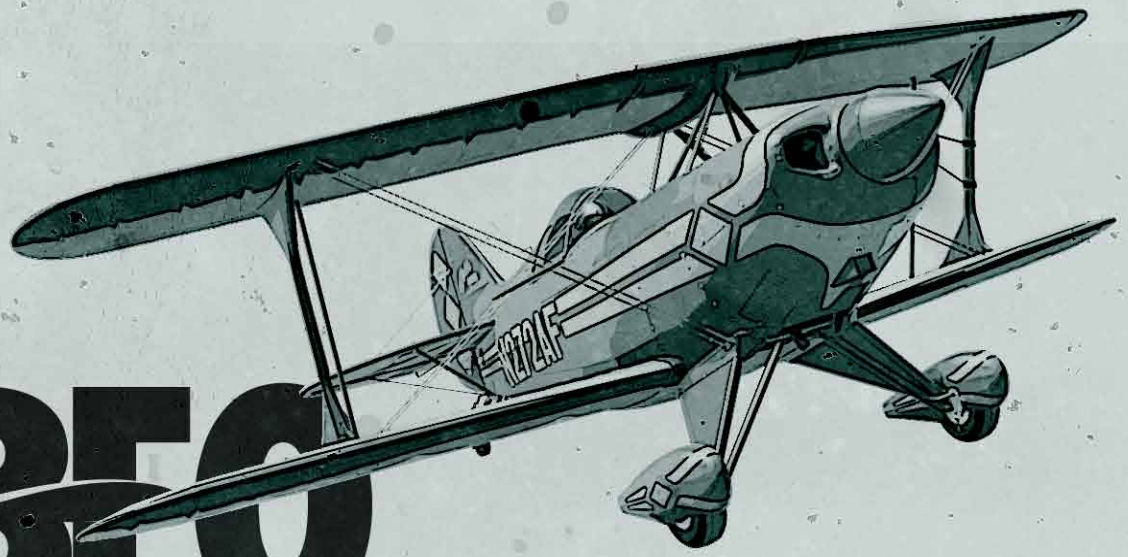

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AEROBATICS MANEUVERS

AEROBATICS MANEUVERS

THIS DOCUMENT INTENT TO EXPLAIN AND SHOW ABOUT BASIC AEROBATICS MANEUVERS FOR PRACTICING AND HAVING FUN IN THE FLIGHT SIMULATOR. DO NOT ATTEMPT A REAL AEROBATIC FLIGHT BASED ON THIS DOCUMENT

BASIC CONCEPTS

AEROBATICS ACCORDING TO THE FAA, AEROBATIC FLIGHT IS DEFINED AS "AN INTENTIONAL MANEUVER INVOLVING AN ABRUPT CHANGE IN AN AIRCRAFT'S ATTITUDE, AN ABNORMAL ATTITUDE, OR ABNORMAL ACCELERATION, NOT NECESSARY FOR NORMAL FLIGHT."

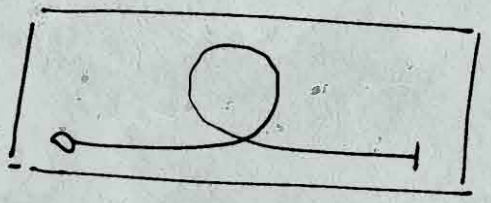
AEROBATICS AIRPLANES

AEROBATIC AIRCRAFT ARE SPECIALLY DESIGNED FOR EXTREME AERIAL MANEUVERS WHICH REQUIRE A LOT OF POWER, SPEED, CONTROL AND SECURITY. STRUCTURES, FUSELAGES AND SYSTEMS OF THESE AIRCRAFT ARE DESIGNED TO WITHSTAND EXTREME FORCES AND JUMPINESS AEROBATIC MOVES.
THESE AIRCRAFT, UNLIKE THOSE OF NORMAL AND UTILITY CATEGORY MUST HAVE SPECIAL

GS

A PERSON ON THE GROUND EXPERIENCE 1 G, WHICH MEANS HE OR SHE FEEL ITS OWN WEIGHT. IN AN AEROBATIC FLIGHT YOU CAN EXPERIENCE TO **3** OR EVEN **4 GS**, WHICH MEANS **3** OR **4** TIMES YOUR OWN WEIGHT IN THE CASE OF POSITIVE GS. CERTAIN MANEUVERS THAT GIVE A SENSE OF WEIGHTLESSNESS (ZERO GS) OR FEELING OF LIGHTNESS (NEGATIVE G) ARE ALSO TYPICAL OF AEROBATIC AERIAL MANEUVERS.
MANY AEROBATIC AIRCRAFT HAVE AN ACCELEROMETER TO MEASURE THE AMOUNT OF GS.
THE HUMAN BODY CAN RESISTS ONLY FOR A FEW SECONDS **3** TO **4** POSITIVE **G** OR 1 NEGATIVE **G**, SO THAT EXTREME MANEUVERS ARE USUALLY OF SHORT DURATION.

