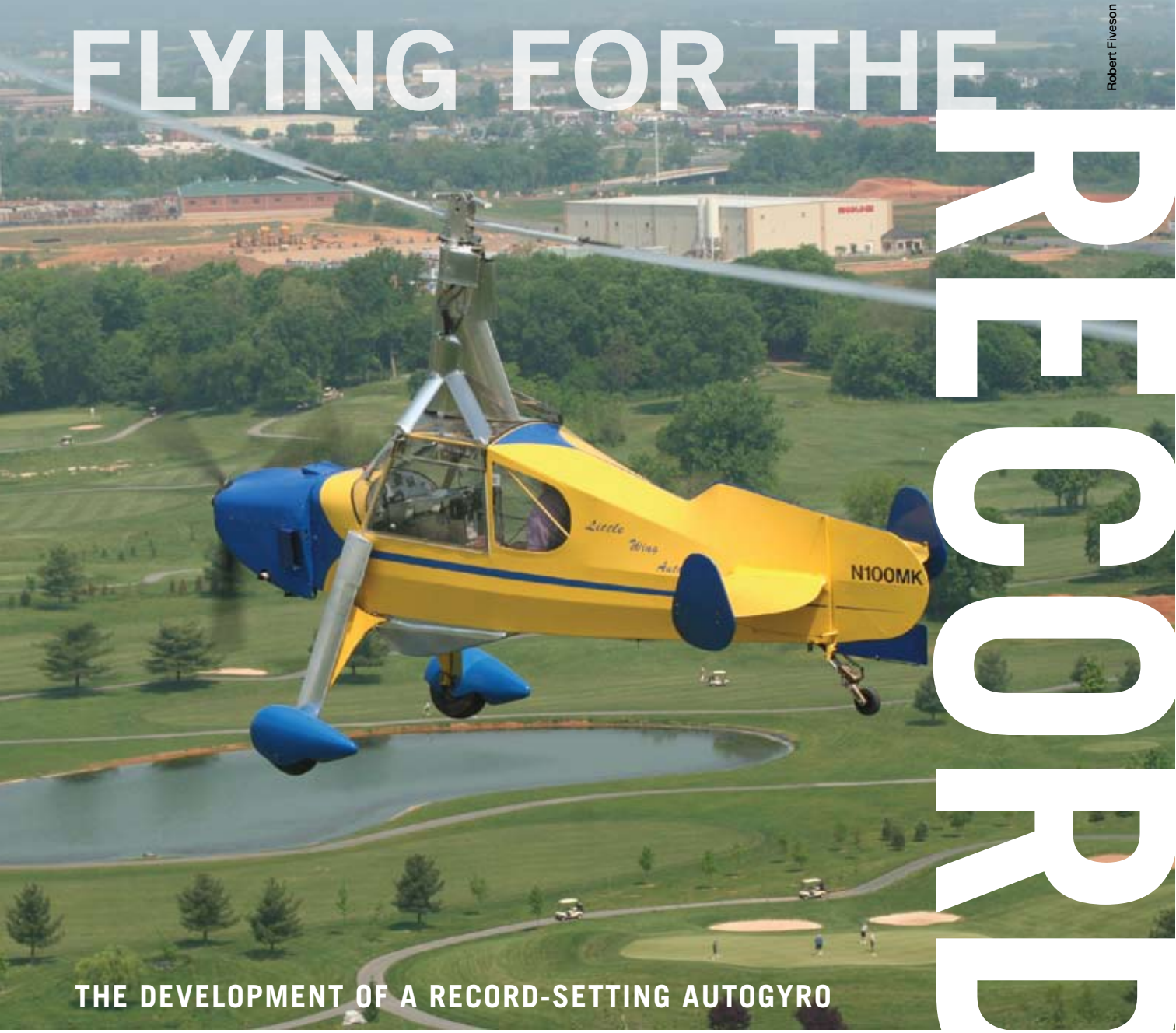
FLYING FOR THE RECORD

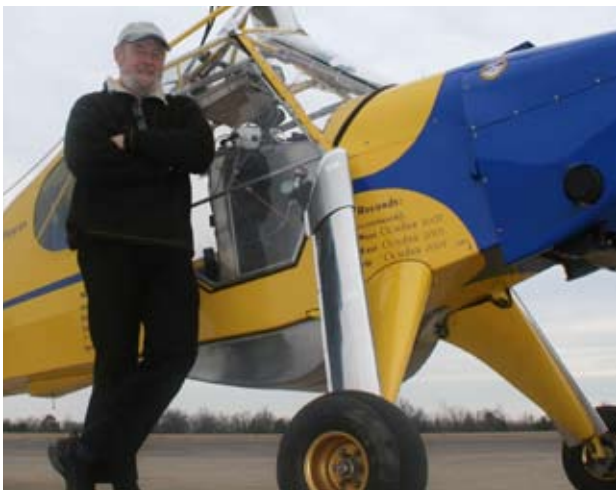


Robert Fiveson

THE DEVELOPMENT OF A RECORD-SETTING AUTOGYRO

ANDY KEECH, EAA 169840

The 1930s was a decade of gyroplane development that eventually led to helicopters. The tractor gyroplanes developed then flew high, far, and acceptably fast. They had the capability of landing in their body length and could land across the runway in a strong crosswind. Their safety record was not matched by general aviation aircraft for another 40 years.



Andy Keech and *Woodstock*

But, development of the tractor gyroplane ceased with a demonstration of a Fiesler Storch in 1938, which established that specialized fixed-wing aircraft could perform most of the important capabilities of the gyroplane. Fixed-wing machines were less expensive, more robust to battle damage, and their development was a faster maturing science. Gyroplane development went into remission for well more than a decade.

The re-emergence of the gyroplane came about 15 years later, in the mid-1950s, in the much different form of Igor Bensen's Gyrocopter with the engine behind the pilot. This layout was copied, cloned, and improved in various forms, but overall it produced an unfortunate record as one of aviation's most accident-prone ways to fly.

Ron Herron, EAA 420005, and I looked at the tractor layout and wondered how much *more* successful it could be with modern materials and a modern aero engine. With some 60 years gone by one could only wonder. Our curiosity…and the results we achieved…occupied eight years of our lives. It was time well spent.

The only realistic and convincing way to judge success is to make unquestionable, officially verified, and internationally recognized performance attempts at the widest range of world records, witnessed by the National Aeronautic Association (NAA) and certified by the Fédération Aéronautique Internationale (FAI).

