needle) and told me to stop watching the airspeed indicator after I had established 43 knots on the descent. With some reluctance I followed this advice. On our next approach, Peterson sat beside me urging me in the style of Obi Wan Kenobi to reach out with my senses and "feel the lift." Lo and behold, the technique worked. I set the Wren down on my touchdown point and had it stopped in 300 feet. End of the day's lesson.

The next morning we began our practice by making diagonal approaches to one of the wide runways at Buckeye Municipal Airport, Buckeye, Arizona (the home of Wren Aircraft). At first I used a diagonal length of about 500 feet and gradually worked my way down to a diagonal length of about 400 feet. Peterson told me to choose a landing point ahead of the runway threshold, because even at the slowest approach speed, I would float perhaps 30 feet before touching down.

Now I was ready for the acid test—the 300-foot pad. I set up my stabilized approach, ignored the airspeed indicator, flared 30 feet ahead of the pad, hit right on the edge, held the stick all the way back, pushed the flaps-up button and applied brakes. The Wren was stopped in about 270 feet, as per book figure. I landed on the 300-foot pad several more times, until it really did not seem to be such a short distance.

Finally, I decided that Peterson perhaps was exaggerating the pad's short length. So I climbed out of the airplane and paced it off—100 strides, exactly.

When I returned to Frederick Airport in Maryland, I thought I would try some short-field approaches in a Skylane. With two onboard and full fuel, we were carrying about as much weight as in the Wren, but the density altitude in Frederick was much lower. Following my Wren procedures, I set up a stabilized approach at the short-field landing speed indicated in the *Skylane Information Manual*, 61 knots.

I wanted to make the first turnoff located 750 feet down the runway. But I flared over the threshold and floated, floated, floated, missing the turn. On the second pass I slowed to 55 knots and still missed the turn. On the third pass I slowed to 50 knots indicated, which actually is 57 knots calibrated and safely above the 49-knot stall. The airplane was wallowing a bit and sinking fast, but the approach was stabilized and I thought we would make it. A shot of power over the threshold saved us from a hard landing. I quickly retracted the flaps and applied brakes. This time I made the turn.

Once off the runway, I looked back and saw another Skylane pilot trying to duplicate my approach. But he was not slow enough. He landed long and missed the turn. It was then that I realized I had learned something in the Wren that I could take with me to any airplane. *—JJM*

X 6 mains and an 8.00 X 6 nosewheel. But you cannot order fairings for these. Peterson says, "You almost can walk on water with the optional tires, but they slow you up, too."

The Wren's pitot tube is moved outboard four inches and dropped four degrees to give more accurate speed indications at slow speeds. The Skylane airspeed indicator will indicate 40 knots when the airplane is flying at a calibrated airspeed of 52 knots. The Wren will indicate 35 knots when flying at 36 knots.

The Wren is fitted with a standard Cessna Skylane variable pitch 82-inch McCauley prop and can be ordered with an optional 88-inch McCauley propeller for greater acceleration on takeoff. With the larger propeller you also receive a longer nose strut.

Wren Aircraft cuts a new, standard T-formation instrument panel, adds new gyros, will install new King or Bendix radios and a Century II autopilot.

The first production Wren to be built in Peterson's Buckeye facility was scheduled to roll out in mid-July. According to Peterson, subsequent Wrens will be produced at the rate of two-and-a-half a month, which will be increased to a maximum of four a month.

There have been no airworthiness directives on the Wren modifications. The cost of a new Wren is $69,000; the cost of modifying a Skylane is $29,000.

Even with all of the Wren's high-lift devices working for you, it takes practice consistently to land the airplane in 300 feet. Buckeye Municipal Airport, an ex-military, auxiliary landing site near Luke Air Force Base, Arizona, is a

WRENAISSANCE

The Wren is the brainchild of the late James D.L. Robertson, who is best known for developing a series of STOL modification kits for many single- and light twin-engine aircraft. Robertson studied aerodynamics at Iowa State College, business administration at Harvard University and served a brief stint as a design engineer for the Helio Aircraft Corporation working on the Helio Courier STOL airplane. The Courier, designed by Dr. Otto C. Koppen of the Massachusetts Institute of Technology, has leading-edge slats, 75-percent span flaps, a combination of spoilers and ailerons for roll control and truly impressive STOL performance: takeoff run, 335 feet; landing distance, 270 feet; flaps-down stall speed, 26 knots.

