SIG'S KADET SENIOR ARF

SIG's Kadet trainer was one of the first, and one of the best, R/C trainers ever designed. Through the 30+ years it has been available, the .40-sized "Kadet" has taught the mysteries of airspeed control, proper attitude and basic aerobatics to tens of thousands of new R/C pilots. The old Kadet still lives on in both the updated Kadet LT-40 kit and the Kadet LT-40 ARF. Both versions are still helping to train more R/C pilots, as they are two of the easiest trainers to fly.

A few years ago SIG introduced a larger version of this proven airframe as the Kadet Senior ARF. The 70" wingspan of the .40-sized Kadet is increased to 80". The wing area grows from 910 sq. in. to 1,200 sq. in. The larger airplane weighs 7.75 lbs, just 29 % more than the smaller, original version. The much larger wing and moderate weight increase result in a low "wing loading", only 15 ounces per square foot of wing area. These are very good numbers for so large a plane.

The Kadet Senior's low wing loading is just one reason it is well suited to the training roll. The very large tail surfaces, (302 sq. in. for the stabilizer and 105 sq. in. for the vertical fin) combine with the large fuselage area behind the wing to keep the Kadet Senior pointed straight ahead, even during "deep stalls". This "yaw" stability at low speeds helps the student pilot to keep the nose pointed the right way during slow flight and landing approaches.

Because the Kadet Senior has good yaw stability, the ailerons can be made larger than is usual on a trainer plane. Large ailerons give more control response but can also cause an effect known as "adverse yaw". Adverse yaw happens because the "down" aileron of a flat bottom wing has more air drag then the "up" aileron and this causes the plane's nose to actually point AWAY from the direction of the turn at slow speeds. The Kadet Senior did not exhibit any trace of this condition except during post-stall recovery.

The Kadet Senior ARF builds along the standard ARF format. While it is not a Ready To Fly plane, it takes only about 30 hours to build. The builder must supply the .60 size engine and a four-channel radio with five servos (the ailerons use two servos).

Photo 1

Photo 2

Photo 3

As Photo 1 shows, the fuselage servos mount in the traditional ARF manner, using standard balsa pushrods. The aileron servos are mounted in each wing half just in front of the ailerons, (the dark wing areas in Photo 8). Each half of the two-piece wing slides onto a metal wing spar and a steel positioning rod (Photo 2). Front tabs lock into a notch in the fuselage (Photo 3), locking the wing halves together. Two nylon bolts lock the wing's rear together and hold the wing onto the fuselage. The 80 " wing transports as easily as a 40 " wing because of this unique construction.

The airplane we tested was the red ARF version, (a blue version is also available), equipped with a JR radio and Hitec HS-635MG servos everywhere but on the throttle. The throttle used a Hitec HS-422. A special engine powered the plane. The engine shown in photo 4 is the very first four-stroke model engine ever made – the OS .61. With exposed rocker arms and pushrods, this engine matches the Kadet Senior's image in looks and sound. (Photos 5 & 6)

Photo 4

Photo 5

Photo 6

The engine has about the same power as a .40 of today. It turned the 12 x 6 Master Airscrew at 9,200 rpm. The engine idled at 2,400 rpm. The center of gravity was located 3.75 in. back from the leading edge. This was just slightly ahead of the recommended 3.87 in. Control surface movements were 1 in. for elevator and 1.25 in. for rudder. The ailerons moved 1.25 in. up and 1 in. down. Having more up than down aileron throw helps reduce any adverse yaw effects. The angle of the aileron control horn that causes this asymmetrical movement is built into the plane at the factory.

The wind was calm, the temperature hovered around 50 degrees and the skies were gray. We taxied the Kadet Senior a full 100 ft. out to the runway over 4 in. long grass. The plane taxied well with no tendency to drop a wing or "nose in". Taxi and turns were stable, as the main gear is widely spaced. The provided 3.25 in. wheels rolled easily over the long grass.