Aviation in general and gyroplanes in particular have a tradition of advance promises of performance, sometimes from nothing more than an artist's computerized impression of a futuristic design. Ron is a modest and understated designer/builder, and we came to an early agreement we would never telescope our performance intentions ahead of an attempt and would not release the news of successes until they were officially verified by the FAI in Lucerne and posted on its website.

If we were to turn the momentum of rear-engine autogyros to the safer tractor layout, we would spare no effort to the credibility of what we were doing.

WOODSTOCK

Ron and I began as naifs in the record-setting game… in all aspects. The technical challenges as seen by myself (as pilot) were resolved and handled by Ron (an airframe and powerplant mechanic and instructor with 30 years' experience and a lifetime focus on autogyros). I found the record range was a treasure trove of confusing options and alternatives. Eventually it emerged that there are simply two measures of performance…*how far* and *how fast*.

In the horizontal they are *distance* and *speed*. In the vertical they are *time to climb* and *altitude*. These are obvious for good reason; anyone with an aircraft wants more rather than less of all these measures. When we began this project we knew there was only one aircraft in the world to hold all four forms of performance as world-class records–a Russian military aircraft, the Beriev M12.

Aviation is not rocket science. The oppositions to performance are gravity and drag. We decided that all efforts would be made to reduce the weight of the aircraft and to clean it up so that it would slip through the air with less turbulence. With a high-altitude engine we added the option of working in thinner air (around 15,000 feet).

Weight reduction was our top priority. We decided we would spend up to $300/pound in options for lighter components. We chose a very light radio and used glider fabric (1.7 ounces/square foot) rather than standard aircraft fabric (2.7 ounces/square foot). When painted, the former weighed 6 pounds less than the latter. That is the weight of an extra gallon of fuel—another 10 minutes of range and a faster climb and higher ceiling.

AS WITH ALL RECORDS, I SAW HOW I WOULD FLY IT DIFFERENTLY IF FLOWN AGAIN.

