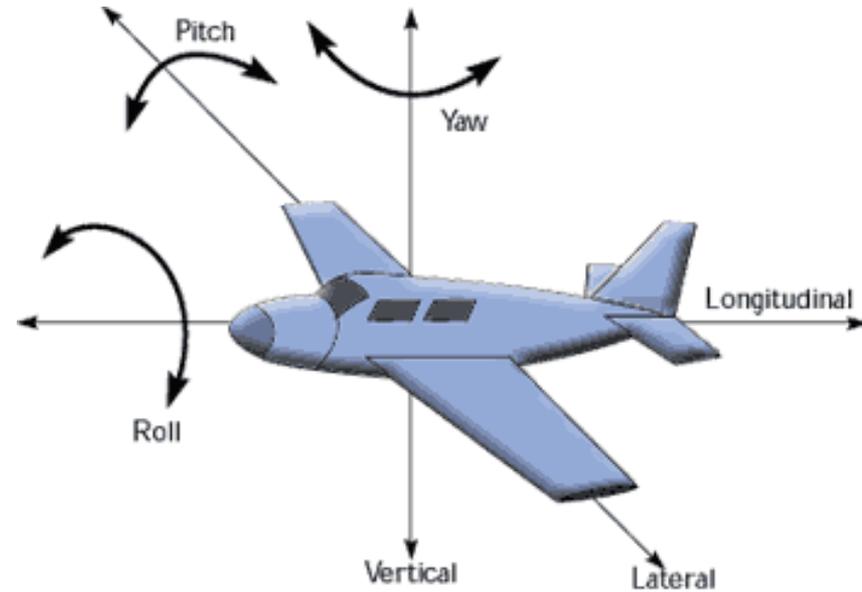BY:
Manrico Mincuzzi
RD Imac Europe
Milano, 2022.

Prepare Airplane and Radio for IMAC Precision Aerobatics

- ❑ Mind key general principles

- ❑ Prepare your Airplane

- ❑ Introduce Permanent Radio Settings

- ❑ Introduce Radio Settings that can be Activated

- ❑ Program your Radio for Precision Aerobatics

Mind key General Principles

- ❑ Focus your attention
- ❑ Implement safety solutions

axis of yaw (vertical)

axis of roll (longitudinal)

axis of pitch (lateral
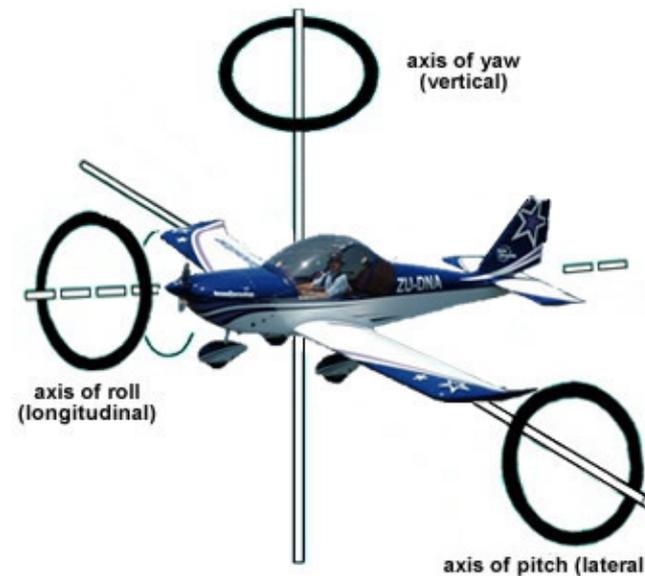
- ❑ Always use a strap or a tray to hold your radio to your body
- ❑ Never loose site of your airplane, never look to the radio.
- ❑ Think about the precision of the sequence, do not think about your switches.
- ❑ Minimize the use of switches, sliders and knobs.
- ❑ Automatize your movements creating standard procedures

