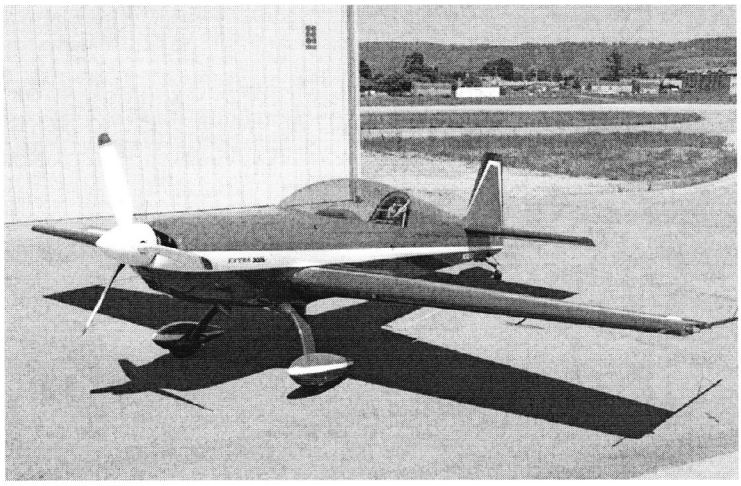
AEROBATICS

A Personal Experience



Presented by:
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How is the wind? I look out my bedroom window and look to the west. The leaves on the Hickory out back are moving only slightly in a northwesterly direction.
Good, about 3-5 knots. Looking at the sky, there are a few high fair cirrus mare's tails at about 25,000 ft. I guess and some light ground fog that will burn off soon. I can feel the slight hollow in my stomach, a mixture of joy and fear that brings me back to being a kid on Long Island on a big surf day. Then we would look for bad weather to bring in 8 to 12 foot waves with a storm front. Always ragged but powerful, it was big board weather and these were days of surfing in wetsuits in cold dark green water on waves that were trying to eliminate your insolence in an impersonal manner. Many times you could hear other guys doing the same thing in the fog and not see them. Of course, most of the time it was small surf and screwing around on a sunny beach, but the storms brought the juice and the adrenaline.

Today the waves are in the sky but the feeling is the same. Now we want clear skies and calm winds though. It's early and I already have my Nomex flight suit, gloves and favorite jacket in my bag. Breakfast will be some hot tea and nuts eaten on the way to the airport. I say goodbye to Sally and the kids on my way out, feeling a little like a thief leaving a house. I don't want too much emotion with this separation from the ones that I love, it's better to have a clear mind now. The question of WHY is not appropriate at the moment; nor is the contemplation of the results of an unsuccessful flight. The sky is cobalt blue and soon I will be alone and free in a place that is unimaginable to most of the people still sleeping on the ground.

I like to drive with the windows open, even on cold days so that I feel the air. Today it is dry and there is the smell of a distant wood fire that I have come to associate with Kentucky in the fall. I don't want the separation of a car's heater and windows; no it is better to be in the elements as soon as possible. There are not many cars on the road and the drive is automatic really. I check the wind direction and velocity on a couple of flags along the way; no surprises. In a few minutes I am at the hangar doors. The entire airport is silent except for the outdoor loudspeaker which is tuned to the common air traffic radio frequency for this part of the state. "Outlaw traffic, Piper N 35 papa sierra is short final runway 22" is announced to no one in particular. The hangar door is heavy and screeches loudly, as if in pain while I pry the doors apart on their old tracks. The noise is almost shocking at this airport, where everything else is tied down or behind other doors. Even the machines are asleep. Behind these unwilling barriers is my prize. The Extra 300 looks like it is moving even when it is sitting still. The curve of the fuselage blends seamlessly with the angular wings as it sits with its nose and 3 bladed prop pointed towards the sky. There is an elegant efficiency about this plane and nothing is superfluous. If is doesn't do something to improve the flight characteristics of the design, it isn't there. As I walk closer, the bubble canopy reflects my image back to me in a funhouse distortion which will be replaced with superb all around visibility in the air. In fact, at times it doesn't even seem to be there at all if the lighting is just right, when it can leave me with the impression of being outside of the aircraft.

I change into my sage green Nomex flight suit, a gift from my flying buddy Dick Frymire, former F101 Voodoo driver and Ky. Air National Guard Commandant. Next to

go on are the gloves and then somewhat incongruously, a pair of soft running shoes. These give me a light touch on the rudders which are sensitive to begin with. Pilots often talk about "kicking a rudder" and not surprisingly rudders don't seem to like being kicked. Aerobatics is all about feeling the plane and it is best to think in terms of degrees of pressure on the flight controls. A loose pilot who moves fluidly with the airplane can actually control it without conscious thought and will be rewarded with most sublime flying experience, that of moving through the skies in all dimensions without really being forced into thinking of how he is doing it.