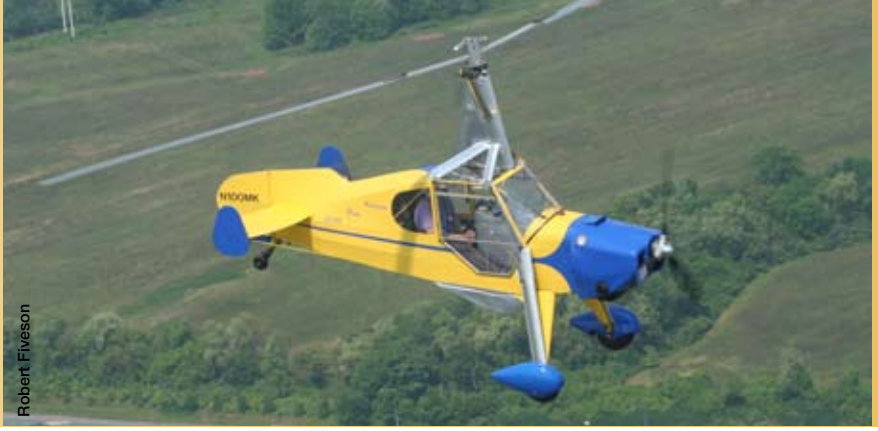
The frame was tubular steel, which is light, strong, and provides a robust and stiff roll cage. We carried the very lightweight philosophy into all decisions, including mini diode lights in the cabin and 3-inch wide strip maps where charts were required in the longer flights.

The engine was a turbocharged Rotax 914. It is light and capable of 100 percent power to 16,000 feet, and apart from the 32 records held by this aircraft, the 914 flew the previous world records (by Barry Jones and Bill Clem) for distance and altitude. It has operated on other aircraft (when highly modified) to 60,000 feet. A normal, stock 914 has even flown over Mt. Everest (29,000-plus feet). I found it to be trouble-free.

Ron made a progression of streamlining alterations. The most effective was fairing components within the prop arc (landing legs, bracing supports to the mast, and rounding out the interface between the horizontal stabilizer and the fuselage). This produced a 15 mph increase in speed and was the most heartening discovery to me. Ron's grasp of the most effective modifications for the missions was always better than expected. Fairing the rear of the mast and the wheels improved the speed only by a trifle.

The previous tractor gyros (in particular, the Pitcairns) were sized to the Fleetwing fuselage and 300-hp radial engines. We began with a blank sheet of paper. There was no reason to make our gyro oversize, so it was built to my body size--18-inchwide shoulders and 160 pounds. This produced an airframe with no waste aerodynamically and at a size that could fly and compete in both autogyro (E3) weight categories (above *and* below 1,102 pounds): E3a and E3b.

Empty weight ranged from 550 pounds to 600 pounds depending on configuration: stripped down for altitude or tanked up for maximum range. The aircraft could fly very well at more than twice its empty weight. On one flight it grossed 1,132 pounds at takeoff.


Robert Fiveson


Bonnie Kratz

To fly to the scope of our intentions we required oxygen and a transponder. These were placed forward of the pilot where they could be adjusted and controlled. With this were two GPS units, powered by aircraft power and batteries for redundancy in navigation, and a flight recorder to confirm performance.

Cabin heat was omitted simply by our not thinking about it until it was too late to build it in. This preyed on my mind for five years until it was put to the test. Flying CAVU (ceiling and visibility unlimited) with layered black clothing and in a mildly ventilated cabin produced a snug enough accommodation.

We dubbed the autogyro an LW5, "LW" for "little wing," painted it yellow, and called it *Woodstock*.

THINGS HAPPEN IN THREES

We started our record flying with little understanding of how to estimate anything near the maximum performance. We had little experience in focused performance, except in transcontinental record flights ("There and Back," *EAA Sport Aviation*, May 2005), which had elements of speed, distance, climb, and altitude. So we had some understanding of what could be expected.

In discussions with Ken Wallis, my mentor (Ken held all the records in the gyroplane class at one time), it appeared that one needs three attempts at records to get a rough approximation of how well we will fly, determine improved strategies/technical modifications for later attempts, and make refinements based on what we learned to this point. Then you make a "push the envelope" flight in the final round.