THE LOOP



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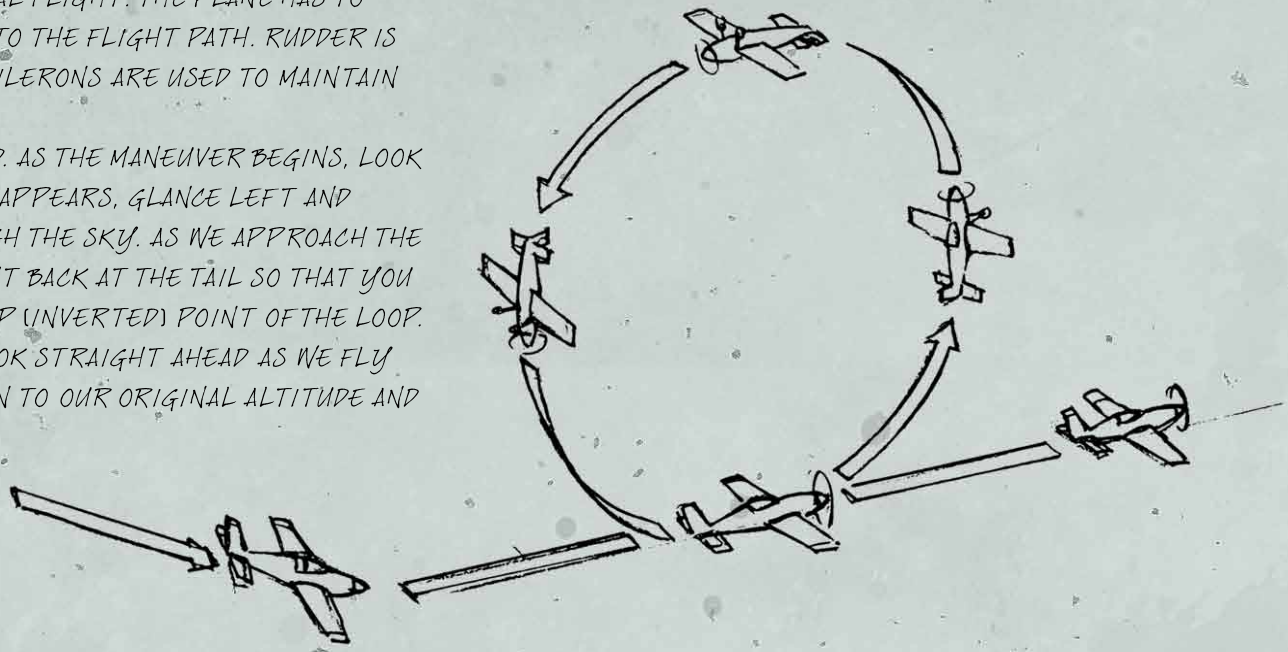
THIS IS ONE OF THE MOST BASIC MANEUVERS, BUT NOT EASY TO FLY WELL. IT HAS TO BE PERFECTLY ROUND; ENTRY AND EXIT HAVE TO BE AT THE SAME ALTITUDE. THE DIFFICULTY IN FLYING THIS MANEUVER WELL IS IN CORRECTING FOR EFFECTS OF WIND DRIFT

THE MANEUVER STARTS WITH A PULLUP OF ABOUT **3-4 G.** ONCE PAST THE VERTICAL, THE BACK PRESSURE ON THE ELEVATOR IS SLOWLY RELAXED TO FLOAT OVER TO TOP OF THE LOOP TO KEEP IT ROUND. PAST THE TOP, THE BACK PRESSURE IS SLOWLY INCREASED AGAIN THROUGHOUT THE BACK PART TILL HORIZONTAL FLIGHT. THE PLANE HAS TO STAY IN ONE PLANE WITH THE WINGS ORTHOGONAL TO THE FLIGHT PATH. RUDDER IS USED TO MAINTAIN THE PLANE OF THE FIGURE AND AILERONS ARE USED TO MAINTAIN THE ORIENTATION OF THE WINGS.

DURING THE LOOP, LOOK AROUND TO STAY ORIENTED. AS THE MANEUVER BEGINS, LOOK STRAIGHT AHEAD, BUT AS SOON AS THE HORIZON DISAPPEARS, GLANCE LEFT AND RIGHT TO WATCH TO WINGS TRACING AN ARC THROUGH THE SKY. AS WE APPROACH THE VERTICAL, STRETCH YOUR NECK AND LOOK STRAIGHT BACK AT THE TAIL SO THAT YOU CAN SEE THE HORIZON APPEAR AS WE REACH THE TOP (INVERTED) POINT OF THE LOOP. THEN SMOOTHLY TILT YOUR HEAD FORWARD AND LOOK STRAIGHT AHEAD AS WE FLY DOWN THE BACK SIDE OF THE MANEUVER AND RETURN TO OUR ORIGINAL ALTITUDE AND HEADING.