The plane lifted off, almost by itself, after a 55 ft. uphill takeoff run. Photo 7 shows that very little elevator input was required, even over the long grass. This plane does have a lot of lift. The wings remained level and steady throughout the initial climb out. We were impressed that so little right rudder was required to maintain straight flight. The climb out attitude was about 20 degrees and the climb speed remained steady.

This plane was not equipped with EagleTree's Flight Data Recorder (as are many of Sport Aviator's flight test planes) so no definite airspeeds are available. We estimate that the climb speed was not more than 20 mph and the rate of climb was around 1,000 feet per minute (fpm). A hands-off, straight climb and slow airspeeds are two attributes of a very good trainer. The student pilot has time to think about that first turn and doesn't need to worry about keeping the darn thing going straight ahead.

After adding a few clicks of elevator trim and one of right aileron, we tried some right and left level turns. The first flying difficulty most new pilots experience is coordinating elevator and aileron inputs during a turn. In order for the plane to remain at a constant altitude during a turn, the wing needs to produce more lift than when flying straight and level. Adding "up" elevator generates the extra lift. If the student pilot adds too little elevator, the plane dives, picks up airspeed and then climbs steeply as soon as the wings are leveled. If too much elevator is added, the plane climbs in the turn, loses airspeed and stalls.

The Kadet Senior required so little up elevator in a 45-degree banked turn that making level turns should present minimal problems to the student pilot. Just a hint of elevator was all that was required for good turns. Even 60 +-degree banked turns required very small elevator inputs. Turn coordination should be easy to learn in this plane.

After checking out level turns, we started to put the Kadet Senior through its paces. First came the power-off stalls. The first few attempts were not particularly satisfying. The plane just wouldn't stall. It only "mushed" a little while descending at about 500 fpm. We finally got the stall break by pointing the nose up sharply to about 40 degrees and letting the airspeed bleed off. (Photo 8)

Photo 7

Photo 8

At the break, the right wing always dropped but was easily raised with left rudder. The ailerons, as on all flat-bottomed wings, lost most of their effectiveness at the stall break. While they would eventually "pick up" the down wing in the stall, there was considerable adverse yaw during the process. The nose drifted right about 45 degrees before the wings leveled. Using rudder to recover was easier but not required. Level, power-off stall speed was less than 10 mph, estimated.

Next came the stall tests with the plane in a 60-degree bank at half power. Full up elevator stalls in this position illustrated one of the most important abilities of an excellent trainer. In either left or right turning stalls, the nose dropped back to level flight and so did the wing. No matter the direction of the turn, the Kadet Senior recovered to level flight *by itself* and then began to climb in response to the full up elevator input that remained throughout the stall. Releasing the up elevator resulted in a slow but steady climb, straight ahead. You can't ask more of a trainer than that.

Self-recovery abilities like this are what is meant when pilots say an airplane is gentle and forgiving. Many sport planes, and all aerobatic performance planes, would snap out of this type of stall either over the top or out the bottom and then into a spin. Not so the Kadet Senior.

We then tried a series of "deep stalls". In a deep stall, the full up elevator input is maintained and the plane allowed to stall repeatedly while descending. If a plane has any bad stall characteristics, deep stalling it will reveal every one of them. The Kadet Senior went through repeated deep stalls, (called Phugoid Oscillations--just think of the way balsa gliders repeatedly climb and dive when you throw them), with only a slight right wing drop, corrected by left rudder. There were no snap rolls, no spins, no bad habits at all.

But sometimes a plane can be designed to be too forgiving and gentle. Such planes can't do much more than fly straight and level. So we flew the Kadet Senior through some basic aerobatics just to see what would happen. First came the rolls. Aileron control was about the same as all ailerons on flat-bottomed wings. The plane responded quickly to the initial aileron inputs but response rate slowed as more aileron was added. This is a good thing for trainers. The initially quick roll response prevents the student pilot from putting in excessive aileron control. The diminishing aileron response rate enables the student to recover in case too much aileron has been inputted.