The costs involved are essentially the same whether one succeeds or fails. Therefore it is normal to be conservative on the initial attempts to gain the record and avoid the loss of confidence and momentum that comes with failure. This is most true with the long-range speed and distance flights that are flown concurrently. To sustain high power through the speed flight runs the risk of not completing the flight from fuel exhaustion on the distance requirement. Therefore one flies slower (than ideal for speed) to conserve fuel for distance.

In our case, we made significant improvements in speed and distance on all rounds, yet on all of the long flights (seven!) I still landed with two hours of fuel remaining, mostly because the improvements in the aircraft and our technique kept advancing faster than our performance expectations. While that may be technically wasteful we were very happy with the outcomes.

WEATHER

Weather is a big factor in performance flights, particularly in speed/distance flights where wind and access to high altitude play a big part. Beginning with the start of building *Woodstock* through the last flights–eight years–I kept a year-round Internet awareness of the jet stream. This allowed me to anticipate its effect on the flights and to choose the ideal part of the year to make the attempts. The jet stream bottoms out in the south mid-winter, and that coincided with our location at North Little Rock Municipal Airport in Arkansas. Engine performance considerations relating to oil temperature and power output come with low temperatures.

North Little Rock had one obvious advantage; it was within a short walk for Ron to work on the modifications to the LW5 at leisure, though it required me to commute 1,100 miles from Washington, D.C. to fly. Having a National Oceanic and Atmospheric Administration weather station on the airport also helped because the staff took a friendly and focused interest in our enterprise and spared no expertise or time giving us the best advice as to what to expect many days in advance of flights. This was a big component in our confidence and success on the more serious and longer flights.

NAA WITNESSES

The NAA provides a trained witness to oversee flights for accurate judging and recording of the tasks undertaken. This includes weighing of the aircraft on certified scales, adherence to the rules, timing of arrivals and departures, paperwork, and so on. They generally have flying experience; some have a lifetime of professional expertise. The most helpful was Ted Kelly of Clarksdale, Mississippi, a retired United 747 captain.

In the days leading up to the most demanding distance flight, he accompanied me to the weather meeting to see how the office functioned from the inside. While we were watching the information being displayed on the computer screen he asked if we could see the isobars and isotachs. This was hardly a question I would have asked because I did not know the significance of the question. However, airline pilots know that when the isobars (pressure lines) and isotachs (wind speed lines) are parallel, the air is free of turbulence. That realization and confidence allowed a more aggressive approach to engaging higher altitudes. We had the perfect day. CAVU all the way, and wind on the tail. On that day (February 3, 2007) we reset our previous world straight-line distance record by an additional 200 miles (a 30 percent improvement on the

Far left, ***Woodstock*** in flight. Left, to give you an idea of the cabin environment in which Andy flew, the cabin is 23.5 inches wide, and he sat with the aluminum gas tank, which measured 21.5 inches high by 24.5 inches deep by 12.25 inches wide, essentially in his lap.

Working together, Ron Herron (standing) and Andy Keech spent eight years developing ***Woodstock*** to prove how modern materials and engines might make the tractor gyroplane a practical aircraft again.

previous distance record). At one time during the flight, groundspeed showed 206.1 mph.

Other support came from Zane Anderson, who allowed me to use his warm and spotlessly clean hangar to house and weigh my machine before each flight. Randy MacKenzie also provided certified scales on time and at the hangar when required.

GETTING IN SHAPE

For a sedentary activity such as flying there may be little requirement for exercise. I knew an Olympic gold medal rifle shooter who did not exercise at all and looked like the Michelin man, yet was still the best in the world.

In my case, fitness is at least mentally reassuring. In the eight years of building and flying *Woodstock*, I rode 35,000 miles on my bikes. A few months before the last round of record flights I rode 1,100 miles round Iceland in three weeks. If I am physically slack, I may be less focused and therefore could be undeserving of success. This is my only concession to superstition of any kind. In light of our rule to keep all weight off the aircraft, it made sense to keep weight off the cargo also. Fear of failure runs deep.

PRACTICE MAKES PERFECT

Rehearsal for the flight was both mental and actual. With 11 months between the mid-winter record efforts, there was a luxury of time to preplan over charts with weather history as to how best to fly the future flights.

