Robinson R44

PILOT REPORT

by Craig Lunaas

I have to admit that the Robinson revolution passed me by. I graduated from flight school in the U.S. Army in 1978, the year before the first R22 was certified. After seven years in the army, my civilian career path led directly to multi-engine turbine helicopters, a world apart from single-engine pistons. Of course, I had heard about Frank Robinson designing the R22 in the 1970s and then the R44 in the 1990s, but I never had the opportunity to fly either a Robinson or any other piston helicopter after flight school.

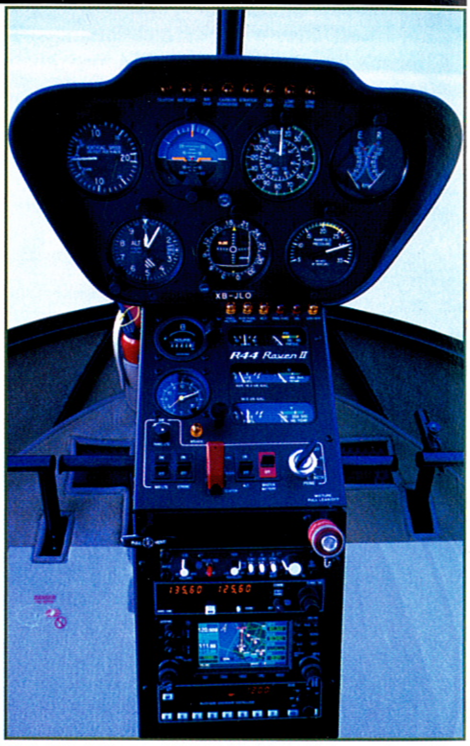
My memories of the old-technology TH-55 (Hughes 300) piston trainer in flight school were less than fond. I was intimately familiar with "George," the overspeed governor, because every time I would give the engine a little too much gas, good old George would kick the rpm back down again with predictable results. I'm sure I was the one easily spotted on downwind, tail wagging every time I bumped into George.

Times and helicopter technology have certainly changed over the past 20 years and then some. When asked to fly the new R44 Raven II, I was expecting a larger version of the piston-powered trainer that I flew in 1978. What I came to realize is that Frank Robinson has designed a state-of-the-art four-place ship, in systems and performance more closely resembling turbine-powered helicopters costing many times more. Not only has it designed a modern, cost-effective machine, but Robinson Helicopter has quietly moved up in manufacturing and sales, garnering almost 65 percent of the North American helicopter market last year.

The first R44 Raven with the carbureted Lycoming IO-540 was certified in 1992, and since then more than 1,300 of the helicopters have been delivered. The higher-performance fuel-injected Raven II was certified last year, and more than 40 have been delivered, with additional orders for more than 100 on the books. Outwardly, both R44 versions look the same. The main differences between the two are the Raven II's higher-horsepower injected engine; slightly larger main rotor blades to reduce vibration; main- and tail-rotor tip caps designed to reduce noise; and a 28-volt DC electrical system. According to v-p of product support Kurt Robinson, perhaps the simplest change for the Raven II may be one of the most appreciated: the ignition key also opens all of the door locks, eliminating the need for two separate keys.

Robinson Helicopter of Torrance, Calif., is not so much a helicopter company as it is an engineering company. In designing safe, low-maintenance, easy-to-fly and inexpensive-to-operate helicopters, Frank Robinson had to approach some things from a different angle. Take, for example, the hydraulic system. The first installation tested used an existing system that could have been quickly certified. Like most hydraulic systems, however, it seeped fluid. Instead of taking the easy route to swift certification, Robinson spent two years designing a simplified hydraulic system that would not leak. Instead of adopting the sliding pilot valve used in most servos, Robinson engineers designed a valve that rotates to protect the seals. The valve is manufactured in house to a tolerance of a millionth of an inch.

Most of the parts outside avionics and instruments are manufactured in house using both computer numerically controlled (CNC) machining centers and hand labor. None of the manufactured parts is outsourced because Robinson can maintain stricter controls on both quality and quantity. To ensure quality, all dimensional components are inspected both by hand and by computerized machines to ensure that they meet tolerances. All of the main- and tail-rotor blades are also manufactured in the plant, and every 75th main rotor blade undergoes destructive testing to ensure the quality of manufacturing and bonding. A sample of every blade manufactured is kept at the Robinson plant for the life of that blade.