The next step is the pre-flight walk-around and inspection. It begins with the most obvious of observations. Is everything there? Is a wing bent, is the prop hub leaking oil, are the tires flat and so on. Then it is on to specifics. I start by unlatching the canopy and checking to see if the front restraining straps are properly immobilized. No use watching a metal tipped strap smacking against the Plexiglas during the first snap roll of the day. Next, I check the fuel computer, zero the altimeters and check the avionics panel for popped breakers and the like. It is very important not to have debris of any sort in the cockpit. I then go to the front of the plane and check the prop for damage, the spinner for security and the intakes for patency. I then unscrew the oil access door and check for 12 quarts, the recommended amount for aerobatics. If not properly secured, the dipstick can spew oil in a negative G maneuver, covering the canopy with black oil as a teacher of mine learned from a student's preflight mistake. I then visually check the fuel level in the wing and aerobatic tanks. More than five gallons per wing tank can damage them in high G maneuvers, so it is important to have enough for the flight to and from the practice area and no more. The gas is then checked for water contamination, a potentially deadly event. I walk counterclockwise around the plane to the left wing. Grabbing its' tip, I vigorously rock the whole plane up and down to check for looseness or unusual movement. The wings are carbon fiber and are designed to take more than 20 plus or minus Gs, much more than a human can tolerate. However this strength is unidirectional, and if bent in the wrong way the wings are surprisingly delicate. The Extra has huge ailerons which extend for most of the wing span. These are augmented by spades, an aerodynamic shovel like device that is attached to the aileron and increases the mechanical advantage of the aileron. The plane will roll at 360 degrees per second at full deflection, which is faster than that of an F 15. They are checked for security. The fuselage is a steel tube frame, covered with fabric. This is technology that is at least 80 years old, except for the fabric type. When tapped with the finger it should be drum tight and free of wrinkles. The tail assembly with its rudder and elevators is checked for freedom of movement and defects, and then the same procedure is repeated on the other side of the plane. The plane is then rolled out of the hangar. I put on my chute and headset and climb into the plane, careful to step only on areas stressed for weight bearing. I sit down on the leather seat which reclines about 20 degrees to allow for better G tolerance. My legs extend almost straight ahead producing an almost straight line from the feet to the hips, also minimizing blood pooling during high G maneuvers. The Russian Sukhoi aerobatic planes that I have trained in exaggerate this position even further and place a huge joy stick almost in front of the pilots' face. The 5 point restraints are tightened down to the point of immobilization and then rechecked. The headset is plugged in and the union between pilot and plane is complete.

The engine is primed and the starter engaged. After a few blades the engine catches and smoothes out. Now we wait, the airplane and I. It's time to get reacquainted as the engine warms up. This can take 5 minutes or longer depending on the outside temperature and conditions. It's taxi into position, run through the preflight check list and then full throttle.

The whole take off run is over in about 6 seconds or so, but during that time the plane will try to veer to the left as the gyroscopic force of the propeller and engine torque take effect. This is countered with right rudder and right aileron. This tendency is present in all propeller aircraft, but is particularly exaggerated in a taildragger type without a nosewheel. The Russian aircraft have props that turn counterclockwise, in the opposite direction of American and European planes, so a pilot new to Russian aircraft will have to reverse this pattern. By now the airplane is accelerating through 100 mph and a smooth pull on the stick will nail me back in the seat and the world is being left behind at 3,000 ft. per minute. This is one of my favorite moments in flying. The sheer power of the plane and the speed of the ascent is magnificent and unlike any thing else short of a fighter plane. In fact, the performance of the Extra at this point of the flight is very similar to a Mustang or Spitfire of World War 2. The pitch of the nose is so high that it is wise to turn left and then right is a sort of see saw maneuver to make sure that no one is in the blind spot ahead of the plane. At about 2500 feet, I switch to the wing tanks and set up for the short cruise to the aerobatic area. Bring the nose down and the plane will cruise at 170 mph. Trim for cruise. Now is a good time to loosen up with some Dutch rolls and climbing and descending 45 degree lines. These are maneuvers designed to improve rudder, aileron and elevator coordination. They also acclimatize the pilot to the positive and negative Gs as the blood rushes to and from the head.

In 5 minutes or so, I am over Standard field in Elkton. I like to have an airport nearby for possible emergency landings. "Campbell approach, Extra 245 echo x-ray is with you at 4000 over Standard, requesting VFR flight following." After a positive reply from Campbell, it is time to switch to aerobatic tanks. A 360 degree turn confirms no local traffic.