In 1962, Robertson developed his own prototype STOL airplane, the Skyshark. It was a big single with a 420-hp engine. Massive double-slotted Fowler flaps (42 percent of the wing chord) hung from the wings and extended down to 80 degrees. The flaps extended simultaneously with a full-span leading-edge extension known as a shroud. Not only did the Skyshark have a canard, but a canard with rudders. It was a weird-looking craft that, in appearance, lived up to its sharkish name.

If *Jane's All the World's Aircraft* for 1962 to 1963 can be believed, the Skyshark could take off in 85 feet, land in 35 feet and fly as slowly as 17 knots—rather impressive performance for an aircraft with a maximum takeoff weight of 5,000 pounds. As a proof-of-concept airplane, it was a technical triumph, showing the level of STOL performance that could be obtained from an aircraft. As a marketing venture, however, it was a flop.

The Skyshark never was offered to the public. It would have been an extremely expensive airplane to manufacture and probably offered more STOL performance than anyone needed. But many of the lessons learned from the Skyshark were incorporated into the Wren, which Robertson designed with the assistance of A.E. (Doc) Morris, an aeronautical engineer with extensive bush-flying experience in Paraguay. The Wren was certificated in 1964 and produced by Robertson's newly formed company, the Wren Aircraft Corporation of Fort Worth, Texas. That same year, according to company president J. Todd Peterson, who retains the company's records, the board of directors voted Robertson out of his position as director of the company. It is not clear from the records what led to Robertson's ouster.

In 1965 Robertson went to work for Boeing. The next year he started the Robertson Aircraft Corporation in Bellevue, Washington, and introduced his very lucrative line of STOL modification packages. Certain elements of the Wren's design (a leading-edge cuff and drooped ailerons) were incorporated into the modifications. Robertson died in 1968.

Wren Aircraft sales increased each year between 1964 and 1967. These Wrens came with a reversible-pitch propeller that is not offered on the currently produced aircraft. Peterson believes the reversible prop is too complicated for bush operations and requires too much maintenance. The reversible prop also had to be smaller than the standard propeller and therefore provided less thrust on takeoff.

In 1968, the company began developing a prototype STOL modification for the O-2, the military version of the Cessna 337. The airplane was configured for night reconnaissance in Vietnam. Wren Aircraft also was working on a quiet version of the Wren for the Air Force. That year Doc Morris, who was serving as vice president and head of research and development, died when an engine fire in a Wren designed for quiet flight led to a crash.

Morris's death, the cash drain caused by the military research and development work and the rejection by the Air Force of both the O-2 and Wren designs precipitated Wren Aircraft's bankruptcy in 1969.

Galen Means, an aeronautical engineer from Wichita, bought the Wren supplemental type certificates from the bankrupt company. Means sold them to Peterson in 1977. At the time, Peterson was operating an aircraft repair station in Thedford, Nebraska, and flying the air-show circuit in an Akro Duster II. He moved his operation to Buckeye, Arizona, in February 1982. Like the Air Force, he was attracted to the area by the preponderance of VFR-flying days and also by the extremely low rent he pays for hangar space at the Buckeye airport.

Peterson says that the Wren was an aircraft ahead of its time. Judging from his eight month backlog in orders, the time is now right to be making Wrens. —*JJM*

good location for such practice. The little-used airport has three runways set in a triangle that allow a pilot to land into the wind almost always. But the Wren rarely lines up directly with a runway. Wren landings usually are conducted on the diagonal, or across one of the tips of the triangle. Peterson has had asphalt laid over a 300-foot diagonal patch of one of the runways. This is the main practice area for STOL takeoffs and departures.

On the first day of my three-and-a-half day visit to Wren Aircraft, Peterson took me up to familiarize me with the Wren. A hot wind was whipping across the desert at about 30 knots, sweeping stinging sand into the air. Peterson performed a runup on the roll to minimize the chance for propeller nicks on the gravel surface. Flaps were extended to their full 30-degree down position and checked visually. Mixture and prop were set full forward. We were ready for takeoff.