But how did the plane roll? Better than we would have thought. A single roll, started with the nose pointed upwards about 30 degrees, was completed without requiring the dreaded "down elevator". Roll rate was about 2-3 seconds and the plane recovered to level flight. Multiple rolls were easy, requiring a minimum of down elevator during the inverted portions. No matter the number of rolls, the plane continued straight ahead on its original flight path (unless we messed up the elevator timing). Great roll qualities for a trainer.

Next came stall turns. The Kadet Senior's vertical fin is large but the rudder is not. Stall turns could only be performed while there was still some vertical movement. The traditional stall turn with rudder inputted when the plane stops its vertical ascent, just didn't work, even at high throttle. As with all planes having dihedral, some opposite aileron was required to maintain direction during the maneuver.

The engine used in this plane just isn't the most powerful .61 ever made. It sounds and looks great, but doesn't have a lot of power. The Kadet Senior is designed for .60 2-stroke or up to .90 sized 4-stroke engines. Even so, this airplane performed 75 ft. diameter loops with no problems. Three loops in a row presented no difficulties, probably due to the very light wing loading. We have flown other more conventionally .61 powered Kadet Seniors that have no difficulty flying repetitive 150 ft. diameter loops.

Inverted flight required half of the available "down" elevator input to maintain level flight. Despite having dihedral, the plane did not offer to "roll out" of inverted flight unless prompted with ailerons. 45 degree banked inverted turns used about all the remaining down elevator control to remain level. Steeper turns began a slow, but controllable descent in the turn despite full down elevator. We have maintained level, 60-degree, inverted turns in another, more powerfully equipped, Kadet Senior. Neither Kadet Senior would consistently perform an outside loop, usually rolling out at the bottom.

Snap rolls were very gentle affairs. The snap roll was more than 20 feet in diameter and very slow, about 2 seconds. Not suitable for an aerobatic contest, but a lot of fun, and safe, to do.

Photo 9

Photo 10

Photo 11

Photo 12

In addition to its outstanding trainer performance, The Kadet Senior looks great in the air. Photo 9 shows the Kadet Senior in a low fly-by. In Photos 10 and 11, it is easy to see that the Kadet Senior just looks so different from most of the everyday trainers found at flying fields today. The transparent film covering shows the plane's internal structure and adds to its good looks. However, the builder, Mr. Frank Costello, added the thin black trim lines separating the red sections from the white areas. Frank also added the red fuselage top section inside the windshield. Such small trim enhancements to an ARF help make it look different from other identical planes.

After every great flight, there must be a great landing. The very light wing loading and exceptional directional stability make landings too easy, even for student pilots. The approach was flown at 1/3 throttle with the airspeed about 20 mph. Altitude control was easy to maintain. The 90-degree turns from downwind to base to final approach required very little up elevator input to maintain the constant descent rate of about 200 fpm. We held about 1/3 up elevator, with the engine idling, to maintain the descent with the nose just slightly below level. As Photo 12 shows, very little extra up elevator was required to flare the plane into the perfect nose-high landing attitude. Landing speed was about 10 mph with a 20-foot rollout.

At any time during the approach, except during the turns themselves of course, adding full power would begin an immediate recovery climb. The airplane climbed at a comfortable angle with no signs of stalling. The Kadet Senior's easy recovery ability will come in handy should the student pilot need to quickly abandon a landing approach.

The Kadet Senior's very light wing loading helps it to be a great trainer. But there is a tradeoff, as there always is with "things mechanical". Because of its light wing loading, the Kadet Senior responds quickly to wind gusts. Steady wind is no problem for this plane. We have flown it successfully in steady winds up to 18 mph (measured).

However, severe wind gust conditions require a steady hand on the elevator. Happily, the Kadet Senior responds to heavy wind gusts by pointing the nose UP. This climb response is much preferred over many other sport planes' diving response. At least the student pilot has time to learn elevator corrections for gusts when the plane climbs in a gust instead of descending. The worst that happens is that the landing is a little "long" on the runway rather than the approach being too "short" and not reaching the runway.