Set Airplane and Radio for IMAC Precision Aerobatics
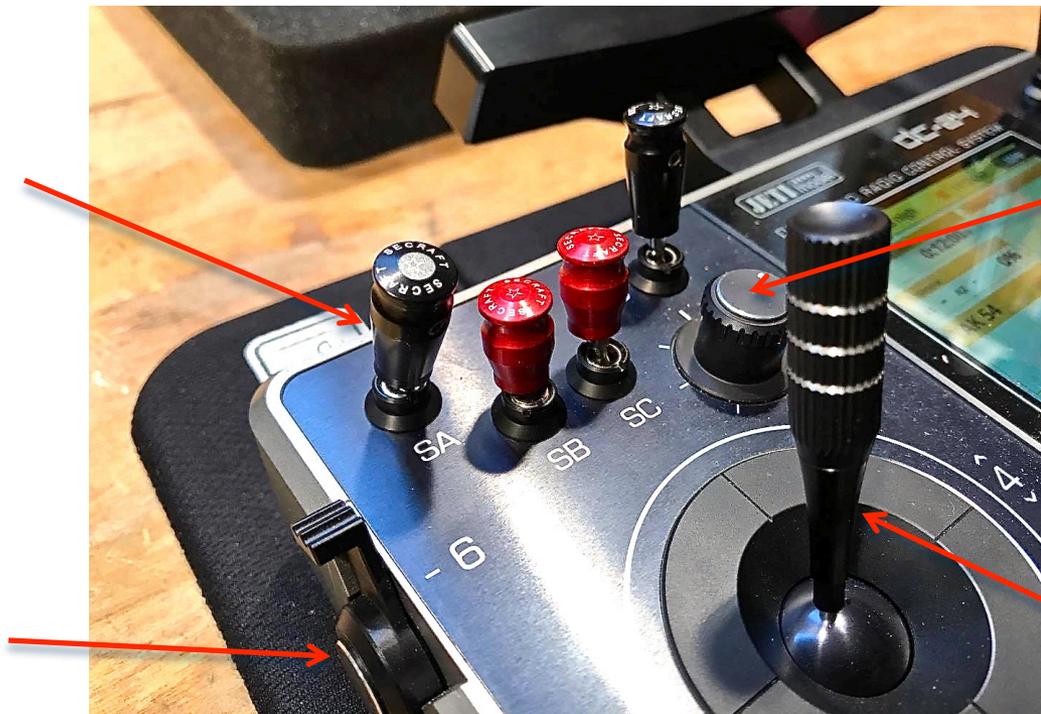
Implement Safety Solutions

- ❑ Adopt 'Stupid Proof' solutions, so that anxiety or lack of attention will never be the cause of accidents.
- ❑ Operate dangerous functions, such as Throttle Cut, only with sliders or knobs.
- ❑ Use switches only to activate relatively not dangerous functions

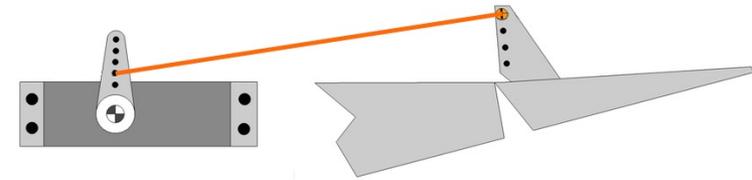Set Airplane and Radio for IMAC Precision Aerobatics

Prepare your Airplane

- ❑ Reduce the sensibility of the sticks

- ❑ Align your elevator

- ❑ Position your Center of Gravity (CG)

- ❑ Check your engine incidence

MECHANICALLY SET THE SERVO THROW FOR EACH MOVING PART

In order to more effectively achieve aerobatic precision, it is important to reduce the sensibility of your sticks according to your finger's ability to control micro movements. This is essential especially around the center of the stick movement. An excess of sensibility of each moving surface will make precision aerobatics very difficult to achieve.