Peterson pushed in the throttle and

SHORT & SWEET

we rumbled across the runway. The airspeed needle crept up to 30 knots. As we neared the edge, Peterson pulled back slightly on the yoke and we were airborne. Later, when I tried it for myself, I learned how easy short-field takeoffs are in the Wren.

Once off the ground, proper technique calls for easing off the back pressure to establish the Wren in an almost nose-level attitude. The airplane then will quickly accelerate to 52 knots, best-angle-of-climb speed, and, according to the manual, begin ascending at 950 fpm at sea level and standard temperature at maximum gross weight in the Normal category. We were flying at a few hundred pounds below max gross weight and at a density altitude of about 4,000 feet. Our initial rate of climb was between 800 and 1,000 fpm.

The Wren differs from other STOL airplanes in its ability to climb in an almost flat attitude rather than clawing for altitude, nose 20 degrees to the horizon. An Air Force test pilot who flew the Wren wrote in his report on the aircraft, "The near-level attitude of the fuselage indicated that the wings were producing the lift required for the STOL performance. This was a gratifying feeling of safety to the pilot who has flown other aircraft that gain STOL performance from engine power and thus give the 'hanging-on-the-prop' feeling of insecurity."

Wren takeoffs provide two safety advantages. First, the nose-level climb provides excellent forward visibility. Second, a lower level of skill and technique is required to safely land after an engine failure. Peterson demonstrated this by having me take off straight down the runway rather than diagonal to it as is the standard procedure. At 50 feet he chopped the power. Slight forward pressure nosed the Wren over into a gentle, 43 knot glide down to the runway. We stopped about 1,500 feet from where our takeoff roll began.

Another advantage of the Wren takeoff is that it allows you easily to maneuver around objects over which you would not be able to fly. With flaps down and 43 to 52 knots, the Wren is extremely nimble. Steep turns immediately after takeoff are no problem as long as you provide sufficient altitude to avoid catching a wing tip. Peterson will take off, lower the nose until he has 52 knots and rack the Wren into a 60-degree bank no more than 20 feet above the surface. One of his favorite maneuvers is to take off, bank into a steep turn, complete a three-sixty and land in the same spot still banked with the wheel on the banked side touching first. The entire turn is completed in a 300-foot radius.

With power off and the yoke held all the way back, the Wren will just descend in a flat attitude at about 500 to 600 fpm. Ailerons and drag plates still are effective, and the Wren actually can be mushed all the way down to a landing, albeit a hard one. Releasing the back pressure is all that is necessary for stall recovery. A pilot can recover from a power-on stall without losing any altitude if the back pressure is released promptly.

At 30 to 35 knots, it is possible to violently cross the controls without stalling or spinning. Peterson eagerly demonstrated this by kicking this way and that on the rudder pedals while working the ailerons in the opposite direction. The airplane gyrated back and forth around its axes, making me feel as if I was inside a washing machine. But it did not stall or spin.

At 47 knots, the Wren will cruise at 30 percent power, using just 6.5 gph. It can fly this way almost all day with no danger of overheating. Other airplanes, comparable in weight and power, might be able to patrol at this speed, but would require higher power settings and probably would not be able to achieve sufficient cooling over the engine to stay at it for very long. For 15 minutes or so, Peterson and I followed U.S. Route 10 through the desert watching the cars and trucks pass us by as they exceeded the 55-mph speed limit.

Executing a short-field landing should not be an overly demanding task for a competent, low-time Skylane pilot, but it does require a practiced hand. Basically, the trick is to set up a steep approach at a constant speed of about 43 knots, aiming for a point about 30 to 50 feet in front of the touchdown point. At the last second, the yoke is pulled back and a shot of power is applied to arrest the sink. As soon as the wheels touch, the flaps are retracted and the brakes applied.

The Wren's approach, like its departure, is made in a flat attitude; there is no need to drag it in nose high with a lot of power. As with the takeoff, the flat attitude gives a margin of safety some other aircraft do not provide.