The Kadet Senior requires a bit more work to get ready to fly over a conventional ready to fly trainer. The wing halves do not need to be glued together, but the builder has to install the windows and windshield. (Not a hard job at all.) The result is one exceptionally great flying trainer that looks different from all the other trainers on the field.

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Wing loading – Wing Loading is one means to measure how easy a plane is to fly. It is determined by dividing the plane's weight in ounces by the total wing area in square inches (wingspan x the wing's width, known as its *chord*). Planes with wing loadings in the 12-18-oz./sq. in. usually are gentle and easy to handle. Too light a wing loading makes the plane hard to handle in wind.

Deep Stalls – Stalling a wing means that air is not moving quickly enough over the wing to maintain lift. The plane's nose suddenly drops and the plane descends until it gains enough airspeed for the wings to again generate lift. Deep stalls are repeated stalls maintained by full up elevator, so that the airplane never regains flying speed and the wing remains stalled throughout a series of climbs and dives.

Yaw – There are three control directions in an airplane. Longitudinal control means the nose is pointed up or down. Roll control means the wings rotate around the fuselage line. Yaw control means the fuselage points left or right.

Ailerons – These are the moving surfaces on the wing's trailing edge. Moving these surfaces make the wings rotate around the fuselage centerline.

12 x 6 – Model aircraft propellers are described by their diameter, in this case 12 in. and their pitch. Pitch is the distance the propeller would move forward in one revolution, here 6 in.

Stall & Power-off stalls – These stalls are made by pointing the airplane slightly upwards with the engine set at idle and the wings level. The airplane gradually loses airspeed until there is no longer enough air flowing over the wing to maintain lift. The wing then stalls; losing ALL lift and the plane quickly descends.

Stall break – As an airplane's wing loses lift and stalls, the nose drops sharply through the horizon, continuing downwards to about a negative 60-degree angle. This is the stall "break". Good trainers do not have a fast, or sharp, stall break and usually descend with the nose at about a level attitude.

Snap out – "Snap out" is an expression used to describe the violent, uncontrolled rolling and pitching movement made by an airplane as it loses all flight stability. This condition is a stalled maneuver similar to an intentional snap roll. The plane departs controlled flight, tumbles around its center of gravity and usually requires 50 or more feet of altitude to recover. Snap-outs usually result in a spin if the up elevator is not released during recovery.

Over the top or Out the bottom – These terms refer to the way an airplane departs controlled flight when stalling in a steep turn. Over the Top means the high wing in the turn drops suddenly and the plane rotates and falls out of the turn into an upright spin. Out the Bottom means the bottom wing in the turn suddenly drops and the plane rotates into the turn usually resulting in an inverted spiral dive.

Stall turns—An aerobatic maneuver in which the plane is pointed straight up, loses airspeed and then full rudder is applied. The plane rotates along its yaw axis and points straight down. An attractive maneuver, also sometimes mistakenly called a Hammerhead Stall. A stall turn is done power-off, a Hammerhead uses full power while yawing.

Opposite aileron – Many aircraft roll when rudder is applied. To prevent this rolling response, the pilot inputs aileron control in the direction opposite that of the rudder. Left aileron is therefore the "opposite aileron" for right rudder input.

Snap rolls – An aerobatic maneuver using fast and full elevator input to stall the airplane while full rudder and aileron controls are inputted in the same direction. The stalled airplane quickly rotates around its center of gravity. The plane will enter a spin if these control inputs are maintained. Using up elevator results in an inside snap roll. Down elevator produces an outside snap roll.

Downwind, Base, Final Approach – The typical landing pattern consists of three parts. First the plane heads in the opposite direction to that the pilot intends to land. This is the Downwind and is usually offset from the runway by about 200 ft. The plane then turns 90 degrees towards the runway and covers the 200 ft offset from the runway. This is the Base leg. The plane then makes another 90-degree turn heading straight at the runway. This is the Final Approach that results in a landing, usually.