On one flight–the closed circuit distance task–I laid out 10 courses between the normal arc of wind direction at that time of year in 10 degree increments and loaded these courses into the GPS. On attempt day, I would choose which of these courses most closely matched the wind. That would be the most efficient one to fly as it involved the least crosswind component.

In preparation for the altitude flight there was a requirement for takeoff right at first light in agreement with air traffic control. I practiced dressing in the altitude clothing (sequence and layer on layer) and timed this procedure. It took 10 minutes.

With a series of perhaps a dozen other things I would have to manage myself as I had no trained support crew–and because I become flustered if I get behind and have to rush to catch up–I made two full, timed dress rehearsals. This involved getting out of bed at 3 a.m., eating breakfast, loading gear into the car, driving 40 miles to Frederick Municipal Airport, opening the hangar, preflighting the aircraft, calling the weather briefer, submitting the flight plan, opening the hangar door, pushing the aircraft outside, starting the engine warm-up, taxiing to the active runway, and pre-rotating the blades. I then reversed the procedure and drove home. I did this twice and kept a checklist of the order these items were to be addressed. When the day arrived, I had essentially "been there." The procedure was routine and unhurried. The flight was uneventful and straightforward. Anticlimactic even.

ALTITUDE RECORDS

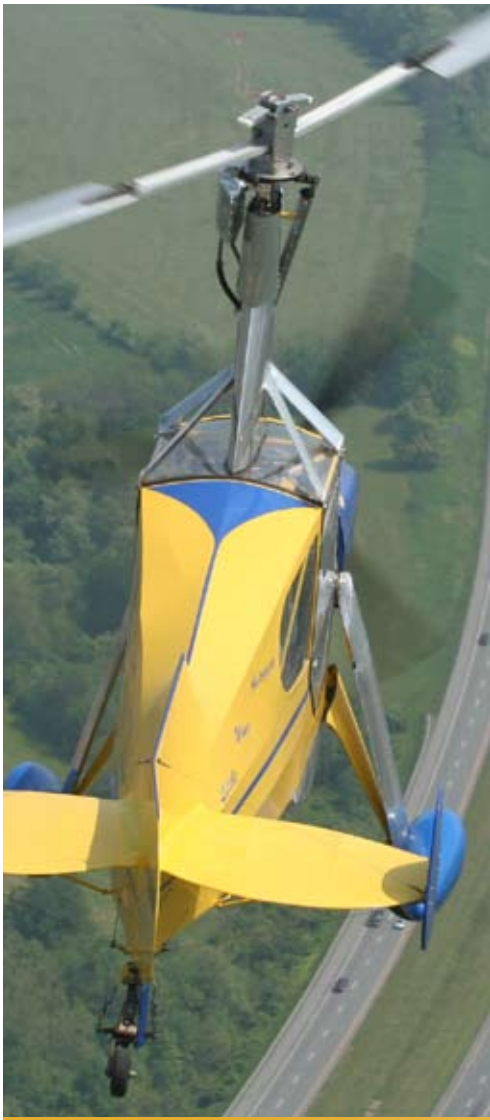
The location for the climb effort was 5 miles east of the Frederick airport, over Lake Linganore. This location is on the edge of the Washington Metropolitan air defense identification zone and 15 miles south of Camp David. It is on a direct line between Camp David and the White House. This is very "nervous" airspace since September 2001 and is patrolled by armed helicopters and jet fighters.

After two test flights to fine-tune the prop pitch setting we were ready to fly the "for score" flight. The first attempt was weathered out so we had a free rehearsal. On Saturday, April 17, 2004, I arrived at the hangar with Al Nance, my mechanical assistant, and Mike Pablo, the NAA witness. When I called for clearance I was told that then British Prime Minister Tony Blair was being hosted by the president at Camp David. There was a security ceiling at 20,000 feet, and the airspace was being patrolled by armed aircraft. We canceled and waited until the prime minister went home.