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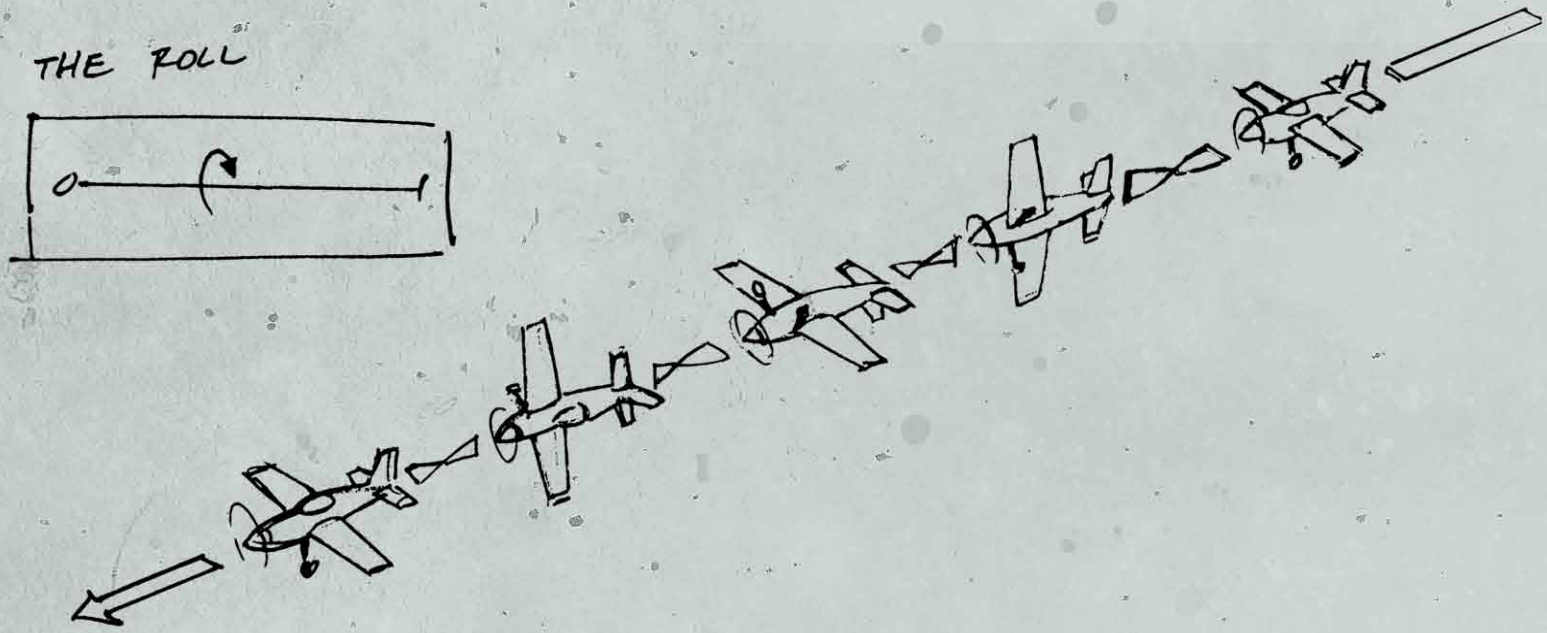
THE ROLL



AILERON ROLLS ARE FLOWN WITH THE RUDDER AND ELEVATOR IN THE NEUTRAL POSITION DURING THE ROLL. THE AILERON IS FULLY DEFLECTED IN THE DIRECTION OF THE ROLL. THIS IS THE EASIEST OF THE ROLLS TO FLY.
THE AILERON ROLL IS STARTED BY PULLING THE NOSE UP TO **20 - 30** DEGREES ABOVE THE HORIZON. THE ELEVATOR IS THEN NEUTRALIZED AND THE AILERON FULLY DEFLECTED IN THE DIRECTION OF THE ROLL. THE CONTROLS ARE MAINTAINED IN THAT POSITION TILL THE ROLL IS COMPLETED. AFTER THE ROLL IS COMPLETED THE NOSE IS USUALLY **20 - 30** DEGREES BELOW THE HORIZON.
DURING AN AILERON ROLL, THE AIRPLANE ROTATES **360** DEGREES AROUND ITS LONGITUDINAL AXIS WHILE THE NOSE REMAINS POINTED AT A SPECIFIC REFERENCE STRAIGHT AHEAD. IN OTHER WORDS, THE AIRPLANE "TWIRLS" AROUND A LINE DRAWN FROM THE TIP OF THE NOSE TO THE TAIL, AS IF YOU HELD YOUR OUTSTRETCHED ARM STRAIGHT AND ROTATED YOUR WRIST AND ELBOW.
THROUGHOUT THIS MANEUVER, LOOK STRAIGHT AHEAD AT A CLOUD, MOUNTAIN PEAK, OR OTHER REFERENCE THAT I POINT OUT.