This R44 Raven II VFR flight deck is equipped with an optional Garmin GNS 430 GPS navcom. An optional 10-hole instrument panel is available for the IFR trainer version; however, it's not approved to fly in actual IMC.

A new engine overhaul center was added in 1998, complete with two dynamometer test cells for precision engine testing. As a result, all engine overhauls are now done at the factory.

Because most R44 owners do not have full-time mechanics, the helicopter is designed to be low on maintenance demands, aside from engine oil servicing at 100-hour intervals. All of the bearings, including the swash plate, are sealed and require no grease. The main rotor-blade grips are wet, but they are sealed and require no daily maintenance. There are also no daily inspections requiring a mechanic, so a thorough preflight by the pilot is sufficient. One helpful pilot aid is the "TelaTemp" pads bonded to gear boxes and bearing housings. If any component begins to overheat, these pads provide an early warning sign that is visible to the pilot on preflight.

Comes in many Different Flavors

Raven IIs come in several different variants, according to customer requirements. The R44 IFR

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Trainer is specifically designed for instrument flight training. Its enlarged 10-hole instrument panel accommodates all the avionics and instruments necessary to qualify and train VFR pilots for an instrument flight rating. Robinson offers a selection of the latest Garmin and Bendix/King avionics.

Although the R44 IFR Trainer was designed for instrument flight training, it is not approved for actual IMC operations. However, the speed, range and stability of the platform would make it a pleasurable IFR machine.

The R44 Clipper has fixed utility or emergency pop-out floats for extended flights over water, landings on lakes and extra security when flying over busy harbors. A low c.g. enhances the Clipper's stability on agitated seas, and its advanced single-bag float design allows safer liftoff after water surface landings. The Clipper's fixed utility floats add approximately 50 pounds to the R44's empty weight, and cruise speed is reduced by only 10 knots. The pop-out floats add about 65 pounds to the empty weight with almost no reduction in the Raven's 113-knot cruise speed, and provide the same buoyancy as the fixed utility floats. All R44 Clippers are coated with specialized corrosion proofing throughout.

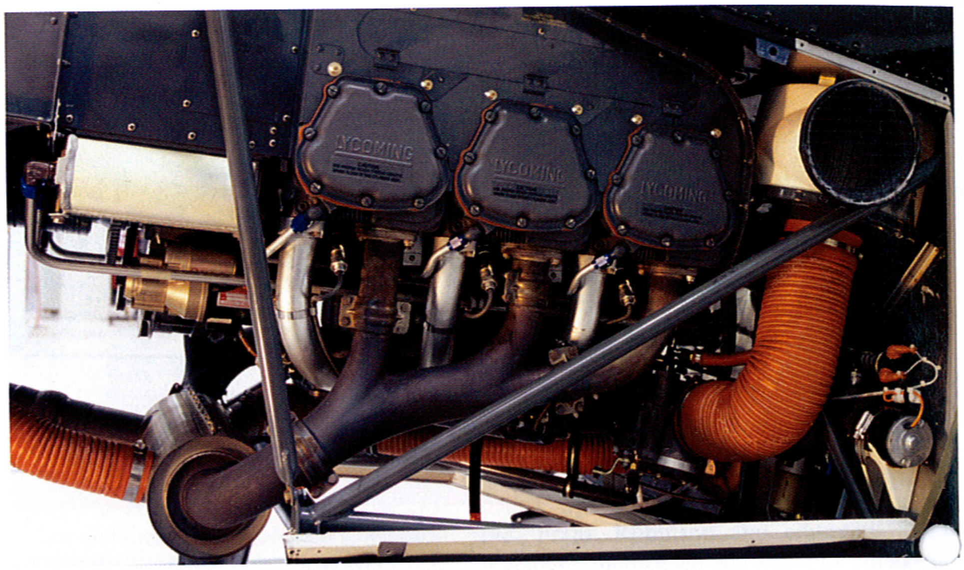
Robinson's R44 Raven II Newscopter comes fully equipped for electronic newsgathering, including a gyro-stabilized camera platform, high-quality camera, microwave package and communications equipment.