I set the plane for 25 inches of manifold pressure, 2500 rpm and push over for 180 knots. Pull for straight and level, then a steady back pressure to 3.5 Gs. The familiar pressure pushes me into the seat, and unseen giant hand presses my arms down and pulls against my cheeks. Add left rudder for the gyroscopic precession of the propeller then gradually back off the pressure. Look left then right wingtip to check the horizon for symmetry. At about 150 degrees I look up to catch the inverted horizon through the canopy. Float over the top, and for a moment I hang nearly weightless against the straps. Pick up the horizon and even up the wingtips. Slight right rudder is pushed to adjust for lack of propeller effect then it is time to begin to pull the stick straight back into my belly. The Gs load up and the back end of the loop should mirror the first half. I start to grunt and tense up my leg muscles to prevent blood leaving the brain as the plane completes the last 6o degrees of the loop and the Gs build up. At the moment that straight and level flight is attained, let up on the back pressure and a smooth round loop is the result. A noticeable

bump confirms this if the pilot has exited the loop at the same altitude as he began. I actually penetrate the same pocket of air that I started from.
I regain 180 knots in a few seconds of straight and level flight then smoothly pull to repeat the first 90 degrees of the loop. A rapid unloading of the stick and the plane is vertical. Check the wingtip sighting device against the horizon to confirm. Full left aileron and the wingtip rotates around the horizon and I complete two full revolutions in less than three seconds. Hard full right aileron and the airplane stops rotating instantaneously. After and altitude gain of 2000 feet in a few seconds the airspeed has decayed to 40 knots, below the stall speed of the Extra. Hard full left rudder, then full right aileron and partial forward stick and the plane pivots 180 degrees to the left in a Hammerhead stall turn and is now on a vertical down line and accelerating fast. This pivot is a moment of perfect balance between lift, airspeed, gyroscopic forces and propeller effect and is a moment of grace and magic. For a split second the airplane pinwheels around its center of gravity and hangs in space. Then the inevitable occurs. The plane cartwheels over and I stop it on a straight vertical down line.

Once again I pull the last 90 degrees of a loop into straight and level at 170 knots. I pull briskly to a 45 degree up line and wait for 130 knots. A sudden pull along with a hard right rudder snap rolls the plane to the right. This produces an accelerated spin in the direction of flight, and the plane yaws, rolls and pitches simultaneously. The horizon disappears in a blur and I wait for 1 ½ rotations and stop it on the inverted 45 degree line with wings level. I draw a straight line for the same length of the snap roll and then round off into a loop in a maneuver that is referred to as a fish tail by aerobatic pilots. At the bottom of the loop the airspeed picks up again and then another vertical upline is drawn. This time I pull the power off and climb dead vertical, all the while correcting for changing torque and gyro forces. After a few seconds the airplane will start to slide backwards, tail downwards. The controls are held tightly in the tailslide, then full back stick produces a reverse airflow over the tail surface and the plane abruptly lurches forward or canopy up in a negative G maneuver and rock past the vertical down line like a pendulum and swings forward and backward once or twice in a decreasing oscillation. The vertical downline is acquired and airspeed is regained. A ¾ loop is performed and then the airplane is rolled to the upright from the top of the loop in the classic Immelman maneuver; first used by German ace Max von Immelman in 1916. Power is slowly pulled off and the nose is brought up to compensate for decaying airspeed to maintain altitude. The controls start to loosen up and 5 knots above stall speed I add full right rudder with full back stick and the airplane spins to the right. After establishing the spin, slight relaxation of the back stick will accelerate the spin. The world is rotating almost faster than the eye can follow. After 1 3/4 rotations I add back stick to resume the normal spin and full left rudder and then forward stick to re-establish normal airflow over the wings and they will start flying again. The world stops rotating and then it's back to vertical downline and recover with a ¼ loop.

All this time I have traded altitude (potential energy) that I achieved with my engine for airspeed (kinetic energy) in a Yo-Yo fashion repeatedly. The G meter has recorded plus 5.5 G (during the snap roll) down to negative 2.5 (during push overs). These are referred to eyeballs in or eyeballs's out Gs and are really fairly mild by comparison to world class

competitors who routinely go plus 10 and minus 6 during a 4 minute routine. All of this is done without the benefit of a G suit. Tolerance is achieved by multiple, incremental flights and general conditioning. Weight training is especially helpful.
At this point in the flight I will usually practice some maneuvers that gave me trouble or are new to me. It's important to fly with a pre-conceived plan and not just buzz around like a demented dragonfly. In any case, after about 25 minutes or so of hard aerobatics the results start to deteriorate and it's time to knock it off. This is especially important if I am flying more than one hop that day. Aerobatics is like ice cream for me, just the right amount is a joy and too much will make you feel bad. This will vary from day to day and with my condition at the moment. Weather also plays a big part in tolerance, with hot, muggy summer days being the worst for endurance and safety by far. I'll take the cold, clear, hard blue of a winter sky anytime.

"Campbell approach, Extra 245 echo x-ray is departing the practice area for Christian county VFR" and then it's time to go. I switch to wing tanks and throttle back to 22 inches of manifold pressure and 2200 rpm. The plane will cruise at 140 knots and I can enjoy the scenery. The Jefferson Davis monument is easily seen and is the best landmark in the area, about 10 miles east of the airport. It always amazes me to see the monument in its melancholy obscurity compared to the big winners of history, such as Lincoln and Washington.