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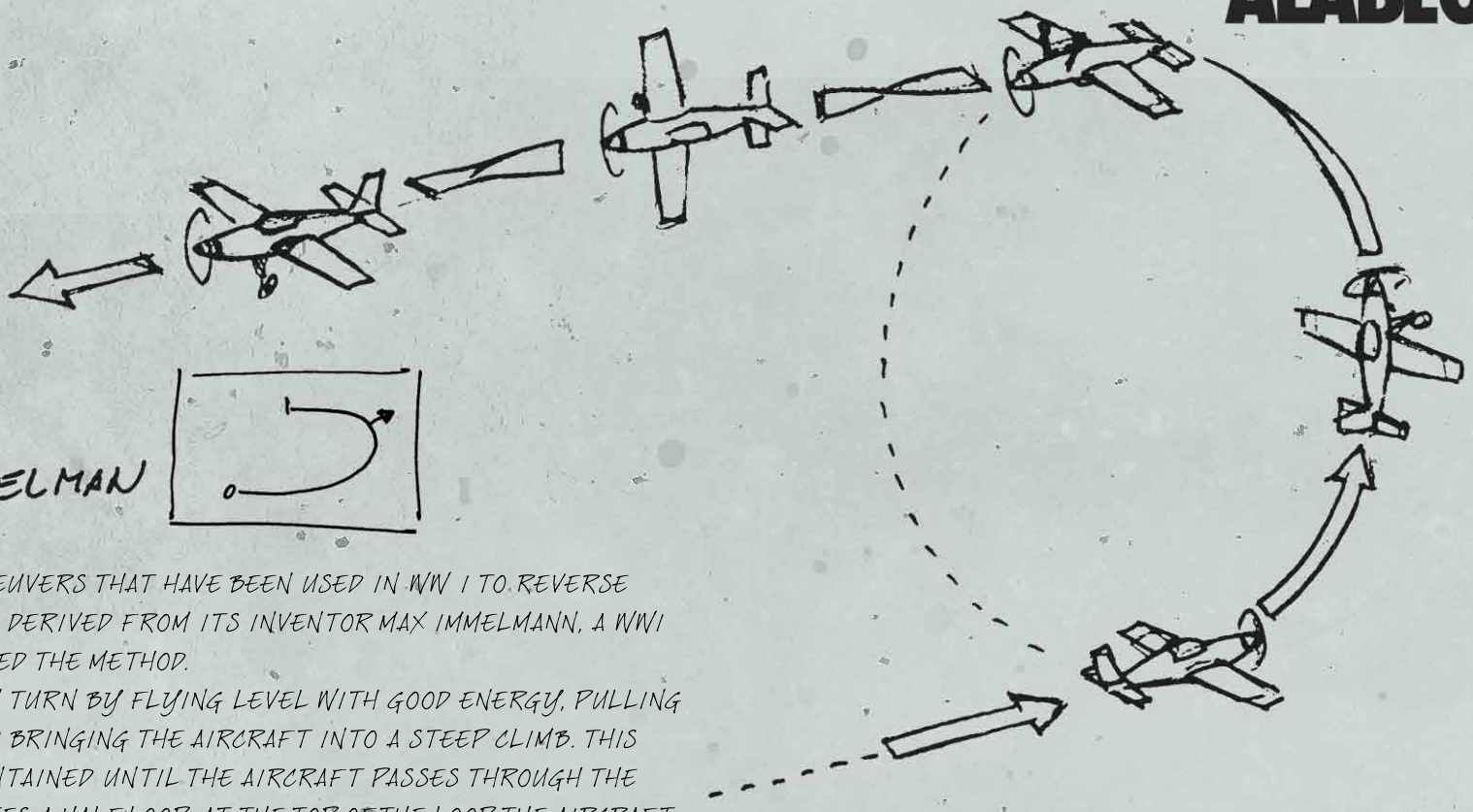
THE IMMELMAN



THIS IS ONE OF THE MANEUVERS THAT HAVE BEEN USED IN WW I TO REVERSE DIRECTION. THE NAME IS DERIVED FROM ITS INVENTOR MAX IMMELMANN, A WWI GERMAN ACE WHO DEVISED THE METHOD.
EXECUTE THE IMMELMAN TURN BY FLYING LEVEL WITH GOOD ENERGY, PULLING BACK ON THE STICK, AND BRINGING THE AIRCRAFT INTO A STEEP CLIMB. THIS CLIMBING TURN IS MAINTAINED UNTIL THE AIRCRAFT PASSES THROUGH THE VERTICAL AND COMPLETES A HALF LOOP. AT THE TOP OF THE LOOP THE AIRCRAFT IS INVERTED AND THE PILOT ROLLS THE AIRCRAFT BACK INTO THE UPRIGHT POSITION. THE AIRCRAFT IS NOW AT A HIGHER ALTITUDE AND HAS CHANGED HEADING 180 DEGREES. THIS MANEUVER ALLOWS FOR SOME ENERGY MANAGEMENT THROUGH ALTITUDE GAIN BUT THERE IS AN OBVIOUS SPEED LOSS.