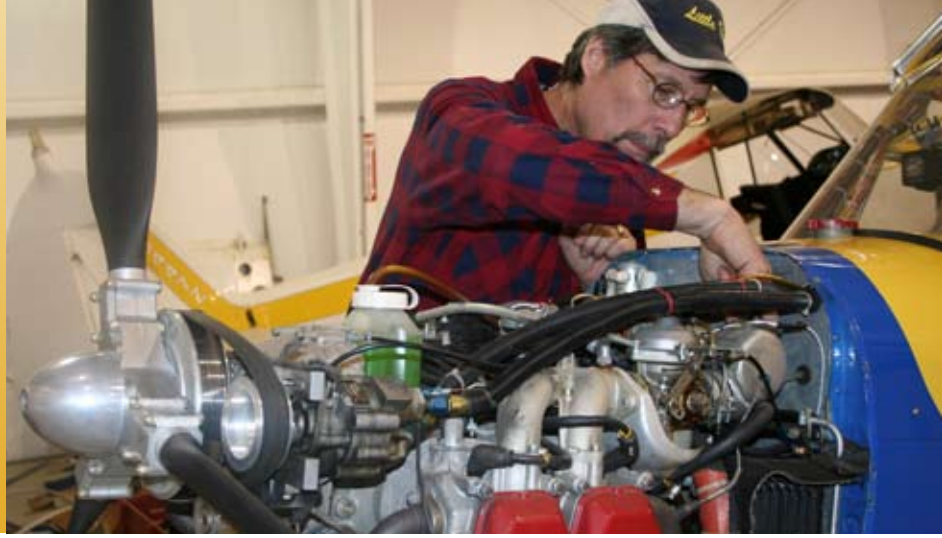
Three days later, Al and Mike met me at the hangar and we proceeded to go through the previously rehearsed procedure through to takeoff at first light. I called to announce myself at 5,000 feet and was assigned a discrete transponder code. I was told by air traffic control that the controller could not "see" me. With a sinking heart I canceled the flight plan and pulled the power off. At this point I noticed that I had not turned on the transponder.

I turned it on and asked if I could proceed, was given permission, and proceeded with the climb while I turned on the oxygen flow. The climb was routine and uneventful through 15,000 feet where I attached the oxymeter to my finger to monitor blood saturation and pulse. I passed through 20,000 feet in 23 minutes. The routine was a cycle of staying at the assigned fix on the GPS, monitoring airspeed to optimum for climb, monitoring engine temperatures, and clearing for traffic outside.

At this point, the climb rate had dropped to 500 feet/minute and the prop rpm moved up to the redline in the thinning air. From then on I



The aircraft set straight-line distance, altitude, closed circuit, and speed records.



The engine is a turbocharged Rotax 914, capable of 100 percent power to 16,000 feet.

needed to continually reduce power to stay below the engine's redline. Rotor speed was 275 at ground level and had moved up to 375.

I passed 25,000 feet and realized I had passed Bill Clem's mark. At this time things began to become busy. Condensation was forming on my headset, on my microphone, in the mask, and on my glasses. The earphones were sliding off my ears, and I had just passed 26,000 feet—my assigned altitude for the flight. In the mix of straightening the headset and waiting for a break in controller chatter, I overshot to an indicated 26,200 feet. I relaxed forward pressure on the stick, and the mild back pressure raised the nose to zero airspeed. The nose dropped, and we were on our way down while asking permission to descend. The controller made a transponder/altitude check during the descent and then cleared me passing through 18,000 feet to proceed on my own means to land.

The total flight was 70 minutes from wheels up to touchdown. I used 7 gallons of fuel and carried 5 gallons (30 pounds) for no purpose, both ways. Of all the record flights I have made, this is the one (26,408 feet) that has the most interest to people. To me it was the simplest, shortest, and most routine of all. It was simply a matter of pointing *Woodstock* upward and waiting for a while.

The climb trace arc from the flight recorder showed that the climb, if continued, would have topped at 30,000 feet. I would have liked to revisit this challenge, but it would require a pressure oxygen system, which are generally affordable only by governments and corporations, but unobtainable by me.

CLOSED CIRCUIT AND SPEED RECORDS

Closed circuit distance and speed records are the truest measure of horizontal performance because they are flown in both directions and therefore neutralize any wind advantage that comes with straight-line flight.

We performed these flights twice (in 2006 and 2007) out to distances of 633 and 702 miles respectively. Within those distances is the option to fly 500 km and 1,000 km speed tasks centered around the turn point at the far end of the flight. There are tradeoffs for speed as extra weight (more fuel) is carried to fly the longer distance.