The airport comes into sight and I switch to the local frequency, check for traffic and announce my intentions to land. I descend to 1000 feet above ground level, switch to aerobatic tanks, full pitch prop and 22 inches of manifold pressure. The plane slows abruptly as the propeller becomes a flat disc and acts as an aerodynamic brake. It nudges me forward against the straps during the deceleration and in a few seconds I am at the pattern speed of 120 knots. This is considerably faster than most light aircraft in the traffic pattern, so it pays to look around carefully.

Abeam of the runway numbers I reduce the manifold pressure to 15 inches and set up a glide with a 300 fps descent. Most aerobatic aircraft are flown around the pattern in a semi-circular pattern and close in to the runway. This is the same style of pattern used by Navy carrier planes and offers improved visibility and an added measure of safety if the engine quits. I mentally fly a slot on final and correct for a moderate left crosswind with left aileron to lower the left wing and right rudder to yaw the nose in line with the runway. Without these corrections the plane would be blown to the right of the runway or even worse, might touch down with a lateral sideload on the tires and ground-loop. This is the inherent weakness of the taildragger configuration and it is much less pronounced with nosewheel aircraft.

I flare at about 5 feet off the runway and wait for the speed to decay. This part calls for patience since it always seems to take a long time and visibility of the runway is now limited to peripheral vision only. A well timed landing will plant all three wheels simultaneous with the arrival of stall speed, 54 knots in the Extra. Now the plane is on the ground and is rolling but not flying. However the cross wind will still need correction and I dance on the rudders to keep it between the weeds. However, as the old saw says

"the flight isn't over until the airplane is chocked in the hangar" is still true and it pays to stay focused on controlling the plane until it is put away.

Soon this is accomplished and I pop open the canopy and relax and enjoy the warmth of the engine. It is quiet again, except for the popping and creaking of the exhaust stacks as the metals contract. Time elapsed for this flight was 45 minutes and I am relaxed and happy as hell. I thank the Lord for allowing me to fly again and put the Extra away. My short trip into the heavens is now a memory but I am already planning for the next time.

Aerobatics is the human intersection between aerodynamics and physics. A pilot performing a spin for example is manipulating the fluid medium that his plane's airfoil is moving through (the air) and producing a desired movement through applied physics. One can fly the maneuver in a rote manner without understanding the principles behind its' successful execution, but does so at the risk of not being able to think his way out of a problem, should it arise and without the ability to rationally modify the maneuver. It is necessary to learn a maneuver in a step by step manner initially to reduce pilot workload in a complex environment but, it is certainly more intellectually satisfying to comprehend the "whys" of control movement and their effects at the end of the day. To this end, I shall try to summarize the basics of aerodynamics and flight physics in a painless and brief manner

So, why do airplanes fly? Let's recall that air is a fluid and its behavior is predictable. An aircraft is a unique machine that can move through the air by generating lift and opposing the downward force of gravity. The presence or absence of an engine, such as in a sailplane or glider is irrelevant. In 1782, Daniel Bernoulli, a Swiss mathematician described the variation in pressure exerted by a moving mass of fluid, in his case water.

$$p + \tfrac{1}{2} \text{ roh } V^2 = \text{constant}$$

where roh is air density in mass (or weight) per cubic feet. The other symbols, p and V indicate pressure and volume respectively. More simply put this equation says that the pressure plus ½ times the density time the velocity squared must always equal a constant value.

To simplify this thought even further lets call the term $\tfrac{1}{2} \text{ roh } V^2$ "dynamic pressure". The p in the equation is really the "static pressure" of the air. Therefore we can state the equation as:

static pressure + dynamic pressure = constant

Static pressure means the pressure exerted by a still air mass. So air or any other fluid can be thought of as exerting a static pressure equally on the walls of its container. Now is air is in motion it still exerts static pressure, but it also would have a dynamic pressure associated with it. This is the pressure that would be exerted if the fluid were brought to

rest. The pressure would be realized if, for example a plate were placed in the fluid in an effort to dam the flow as shown in this diagram.

Practically speaking, Bernoulli's principle states that a fluid only contains so much pressure. It the fluid is at rest, all of the pressure is static pressure, but if the fluid is in motion, then some of the static pressure must be traded off for dynamic pressure. Therefore, as flow speeds up, there is an increase in dynamic pressure and the static pressure must go down, since the sum of the two must always remain constant.