http://www.furball.warbirdsiii.com/krod/acm-immelman.html
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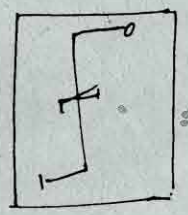
SPIN



SPINS COME IN **3/4, 1, 1 1/4** AND **1 1/2** TURNS.
DURING SPIN ENTRY, THE PLANE HAS TO SHOW A STALL BREAK, FOLLOWED BY THE AUTO ROTATION. THE ROTATION HAS TO STOP EXACTLY AFTER THE SPECIFIED NUMBER OF TURNS. ONCE THE ROTATION HAS STOPPED, A VERTICAL DOWN LINE HAS TO BE ESTABLISHED.
TWO COMPONENTS MUST EXIST TO SPIN AN AIRCRAFT: CRITICAL ANGLE OF ATTACK , WHICH MEANS THAT THE AIRCRAFT IS STALLED AND YAW.

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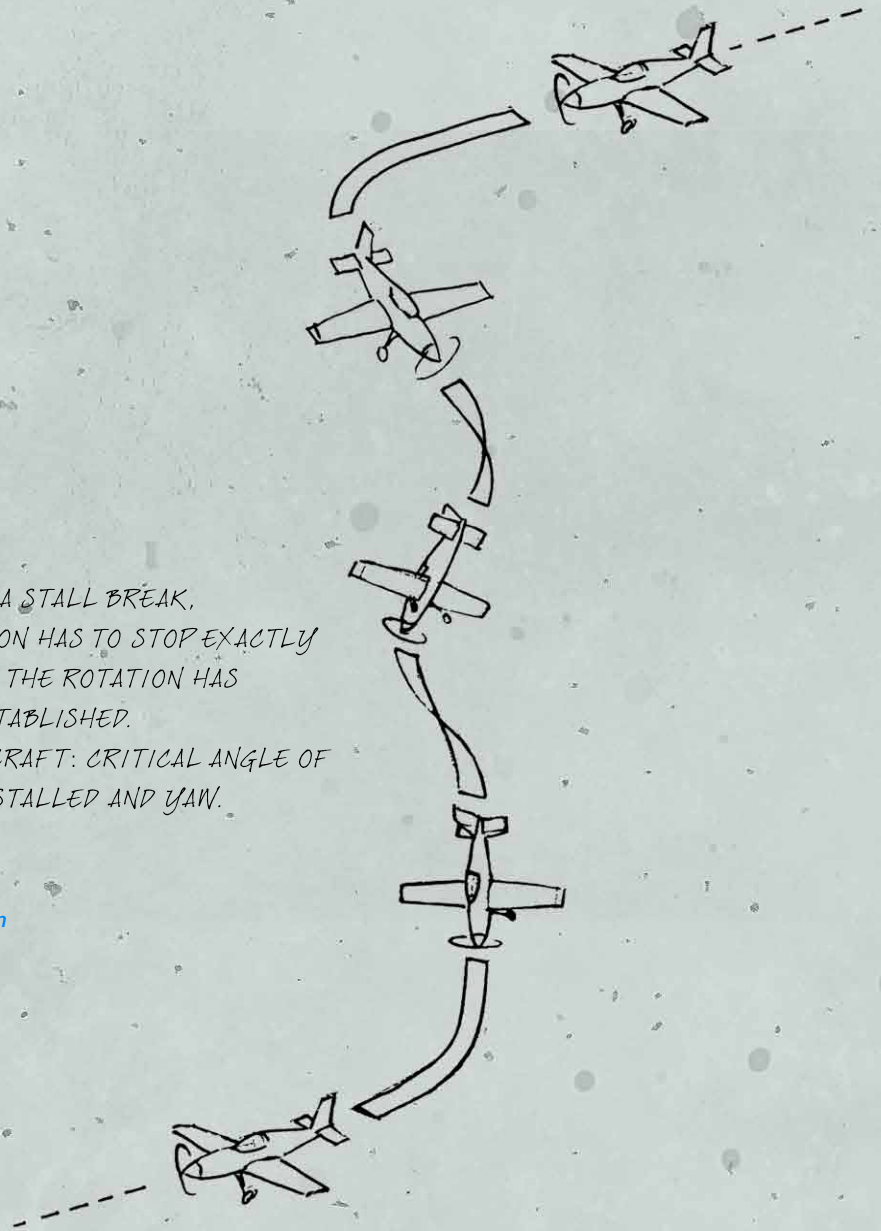