The R44 Police Helicopter is a turnkey aerial platform designed and equipped specifically for law-enforcement agencies. The FSI Inframetrics 445G-MKII infrared sensor with 7X zoom color TV camera system is standard equipment. The nose gimbal mount provides 360-degree rotation and a wide field of vision.

A fold-down video monitor with a 10-inch sunlight-readable color LCD is also standard. The observer can quickly raise or lower the monitor to increase outside visibility when the camera system is not in use. The monitor mount also accommodates the King KFM 985 dual-band transceiver. An optional FM control head may be installed with up to three FM transceivers. The Spectrolab SX-5E below the right-rear seat allows steep left turns without the left skid interfering with the light beam. The high-intensity focusable beam may be controlled by the observer using a hand controller, or as an option the light can be slaved to the nose gimbal.

Simplified Systems

A low-maintenance approach applies to all of the systems, including the engine. Instead of taking a smaller, lighter engine and squeezing more horsepower out of it, Frank Robinson decided to use a higher-horsepower engine and derate it, theorizing (as he had with the R22) that if the engine does not have to work so hard it will last longer. So far none of the in-service Raven IIs has experienced an engine failure.



The Raven II's IO-540 fuel-injected piston engine, top, produces 300 hp. Robinson derated the engine to 245 hp for takeoff and 205 hp for continuous operation to extend the life of the engine. The tail-rotor blades, bottom, are attached to a teetering hub with a fixed coning angle.

The IO-540 is a six-cylinder, horizontally opposed, fuel-injected engine with angled-valve head and tuned induction capable of producing 300 hp. Engine TBO is 2,200 hours. Robinson has derated the engine to 245 hp for takeoff, and 205 hp for maximum continuous operation. An added benefit of this derating is that the engine will produce takeoff horsepower at much higher altitudes.

The engine is controlled by an electronic governor, also manufactured by Robinson. Once the pilot rolls the throttle up to 80-percent power the governor automatically takes over, although it can be easily overridden by the pilot. Another benefit of fuel injection is the absence of carburetor heat, the bane of most piston engines. Fuel is fed by gravity, with an electric prime pump. Should the engine inadvertently shut down, the loss of oil pressure turns the pump off, preventing the engine from flooding during a restart. The output shaft powers both the cooling fan and the drive-belt sheave. The cooling fan provides air to the cylinder heads and oil coolers, in addition to gearbox cooling and cabin heat.

The main rotor system is a two-blade under-slung teetering hinge. The all-metal stainless-steel blades are connected to the hub by two sealed, Teflon-coated coning hinges. The pitch-change bearings are wet and enclosed by a neoprene boot at the blade root. The main gearbox contains a single-stage, splash-lubricated gear set and is driven by a V-belt sheave that lies directly above the engine sheave. The "sprag" type one-way drive clutch is contained within the upper sheave and is easily checked by the pilot for operation on preflight.

An automatic clutch actuator raises the upper sheave when the pilot engages the clutch, and a tensioner automatically stops the engagement when the correct tension is achieved. It will also automatically adjust tension in flight. The tail-rotor drive does not use any hanger bearings, driving a splash-lubricated gearbox. The two metal tail-rotor blades are attached to

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a teetering hub with a fixed coning angle, and use elastomeric teetering bearings and Teflon pitch-change bearings.

The hydraulic system–consisting of a pump, three servos, reservoir and lines–boosts the main rotor flight control while eliminating cyclic and collective feedback forces. However, the flight controls maintain a direct mechanical link, allowing full control should the hydraulics fail. The pump is driven by the main gearbox, operating at a relatively low pressure of 450 to 500 psi. The pilot can turn the hydraulics off, though electrical power is required to do so, providing a fail-safe system.

The 28-volt DC electrical system powers a single bus bar and includes an alternator, voltage controller, battery relay and 24-volt battery. Standard lighting on the R44 includes strobe, navigation, landing, panel and map lights. The warning lights are extensive, and the low-rotor warning also includes a horn activated at 97 percent rpm. Another nice standard feature is the four-place voice-activated intercom system.