Let's look at a wing now. By definition the imaginary line running from the leading edge to the trailing edge of a wing is called a chord. The airflow parallel and opposite to the direction of flight is the relative wind. The angle between the chord line and the relative wind is the angle of attack, also known as alpha. The wing will generate lift by speeding up airflow and therefore decreasing pressure on its upper, more curved surface. This negative pressure literally sucks the wing upward if the wing happens to be upright at the time. The lower surface of the wing also generates negative pressure, but less so than the upper surface and the net result is an upward force. There is also a small amount of dynamic pressure exerted by the airflow against the lower surface. The amount of lift generated is dependant on airfoil design and is a subject of intense investigation by aerodynamicists obviously. Angle of attack directly affects lift, and is the primary control of airspeed in steady flight. The maximum angle of attack at which the wing is capable of generating sufficient lift to sustain flight is the critical angle of attack. When the angle of attack exceeds the critical angle of attack the aircraft stalls. Note that a stall has absolutely nothing to do with the engine failing, in fact it can occur at any speed and in any type of aircraft including engineless aircraft such as gliders or in a fighter traveling at Mach 2. Incidentally, many modern aerobatic aircraft have symmetrical airfoils, which have equal curvature on their upper and lower surfaces. This is an obvious advantage if you want to fly inverted. Symmetrical airfoils are perfectly happy in this situation and they generate lift solely based on their angle of attack.

By definition, an aircraft has three axes of movement. The ailerons cause rotation around the horizontal axis. The elevators cause a pitching movement up or down thru the lateral axis and the rudders produce yaw thru the vertical axis. These control surfaces produce lift which in turn causes movement in the desired direction. However they also produce drag which is why the roll produced by the ailerons must be accompanied by rudder to counter the tendency for the nose to yaw away from the direction of bank during a turn. It was the genius of the Wright brothers to understand these relationships and invent the control surfaces that make controlled flight possible.

Jet aircraft usually produce thrust in a single direction and without the complicating forces found in propeller aircraft. The propeller produces thrust by pushing air behind it in a swirling and asymmetric fashion. A propeller that turns clockwise from the pilot's perspective, as is conventional in Western engines will produce a leftward turning tendency that will be aggravated at high angles of attack and low airspeed. This will require right rudder for correction. The propeller turning to the right, once again from the pilots' point of view, and will twist the plane to clockwise or to the left and will require

right aileron to prevent its' expression. Finally, the propeller acts as a giant gyroscope and will induce a moment of force 90 degrees away from the direction the force is being applied from. All of these physical forces and several others that I will not mention are constantly changing with airspeed, angle of attack and in reaction to other control inputs in a continuously variable manner. Aerobatics, more than any other type of flying, demand a clear understanding of these vectors and a skilled pilot can control or aggravate them to achieve a desired effect. Common aerobatic maneuvers such as tailslides make the airplane slide backwards and straight down, reversing control surface effectiveness. Snap rolls produces a corkscrew effect by stalling one wing and not the other, while a gyroscopic maneuver such as a Lomcavek make the airplane tumble end over end while twisting by using gyroscopic force and propeller effects. Incidentally, Lomcavek means hangover in Czechoslovakian. The Czechs startled the flying world with these seemingly impossible maneuvers in the early 1960's during the Cold War aerobatic competitions that were the flying equivalent of the Olympic Games.

The evolution of aerobatic maneuvers is a colorful and fascinating story. Once the age old problem of control in three axes was solved successfully by the Wright brothers through experimentation and aerodynamic exploration, many others developed the modern repertoire of aerobatics in fairly short order.

The first man to conquer the spin and develop a rational recovery was Lt. Wilfred Park of England. In 1912 Lt. Park was practicing a series of spiral descents in preparation for landing and inadvertently must have gotten low and slow (nose high), If there is a yawing input one wing will stall before the other and a rotation will occur. This is the basic entry for a spin. At about 800 feet AGL the left wing fell, the nose dropped suddenly and the grass below him began to rotate rapidly. This sequence was the end game for many previous pilots, but Lt. Park had the presence of mind to systematically explore his options. First he opened his throttle in an effort to pull his nose up. That failed, so he retarded the throttle. Next he applied full left rudder and aft stick in the hopes of starting a tight turn to the left; also no good. As altitude and time ran out, he let go of the stick to brace for the imminent crash and in a desperate attempt to counter the leftward rotation he applied full right rudder at about 50 ft. AGL. The plane immediately recovered to a normal dive. Park then re-entered the pattern and made a successful landing. He published his life-saving observations in the journal Flight and disseminated his insights. This sequence of throttle off, releasing the back pressure to decrease the angle of attack and unstalling the wing combined with rudder opposite to the rotation is now standard upright spin recovery for most modern aircraft. Unfortunately the Private Pilot training syllabus used by the FAA for about the last 30 years does not include actual spin recovery training, rather it teaches "spin avoidance". This is a tragic mistake in my opinion. Very few of us have the nerve and insight that Lt. Park demonstrated in 1912, which makes the first unscheduled and untrained spin experience the last for most pilots.