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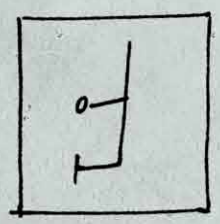
THE HAMMERHEAD



THE HAMMERHEAD, IS A FAVORITE MANEUVER AMONG FOLKS WHO TAKE AEROBATIC RIDES. THIS ALSO IS ONE OF THE MANEUVERS THAT HAVE BEEN USED TO REVERSE DIRECTION WHILE ADJUSTING ALTITUDE AND AIRSPEED BY CHANGING THE LENGTH OF THE DOWN-LINE.

THIS MANEUVER BEGINS FROM A HORIZONTAL LINE. PULL THE AIRPLANE UP SMOOTHLY BUT AGGRESSIVELY TO ESTABLISH A VERTICAL LINE. HOLD THE VERTICAL LINE UNTIL THE AIRPLANE ALMOST RUNS OUT OF AIRSPEED, AND JUST AT THAT POINT, PUSH FULL LEFT RUDDER TO MAKE THE AIRPLANE PIVOT, OR CARTWHEEL, AROUND ITS LEFT WING. THEN ESTABLISH AND HOLD A VERTICAL DIVE BEFORE PULLING THE NOSE BACK UP TO A HORIZONTAL LINE. THE HAMMERHEAD ENDS WITH THE AIRPLANE FLYING 180 DEGREES FROM ITS ORIGINAL HEADING.

STARTING THE HAMMERHEAD, LOOK STRAIGHT AHEAD, BUT AS THE NOSE RISES, SHIFT YOUR GAZE TO LOOK OUT ALONG THE LEFT WING AND ENJOY THE VIEW AS WE CLIMB STRAIGHT UP.

DURING THE PIVOT AT THE TOP, ROTATE YOUR HEAD TO LOOK STRAIGHT OVER THE NOSE FOR THE VERTICAL DIVE AND THE PULL BACK TO LEVEL FLIGHT.

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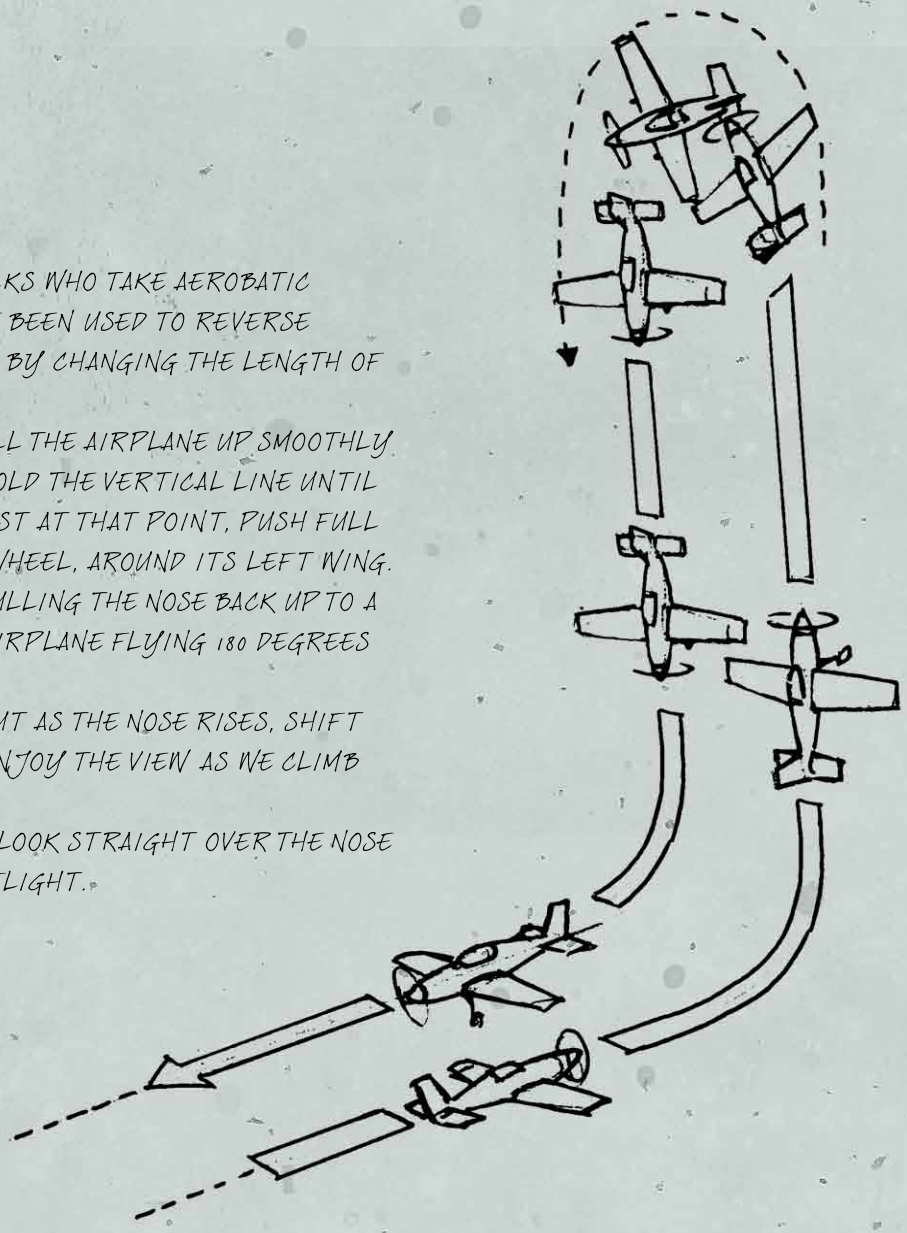