There were other compromises. We preplanned the 2007 flight with 10 options depending on the direction of the wind on the day. Nine of these courses were straight to and from the turn point. The tenth required flying a curved path around the F-16 fighter base airspace at Fort Chafee on the Oklahoma/Arkansas border.

On the day of our attempt, this was the best course for the day and added 77 seconds to the six hours of flight time. To supersede the previous class record by the required 1 percent, I needed to be 35 seconds earlier. So near and yet so far. However, it reset the light subclass record, so there was consolation.

This flight began at dawn, to the west, going low on the way out to minimize head wind while outbound. There is high, rough ground between Little Rock and Fort Smith, and flying low over it while loaded with fuel offered a period of uncertainty and discomfort. My speed across the ground was only in the high 60s, which added anxiety in spite of any expectation of higher speed later to compensate. The unknowns are large early in these flights. Matters and numbers sort themselves out progressively as preplanned references are overflown. A fuel deficiency alternate was planned for all 10 optional courses. General Yeager's rule of always leaving an "out" applies to anyone with a sense of mortality.

As the flight progressed, the vast flat country by the Canadian river passed beneath and eventually Oklahoma City slid by to the south, and beyond that was the turn point at 351 miles outbound. Time showed 4 hours, 30 minutes at the turn, and this was well past my half fuel state.

While carefully (and generously) turning around this point I applied more power and began the climb to a friendlier altitude where the wind would be my ally and the view become more "big picture" as sight distance grew with an eightfold increase of ground clearance. My mindset changed to being more detached and methodical with calculations of groundspeed and fuel burn being primary along with flying the centerline on the moving map.

Within a short time of reaching altitude I became distracted by the pain of a freezing left foot. I had burnt that foot a decade earlier, and apparently circulation was diminished and the symptom was extreme discomfort. I had no choice but "live with it" for another two hours. The landing at North Little Rock successfully concluded my most serious closed circuit flight. However, the experience with cold exposure gave

me considerable concern for the following straight-line distance flight that was planned for even higher altitude with three to four times the exposure time.

I called my friend Jon Johanson who was in the United States at the time. Jon is the alpha male of Earth-Rounders. He flew around the world three times and across the poles and all five oceans in his RV-4. Jon has had the same problem of cold feet at altitude and had the solution-- wrap paper around one's footwear as insulation. I had some paper napkins and a roll of duct tape to secure the paper round my boots. Simple, low-tech solutions are still in fashion. This saved the day four days later during the flight from North Little Rock to Frederick.

As with all records, I saw how I would fly it differently if flown again. I landed with an abundance of fuel. If there were a next time, I would have had no trepidation to fly at high cruise power all the way. This closed circuit flight had been longer than any previous gyroplane flight, even straight line, where the advantage of tail wind all the way can be optimized.

Armed with that awareness we prepared for the final flight--straight-line distance.

STRAIGHT-LINE DISTANCE RECORDS

I flew straight-line distance records three times–in 2005, 2006, and 2007, with distances of 617, 672, and 879 miles respectively. The latter two flights were flown also for heavy subclass records for altitude and time to climb. The last flight was the most interesting, so I will address it in some detail.

We had previously flown record flights with equal success with two different sets of rotor blades. One set was very smooth running, though heavy, wide chord 27-footers. The other set was light, temperamental, narrow chord blades that were 2 feet longer. Both cruised at the same speed, and the longer blades could fly higher. We chose to fly these last flights with the lighter blades (35 pounds lighter) and take up the weight difference by installing an additional 5 gallons of fuel as a seat tank. This way we had an extra

WEATHER IS A BIG FACTOR IN PERFORMANCE FLIGHTS, PARTICULARLY IN SPEED/DISTANCE FLIGHTS WHERE WIND AND ACCESS TO HIGH ALTITUDE PLAY A BIG PART.

Gyroplanes, helicopters and autogyros, built and flown by their owners, will gather at the Mentone, Indiana, airport on August 5 through 9 for the 46th Annual Convention of the Popular Rotorcraft Association.

Contact PRA P.O. Box 68, Mentone, IN 46539, Phone: 574-353-7227, Fax: 574-353-7021, Email: *prahq@medt.com,* or visit *www.PRA.org.*

5 gallons with no weight penalty, and since range, climb, and altitude were targets, this was the best way to go. We had an extra 50 minutes of flying time.