The first "loop the loop" as it was called was the handiwork of Lt. Pyotr Nikolaevich Nesterov in the summer of 1913. He dove his Nieuport IV monoplane, cut his engine and pulled back on the stick over his home field of Kiev, Ukraine. On the way up he restarted the engine, passed the vertical plane and arched around for the first loop. He was

promptly jailed by his superiors for endangering state property. After 10 days of imprisonment his achievement was finally understood and he was released and then promoted. Alas, he was dead within a year or so after deliberately ramming his plane into an Austrian aircraft in the Great War engulfing Europe and Russia. A Frenchman, Adolph Pegoud, the first man to parachute from an aircraft noted that his unmanned Bleriot monoplane looped itself, and after many incremental flights, he successfully repeated the maneuver as a pilot. He was completely unaware of Nesterov's feat a few weeks before. The chronology of theses events is still disputed in bars by French and Russian aerobatic pilots, currently the world leaders in this sport.

Jimmy Doolittle was the first man to successfully complete an outside Loop while flying his 435 hp. Curtiss P1-B fighter, a much more powerful and robust design than that available to Nesterov and Pegoud. Once again, after a series of cumulative flights he attempted the full maneuver. On May 25, 1927 over McCook field in Dayton Ohio, he climbed to 10,000 ft. and pushed over to the vertical and accelerated to the P1-Bs redline. He kept right on pushing so that his head was now on the outside of the loop as he went inverted. When he was vertical again he pushed through to complete the outside loop; a formidable feat by a very formidable pilot and man. Jimmy Doolittle was also a highly successful air racer in the 20's and 30's, helping to design and test ever more powerful and capable aircraft. He paid a visit to Tokyo in 1942 after leading his group of B-25 Mitchell medium bombers from the deck of the USS Wasp and dealt a severe psychological blow the Japanese delusion of home island invincibility. He was ultimately awarded the Congressional Medal of Honor for his heroism. The Doolittle raid changed the Japanese war plan and helped to create the scenario that culminated in the Battle of Midway, clearly the turning point of the Pacific war.

At this point I will comment on the relationship of aerobatics and fighter pilot tactics. Obviously a fighter pilot needs to be competent in three dimensions. However, most aces prefer to maneuver to achieve surprise, rather than dogfight wildly in an aerobatic duel. About 80% of air to air kills are a slashing pass on an unsuspecting prey, followed by a rapid withdrawal. Aerobatics in combat are reserved for approach, evasion and as a last resort to achieve success in a dogfight. There is very little that is fair or chivalrous about this shoot 'em in the back approach, but it is the safest and most successful strategy for the attacker. Fighter pilots are taught that "speed is life" and most are loathe to exchange it for a turning fight. The interrelationship of potential energy and kinetic energy is crucial in combat and the accurate management of total energy is really the common point of air to air combat and aerobatic competition. The emphasis on extreme maneuverability is characteristic of aerobatic specialist designs and is not typical of combat aircraft, at least in the American philosophy. The example of the heavier and much less nimble P40 Warhawk of Flying Tiger fame that fought against the aerobatically much superior (and much lighter) Mitsubishi Zero of the Japanese Naval Air Force demonstrates this attack and withdrawal style of combat versus the aerobatically oriented doctrine of the Japanese. The emphasis on teamwork and using a wingman was also more pronounced in American tactics than it was with Japanese, who preferred a one-on-one personal combat in the Samurai style.

Common modern air to air combat techniques such as the high or low Yo-Yo pass (a combination of Loop, Roll and climbing turn) and scissoring maneuvers (a series of reversing maximum efficiency turns) are aerobatic derivatives. However, the successful fighter pilots' goal is not aesthetics or pure aerobatic flying by any means.

I will close out my talk with some personal observations about flying and my experiences as a pilot. My first flight was in a small plane, actually before my full memory. My father had a business associate with a small plane and he took us up for a joyride around McArthur field on Long Island. My dad says that I asked the pilot to loop it, but I really can't recall any of it.

I do remember building a lot of balsa wood and tissue paper models of famous planes such as the Spirit of St. Louis, Hellcats and so on. The hours that I spent in my basement with the radio on, using a single edge razor blade on the flimsy wood and tissue paper are some of my happiest. I can recall hearing Sweet Caroline by Neil Diamond as I worked away. Maybe it was the glue, but I had a blast. The precision hand-eye work probably helped me as a surgeon later on.

At about the same time, the Mercury and Gemini space programs were running full bore. I followed all of it intensely. I was awakened early one morning to watch Alan Shepard's 15 minute sub-orbital flight and was mesmerized by the drama of it all. Our national rivalry with the Soviet Union was palpable to me even as a kid .It was thrilling to fly and later own a Russian aircraft as an adult coming from this perspective. My boyhood heroes were fighter pilots and astronauts.

Another formative moment for me occurred on hot summer evening when I was 10 or 11. I was outside playing baseball with some neighborhood kids when my Dad called me in. He said "Mitch, let's go to town and I'll buy some new sneakers for you". Well, I had no interest in new sneakers, my old ones were just fine and I told him so. He insisted and off we went in our black '65 Chrysler Newport. Under this ruse, he took me to the Calderon movie theatre, which was delightfully cool and dark. Obviously, this was not a sneaker expedition.