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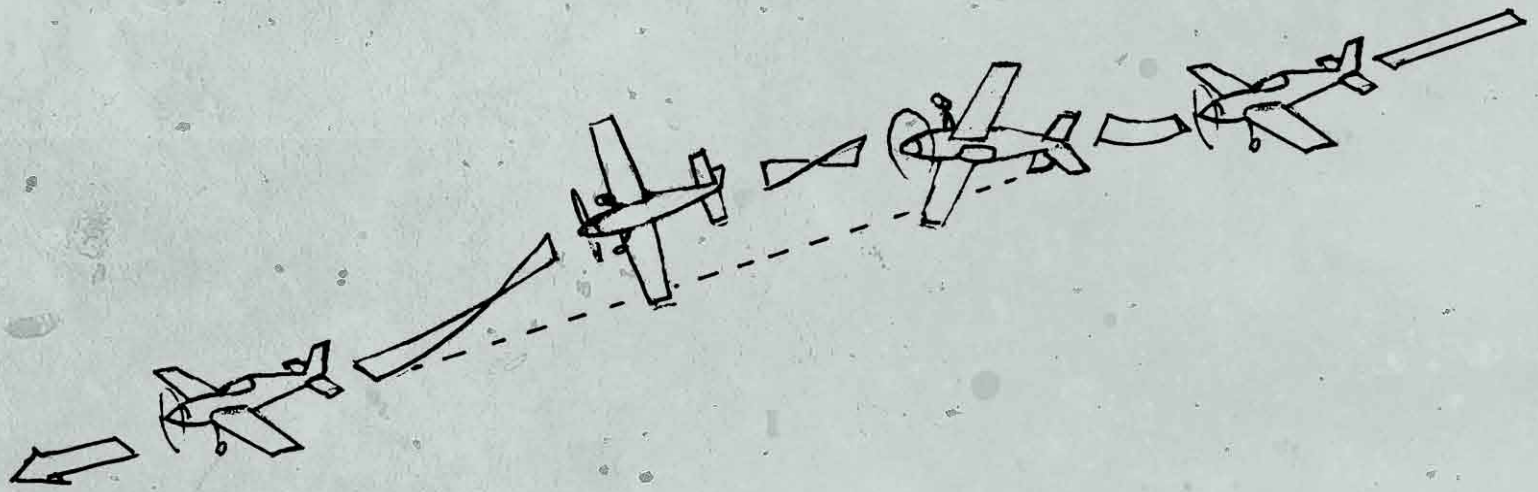
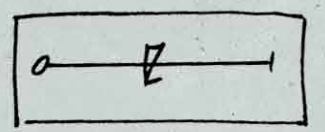


THE SNAP ROLL



ALSO KNOWN AS A "FLICK" ROLL IN EUROPEAN AEROBATIC CIRCLES, THE SNAP ROLL SHARES MORE WITH THE TRADITIONAL SPIN THAN THE CONVENTIONAL AILERON ROLL. SNAP ROLLS HAVE TO BE FLOWN NORMALLY ON A STRAIGHT LINE. IT IS AN AUTOROTATION WITH ONE WING STALLED. IN THE SNAP ROLL, THE PLANE HAS TO BE STALLED BY APPLYING POSITIVE G FORCES. RUDDER IS THEN USED TO START AUTOROTATION JUST LIKE IN A SPIN.

SNAP AND SPIN MANEUVERS SHARE AN AUTOROTATION ABOUT THE ROLL AND YAW AXIS CAUSED BY A STALLED WING AND A YAW INPUT. BOTH AILERON AND SNAP ROLLS ROTATE THE AIRCRAFT THROUGH 360 DEGREES, BUT THAT IS WHERE THE SIMILARITIES END. THE IMPORTANT DIFFERENCE IS THAT CONVENTIONAL ROLLS ARE PRIMARILY AN AILERON MANEUVER FLOWN AT A RELATIVELY LOW ANGLE OF ATTACK, WHILE SNAP ROLLS ARE A RUDDER/ELEVATOR MANEUVER AT A VERY HIGH ANGLE OF ATTACK.