The lead-up to departure at dawn on the morning of February 1, 2007, was tumultuous because of an unwelcome official "guest"; by the end of this flight I'd had four hours sleep in the previous 55 hours. Sleep loss and weight loss are apparently common among record pilots in my conversations with those I know.

Departure was at dawn with a weather wizard's promise the air would be smooth, dry, and clear. The wheels left the ground on time, and I quickly established climb at 60 mph and a full load. The climb was maintained until passing over Osceola, Arkansas, at 16,200 feet to reset *Woodstock*'s previous (heavy sub class) record of 14,425 feet.

Above 10,000 feet, groundspeed began to climb above indicated airspeed as the tail wind began to strengthen. Oxygen was on, as was the oxymeter to check my blood saturation. At this point I noticed that a connection to the oxygen supply had separated, leaving the supply line on the floor of the cabin. The reach was further than I could make by leaning forward, so I took the dipstick mounted on the side of the cabin fuel tank to scratch the line forward until I could reach it and reestablish connection. Saved again by a low-tech solution.

As I clipped the corner of Tennessee and entered Kentucky, the GPS groundspeed began to climb through 120, 130, 140 mph; by the time I entered West Virginia and began to pass over the mountains, I was seeing speeds of 170, 180, and high 190s. It apparently went higher as the GPS showed a stored top speed of 206.1 mph. Wind was as predicted…hale and hearty. This was a once in a lifetime day.

I have always had a private dread of flying over rough, high terrain especially when it is snow-covered. Toward the eastern side of West Virginia I noticed an extended cloud layer below my altitude, and with that comes the possibility of being socked out below at destination. I descended to lower altitude, lower speed wind, and very lumpy air that was bouncing off the mountains. On reaching Martinsburg Airport in West Virginia I could see familiar countryside that led to the destination airport at Frederick.

On circling the Frederick airport, I could see the windsock showing a stiff wind from the west indicating a landing on Runway 30. The approach on final was especially gradual with a flare to a no-roll landing. A pleasant end to a most gratifying flight. Distance flown on this effort was 879 miles, a more than 200-mile improvement on the previous straight-line record in 2006.

REGRETS

On a personal level, I regret the concern for my welfare that I brought to my two most inner circle supporters, my wife, Marie, and my partner in crime, Ron. Also, for wherever I have lost any friends or diminished any friendships along the way. Obsessive personalities involved in enterprises such as these will create abrasive points of view that are unlikely to change, hard to swallow, and as unintended as they are regrettable and inevitable.

The upside is the old friendships with long-time friends who know, anticipate, and tolerate my failings. Those friendships are stronger and more valued because the strengths come from those who brush aside my less pleasant qualities.

On a technical level, I regret not having the assets and opportunity to have a fourth round of flying to reset the major world-class records this aircraft already holds. They can be extrapolated from what we know now from the third round of flights. They are

- Altitude to 30,000 feet
- Time to climb to 6,000 meters at 20 minutes
- Closed circuit distance to 800 miles
- Straight line distance to 1,200 miles
- Speed for 500 km of 110 mph
- Speed for 1,000 km to 115 mph

Those are for someone else. I wish that person the best.

SATISFACTIONS

This aircraft holds world-class records in climb, altitude, distance, and speed. It is the second aircraft in 100-plus years of aviation history ever to do so. Of the 30 records that *Jane's Book of Aircraft* have judged to be "more important," 23 of those are held by individual aircraft, two other aircraft (the Yeager/Rutan *Voyager* and Steve Fossett's *GlobalFlyer*) hold two such distinctions, and this LW5 aircraft holds three. Ron and I are satisfied that we have established tractor gyroplanes to be exceptional performers, and probably still the safest way to fly.

Andy Keech is an instrument-rated commercial pilot as well as a senior parachute rigger. In addition to his record-setting autogyro flights, he was one of the world's top freefall photographers and has produced three books on sky diving. For more information visit www.LittleWingWonder.com.

GO DIRECT

Woodstock was donated to the EAA AirVenture Museum in 2007 and is currently on display. For more information on the aircraft visit:

www.AirventureMuseum.org/collection/aircraft/Herron_Keech%20Little%20Wing%20Autogyro.asp.