As the movie started, the big screen was filled with dogfighting biplanes, filmed high above the clouds. The film was the Blue Max and it took my breath away. Going to a movie was not that common back then for me and to see these planes swirling around only a few feet away seemed very real indeed. The other breath-taking view for me as a 10 year old was Ursula Andress wearing just a towel over her chest. It is still makes me grin.

I began to take flight instruction during my last year in medical school. I took about 12 hours of instruction and soloed in a Schweitzer 2-32 two seat glider. We would tow aloft to about 2500 ft above Plymouth Massachusetts and cut loose. On a clear day I could see the hook of the Cape , with the Atlantic on one side and the purple green cranberry bogs on the other. Plymouth is the epicenter of the cranberry growing world in case you didn't know. Man first learned to fly by gliding, well before he worked out powered flight and

all the pertinent lessons still apply. With advanced techniques one can ride a thermal upward like a hawk and then convert the altitude to miles over the ground or kinetic energy for aerobatics. When I caught a thermal, it always felt like jumping onto a huge elevator combined with the thrill of hooking a 20 pound fish on 10 pound line. In Plymouth, the collision of warm land air and cool ocean air was the engine, while out west the air currents thrown up over the Rockies are the ticket. After graduation, the next 6 years after med school were given over to surgical training and I didn't have the time or money to fly until my last year. I resumed my gliding outside of Baltimore and I hoped to own and fly a high performance sailplane soon.

In 1987, Sally and I moved to Kentucky for my first job and it soon became obvious that western Kentucky was not a hotbed of soaring activity. Sally suggested that I start to take basic power lessons locally. I found a fine local instructor, Bill Lipford. He was the retired Navy captain of a mine sweeper and was not afraid to call it like it was. His gentle ways were imparted to me in a crowded and noisy Cessna 152, the standard trainer for most American pilots. He liked to instruct and smoke simultaneously, which is a really obnoxious habit. I soloed under his tutelage and I was lucky enough to have the thrill of a first solo twice. Overall, I thought that straight and level flying was fun but not very exciting. The Wingovers and Chandelle maneuvers that are part of the Private Pilot course were my favorite part of the curriculum and I would practice them by myself for hours.

One day Sally, my folks and I took a vacation for a few days in Key West. My dad talked me into a "scenic biplane ride", a fairly standard tourist activity. For me however, it was a revelation as we climbed through the puffy white fair weather cumulus in an open cockpit 1941 Waco UPF-7. The water was a transparent turquoise and I could see coral reefs and fishes. The sky went on forever. I was finally home. It could have been 1941, and for me it was. The incomparable Freddie Cabanas was the pilot and he asked me if I wanted to do a loop. I said "sure" and around we went. Next one was mine and that's all she wrote as they say. I went back for 2 or 3 hours of aerobatic training every day during that vacation and finished my 10 hour course with Fred. He is a naturally gifted crazy man who typifies the Key West pirate mentality. His previous occupation, by the way, was importing pharmaceutical materials by air, a very prevalent business in the 70's in Florida. An aerial bootlegger, he could out fly and out BS anyone that I had met to date.

Within 3 months I had located a Great Lakes biplane in Santa Paula California and closed the deal by phone. This is a 1930's design, originally manufactured for the US Navy as a trainer. It was remanufactured in the 1970's with a modern engine and is a simple, rugged and easy to fly machine capable of graceful aerobatics. It is a perfect plane for a novice and in particular is easy to land for a taildragger.

Fred and I met in LA and we were flown by light plane north along the California coast to Santa Paula. We checked out the plane and the next day we headed east into the Mojave Desert en route to Kentucky. There is an intimacy about open cockpit planes. The sights, sounds, temperature and odors of an area are literally in your face. The next

day we skimmed over the mesas and literally dropped into the Grand Canyon. I felt like the world had fallen away from under me as we dove for the Snake River below. We cruised along the Canyon at about 100 feet for a few dozen miles or so and then Fred rolled the plane inverted as I hung by my straps and shot a picture over the nose. After 3 days of spectacular flying we were back home in Kentucky. We were met by a welcoming group of 20 or 30 of our friends. This brought out the showman in Fred, and he flew a really impressive impromptu air show for everyone, despite a wicked hangover.

I still didn't have my private pilots' ticket yet, but I had that finished within a few months as the Great Lakes waited in the hangar for me. When I finally got my ticket, Fred came out and taught me tailwheel and spin recovery techniques then signed me off. Once again, I soloed in a way. I can remember my first loops, rolls and hammerheads. I had to jack my courage up to push over for those first few solo aerobatic maneuvers. Fred got me to do some of them with Sally in the airplane once he thought I was safe. He did it to cement my confidence in my abilities and Sally had the guts to do it. That's the kind of girl she is.