All of the equipment has been installed for easy accessibility for the observer in day or night operations, including independent audio controls, map lights and a convenient pouch for binoculars. The removable left-seat pedals and collective control may be installed to allow a rated copilot to control the aircraft using the center cyclic control.

Flying The R44

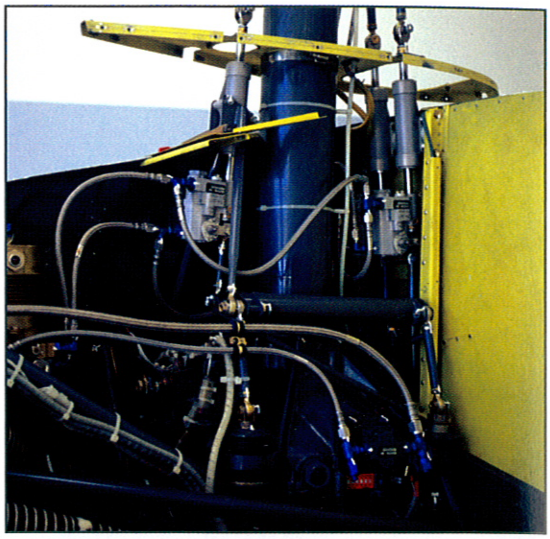
I went to the Robinson plant to fly the Raven II and met up with factory test pilot Dan Benton. Preflighting the aircraft was easy and straightforward. Despite my many questions about the systems, I don't think the preflight took more than 20 minutes. The aircraft, N744AK, was fairly stock, with the bubble doors added on the pilot and copilot sides. Soon to be delivered to a customer in Alaska, it had just undergone the factory acceptance flights and had logged about 14 hours.

Conditions were ideal: sea level, a temperature of 15-degree C, a light breeze and plenty of California sunshine. The equipped empty weight of the aircraft was 1,520 pounds, including 20 gallons of fuel, enough to fly 1.5 hours. With the two of us the takeoff weight was 2,020 pounds, well below the helicopter's 2,500-pound mtow. Even full main and aux fuel tanks would have taken our weight to only 2,200 pounds, leaving 300 pounds for backseat passengers.

Getting comfortable in the aircraft is not a problem. The pedals adjust fore and aft, and at my six-foot height they were very comfortable. The cockpit is also wide enough, especially with the bubble windows, for two adults to sit side-by-side without feeling cramped.

One difference that I noticed was the T-bar cyclic. In spite of feeling different at first, I became used to it in a matter of minutes. A nice byproduct of this design is that it makes it easier to enter and exit the cockpit. The copilot stick is easily removable with a push-pull pin, and a tension spring can be wound to compensate for the lack of weight, thereby balancing the stick for the pilot.

Several useful features include the radio frequency selector, hydraulics switch and a starter switch for in-flight engine starts on the cyclic, leaving the left hand free for mixture control. The collective is conventional with a twist-grip throttle, governor and starter switches.



Robinson Helicopter devoted more than two years to designing the hydraulics system, right, for the Raven II–a small helicopter with big ambitions.

The factory checklist was also easy to use, and the engine started immediately. Since I fly turbine helicopters, I'm not accustomed to engaging a clutch or checking magnetos, but the run-up is about as simple as the rest of the aircraft. Slightly disconcerting is the feel of the automatic governor. Once the throttle is rolled up to 80 percent, the governor automatically advances the throttle the rest of the way. During power changes the throttle is always moving, so you learn to keep two fingers loosely on the throttle and the other two aft on the collective itself so as not to impede the governor operation.

After determining from the chart that our max-continuous manifold pressure for the day was 22.7 inches and our max takeoff was 25.5 inches, we were ready to fly. Liftoff to a hover was smooth. With our c.g. we lifted off in an almost level attitude, with the tail rotor high enough to have minimum pendulum effect. Initial hover in ground effect required only 19 inches of manifold pressure, with a cylinder head temp of only 355 degrees, oil temp of 180 and 65 psi oil pressure. My initial impression was that the aircraft had a stability-augmentation system since it felt so stable and control feedback was minimal. Tail-rotor control in ground effect was positive and required little input.