A balked landing in a Wren presents little hazard. On one of our approaches to the mine strip, Peterson misjudged his approach angle, flared about 75 feet down the runway, floated another 50 feet, touched down, decided he was not going to be able to stop and fed in the power. A classic scenario for go-around disaster. But not in the Wren. Up we soared, quickly accelerating to 52 knots. That go-around demonstrated to me one of the Wren's greatest attributes: It allows you to change your mind at the last second.

Still, most pilots do not need the kind of performance the Wren provides. Someday in the future, however, pilots' needs may change. As the number of airports open to the public continues to shrink, tiedown rent rises and major urban airports become more congested, an airplane such as the Wren is likely to look more attractive to a pilot with a few unused acres in back of the house. One might imagine that in an age of computerized communications, professional people who have moved far away from the cities would use a Wren or similar airplane as their means of transportation to the midtown STOL port.

Of course, that day may be a long way off or may never come. Even if it does, the Wren may not be the everyman's airplane. At the current planned production rate, only 30 aircraft a year will be built. And that will not increase greatly, according to Peterson. "The Wren," he says, "will always be a limited production airplane." □

Wren 460P

Base price $69,000/
modification alone—$29,000
AOPA Pilot Operations/Equipment Category*:
Cross-country $72,500
IFR $79,000

Specifications

Powerplant	Continental O-470-R, 230 hp @ 2,400 rpm
Recommended TBO	1,500 hr
Propeller	McCauley 2 blade, constant speed, 82-inch dia
Recommended TBO	1,500 hr
Length	27 ft 4 in
Height	9 ft
Wingspan	35 ft 10 in
Wing area	175.4 sq ft
Wing loading	16.09 lb/sq ft
Power loading	12.2 lb/hp
Seats	4
Cabin length	8 ft
Cabin width	3 ft 2 in
Cabin height	4 ft
Empty weight	1,680 lb
Empty weight, as tested	1,705 lb
Max ramp weight	3,650 lb
Gross weight	2,800 lb (3,650 Limited category)
Useful load	1,120 lb (1,970 Limited category)
Useful load, as tested	1,095 lb (1,945 Limited category)
Payload w/full fuel	640 lb (1,490 Limited category)
Payload w/full fuel, as tested	615 lb (1,465 Limited category)
Max takeoff weight	3,650 lb
Max landing weight	3,650 lb
Zero fuel weight	1,644 lb
Fuel capacity, std	480 lb (456 lb usable) 80 gal (76 gal usable)
Oil capacity, ea engine	12 qt
Baggage capacity	120 lb

Performance

Takeoff distance, ground roll	270 ft
Takeoff distance over 50-ft obst	550 ft
Accelerate/stop distance	450 ft
Max demonstrated crosswind component	25 kt
Rate of climb, sea level	1,080 fpm flaps up/ 950 fpm flaps down
Max level speed, sea level	130 kt
Max level speed, 8,000 ft	138 kt
Cruise speed/Range w/45-min rsv, std fuel (fuel consumption, ea engine)	
@ 75% power, best economy 5,000 ft	130 kt/813 nm (75 pph/12.5 gph)
@ 55% power, best economy 5,000 ft	109 kt/934 nm (54 pph/9 gph)
@ 30% power, best economy 5,000 ft	47 kt/620 nm (36 pph/6 gph) endurance—13 hrs
Service ceiling	19,200 ft
Landing distance over 50-ft obst	555 ft
Landing distance, ground roll	270 ft

Limiting and Recommended Airspeeds

Vx (Best angle of climb) full flaps	52 KIAS
Vy (Best rate of climb) no flaps	78 KIAS
Va (Design maneuvering)	flaps up 98 KIAS flaps down 37 KIAS
Vfe (Max flap extended)	78 KIAS
Vno (Max structural cruising)	151 KIAS
Vne (Never exceed)	182 KIAS
Vr (Rotation)	30 KIAS
Vs1 (Stall clean)	50 KIAS
Vso (Stall in landing configuration)	25 KIAS

All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, at sea level and gross weight, unless otherwise noted.
**Operations/Equipment Categories are defined in June 1983 Pilot, p. 96. The prices reflect the costs for equipment recommended to operate in the listed categories.*