For the next 2 years I flew frequently and took lots of instruction in the Great Lakes and other trainers with several different instructors. One day I saw a Pitts biplane take off from my airport. It really just levitated and zoomed upwards. I was electrified by its incredible rate of climb and agility. Now I had to have one and soon I was back in Key West with Fred in his 2 seat Pitts learning the ropes. By 1999 I owned a used Pitts S1T single seater. This plane always reminded of a really ticked off fat little bumblebee and I had a decal of my own design placed on the side panel a la WW2. I named it Buzz Job. This plane is much faster, stronger, and rolled twice as fast as a Great Lakes. It has a vertical climb rate that was amazing due to its high power to weight ratio. It made America dominant in world competition in the 60's and 70's despite being an essentially home built design from a man with a high school education, Curtiss Pitts. With little or no frontal view after the flare, a high approach and landing speed, a nasty sink rate and hyper sensitive controls, the Pitts requires absolute attention to detail or you will have a very bad day. For a while I got more keyed up for the landing than any aerobatic maneuver that I was practicing.

By the 90's most aerobatic jockeys were flying monoplanes if they were lucky. The Soviets ended the Pitts years with the Sukhoi 26, 29 and 31 while the Yakovlev design bureau produced the Yak 55 and 54. In the Soviet era these planes were designed and built by fighter plane firms with unlimited stated funding. Exotic and expensive material such as Titanium and Carbon Fiber were used liberally. They were integrated into magnificent airframes and powered by huge, snarling, high horsepower radial engines. Their national team pilots were full time aerobatic athletes and were trained to the highest standards in the world. The results were unbeatable for quite some time.

I bought a Yakovlev 54 in 2002 and was trained by Nikolai Timofeev, a 3 time world aerobatic champion. Nik is now a Florida resident. He has an engineering degree as well as the coordination of a gymnast mixed with the hand eye coordination of an NFL quarterback. He helped to design the Sukhoi planes and is intimate with every aspect of

their structure and performance. He can make these big, brutal airplanes dance. Nik can also teach and coach, making him a very unique resource. Russian planes have incredible toughness, are relatively simple to service if you have an ample supply of spare parts and are beautiful to my eye from an esthetic viewpoint. Fit and finish come in second place, but this in no way affects performance. Problems with parts, factory support and bureaucracy have worsened since the collapse of the Soviet Union. These planes are really Cold War products, designed to dominate a sport with full state support and no care for cost. My Yak was one of only 12 built. It was a thrill to fly each and every time. The snarl of the engine was exciting in itself. The performance is awesome in this class of plane.

During an aerobatic training camp in Ocala Fl. with Nik, I met Brian Leith. Brian is a massive guy and a former Mr. America 3rd place finisher. Brian is a big personality as well; a balls out kind of pilot who loves to tumble through the sky doing gyroscopic maneuvers. Some of his favorites are Newton's folly, the Tsunamai and the Avalanche. I bought my Yak from Brian and we became fast friends. I had the plane about 1 1/2 years and sold it to a dealer who was putting together a young, all female French aerobatic team that was going to fly Yak 54s. I offered to be their coach but had no luck.

Brian found my next plane for me out in California, an Extra 300L. Extras are German built monoplanes that have their distant origin in a homebuilt American design called the Laser. It uses an American built 300 hp engine, not a 360 hp engine found in Russian planes. The plane is aerodynamically smoother and the power discrepancy makes no difference really. The fit and finish is like a high end Porsche and its personality is as German as the Russian planes are Russian. I think that I really prefer the Russian planes for their brute force but for me the Extra is easier to get out of the hangar and fly. All of these designs are really more than I will ever need anyway.

Last month I finally got to fly the legendary WW2 Mustang fighter. I took an hour training flight for an ungodly amount of money in Kissimee Fl. My instructor was a retired Air Force fighter pilot and special ops guy, Eric Huppert, who incidentally had a lot of time in oddball Russian and Chinese types. The plane is large by my standards but fits me well. I studied the pilots' manual carefully before flying it and it is not particularly complex, but once again it is definitely in your best interests to know the manual. We did an hour of alternating combat type maneuvers and aerobatics, which I found very natural. The striking characteristic of this plane is how quickly it will dive and climb, which is not surprising given its 1600 hp and 9000lbs weight. Push the nose down and a few seconds later you are doing 400mph. Pull back and you will gain a few thousand feet in no time. Aerobatics at about 280 mph and 4.5 G are big figures and take much more time than I am used to. This is due to the geometry of the radii involved, of course. It is not a nimble aircraft but it is rock steady and is perfectly designed as a gun platform and air superiority fighter. Visibility through the bubble canopy is unlimited and it flies as smooth as silk. These sentences do not in any way capture the emotions I had as I strapped in and flew. Really, it was my boyhood dreams come true.

So, is this a crazy, expensive and possibly very dumb thing to do? Yes, it is. But, there are days when my soul is free and I can express myself by flying without conscious thought in ways that would makes the birds envy me. I can share this with passengers or in words to some degree, but really the only people who understand it are other aerobatic pilots with the same obsession that I have. Even so, it's ultimately about testing the edges of your soul and I embrace it.

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