I elected to do a max performance takeoff for the first liftoff before we burned more gas, and throttling it to max takeoff pressure we accelerated vertically at well over 1,000 fpm. Due to altitude restrictions I had to level off early, and at cruise power the aircraft easily accelerated to more than 120 kias.

Once clear of the Class D airspace I was able to climb again, and at 90 kias and cruise power setting we were able to maintain a 1,200-fpm steady-state rate. Vibration levels in flight were minimal, although the aircraft had a mild two to one vibration in cruise. Benton explained that on new deliveries it is normal to fine tune the tracking after the first 30 hours or so.

Steep turns and air work were also predictable. The Raven II is responsive and quick, but one of the best features has to be the governor. Through the whole power range from max-performance departure, steep turns and rapid collective changes (both up and down), the governor kept the engine and rotor rpm rock steady.

Turning off the governor proves not to be a problem either, requiring minimal input by the pilot to maintain rpm. Hydraulics off in flight, while not much of a problem, does require more work by the pilot–collective forces are heavy but manageable, requiring the pilot to hold a lot of upward pressure. Cyclic feedback was nonexistent with the hydraulics on, but of course a little noticeable with them off. Hydraulics off in a hover is probably the only area that pilots new to the aircraft will need time to work on. It is easy to over-control the aircraft in this condition, and only practice will refine the control touch.

Visibility is a strong point in this aircraft. Steep approaches can be made without kicking the nose to one side–as in helicopters with larger instrument panels. We did not have much of a wind and the helicopter was light but tail-rotor response was excellent in both IGE and OGE hovering. In fact, it required little pedal movement and I got nowhere near the stops.

The flight manual notes that hover controllability has been demonstrated in a 17-knot wind from any direction up to a 9,800-foot density altitude. Slope landings were also predictable. The aircraft did not have an attitude indicator and there is no published slope limitation, but the slope that I used appeared to me to be about six degrees and felt fine.

Autorotations were exactly the opposite of what I am used to, but a lot of fun nonetheless. Pilots such as myself who are accustomed to high-speed, low-inertia systems will learn that it's OK and preferable to get the collective down as quickly as possible. Rotor speed does not recover quite as quickly with this aircraft, but there is not as much risk of overspeed during turns and attitude changes.

The biggest difference is glide ratio. This aircraft likes to glide forever, and in fact at 90 kias and 90- percent rotor rpm glide the Raven II will fly a mile from only 1,300 feet agl. Since this was a customer-owned aircraft, we did power recoveries. However, once I got used to the glide ratio it was easy to maneuver to a spot on the ground.

Overall, the Raven II is a small helicopter with big ambitions. This helicopter proves that it doesn't take a big budget to get big performance. By once again keeping everything simple, Frank Robinson and company ha[illegible] designed a helicopter that can effectively co[illegible]pete with light-turbine singles at a fraction of the price. ❑

Raven II Performance and Specifications

External dimensions	
Fuselage length	29.8 ft
Fuselage height	10.8 ft
Fuselage width	4.2 ft
Rotor diameter	33.0 ft
Weights	
Max takeoff	2,500 lb
Empty (including oil & avionics)	1,506 lb
Standard fuel	184 lb (30.6 gal)
Auxiliary fuel	110 lb (18.3 gal)
Max payload w/standard fuel	810 lb
max payload w/auxiliary fuel	700 lb
Performance	
Cruise speed	117 kt
Max range (no reserve)	347 nm
Hover ceiling IGE @ 2,500 lb	8,950 ft
Hover ceiling OGE @ 2,300 lb	7,500 ft
Hover ceiling OGE @ 2,500 lb	4,500 ft
Rate of climb @ 2,500 lb & 6,000 feet	1,000+ fpm
Maximum operating altitude	14,000 ft
Price	
Standard	$340,000
Clipper II (fixed floats)	$356,000
Clipper II (pop-out floats)	$363,000
Newscopter	$549,000

Source: Robinson Helicopters