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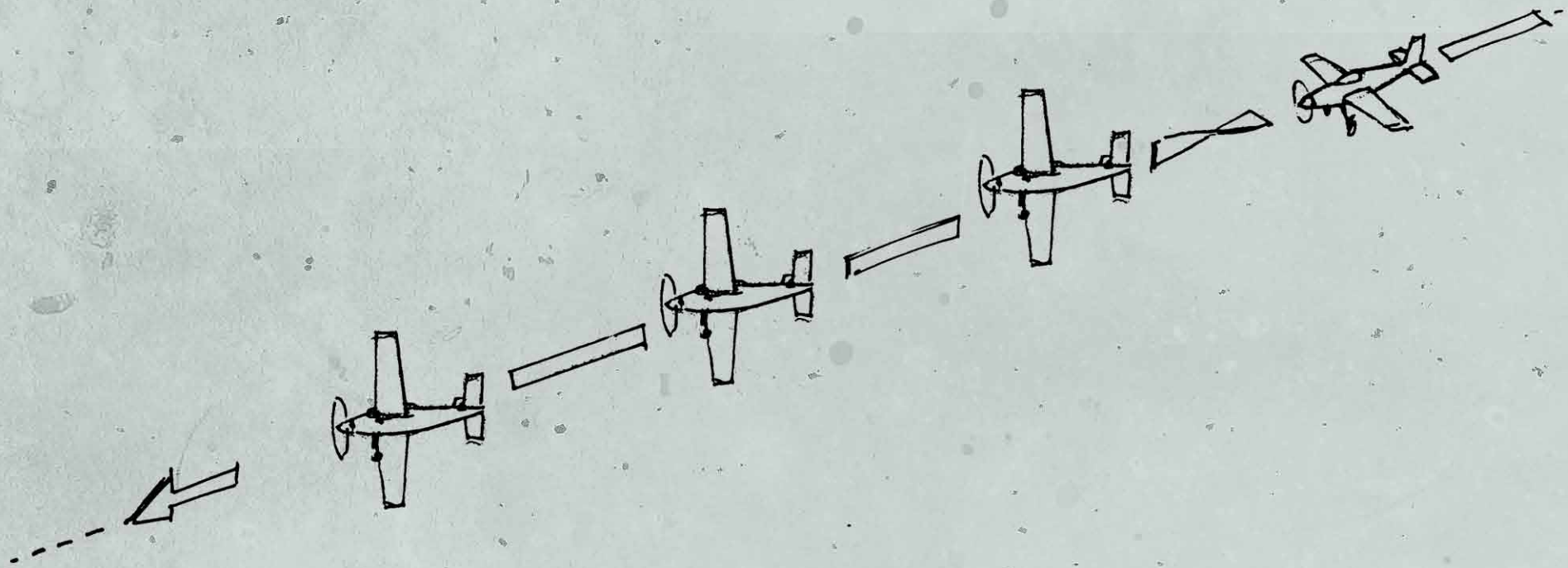
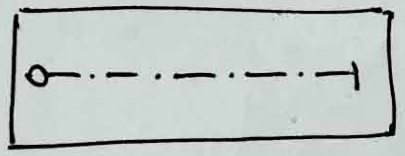


KNIFE EDGE FLIGHT



A GOOD LOW-ALTITUDE MANEUVER IS A KNIFE-EDGE PASS. THE HARD PART OF THIS MANEUVER IS KEEPING THE PLANE IN A STRAIGHT LINE; THE AIRCRAFT WANTS TO TURN WHEN BANKED ON ITS SIDE. THIS CAN BE CONTROLLED SOMEWHAT BY APPLYING FORWARD STICK ONCE YOU ARE PERFECTLY SIDEWAYS. ANOTHER PROBLEM IS LOSING ALTITUDE DURING A KNIFE EDGE. YOU CAN COMPENSATE FOR THIS BY ENTERING THE MANEUVER IN AN ATTITUDE WITH THE NOSE SLIGHTLY HIGH.

FLY STRAIGHT AND LEVEL AT 300 KNOTS OR MORE AND DESCEND TO 500 FEET. PULL THE NOSE UP SLIGHTLY AND ROLL UNTIL YOU'RE FLYING PERFECTLY SIDEWAYS. USE FORWARD PRESSURE ON THE STICK TO MAINTAIN A CONSTANT

HEADING. HOLD THIS KNIFE-EDGE POSITION FOR SEVERAL SECONDS. KEEP YOUR EYE ON YOUR ALTITUDE. ROLL BACK INTO LEVEL FLIGHT AND CLIMB TO **2000** FEET.