Maximize micro control and servo power to the moving surface

- ❑ 20-30° movement for ailerons and elevator is enough.
- ❑ Do not de-multiply servo strength installing very long arms on servo and moving surfaces: 1 to 1.5 inches is enough
- ❑ Maximize the use of all servo 180° pixel range.
- ❑ If throws are still too extensive, install shorter servo arms or reduce the throw using ATV or Dual Rates

Right

Wrong
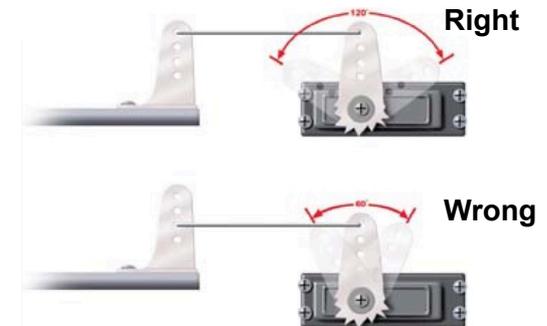
Maximize the use of your radio sensibility. Use each pixel of your throw.

Set Airplane and Radio for IMAC Precision Aerobatics

PREVENT CLIMBS WITH A JAW COMPONENT THAT YOU WILL HAVE CORRECT

❑ If the left part of the elevator is not centered and doesn't move exactly like the right part, your airplane will receive a roll/jaw component each time you will climb or dive. You will then have to intervene with a finger correction, adding complexity to the flight.


ALIGNMENT INDICATOR

RIGID STICKS
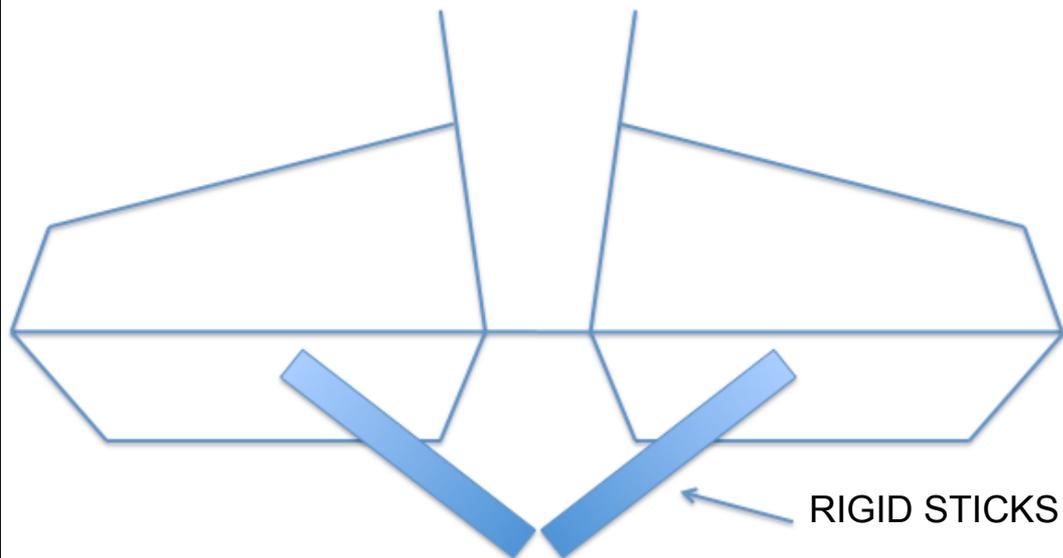
However, if your wings are not level when you start the climb or the dive, you will still experience a jaw effect. **It is very important that you learn how to keep your wings level at all times.**

Set Airplane and Radio for IMAC Precision Aerobatics

CONDUCT THE FOLLOWING THREE STEPS OF ANALYSIS

1. From positive level flight, at full throttle, trim the elevator in order to ensure level flight without need for additional correction, then conduct the following two tests:

2. Fly a 45° down line, moderate or minimum throttle, elevator centered, observe possible positive or negative pitch:

   ❑ If Negative: CG too far back

   ❑ If Positive: CG too far forward

3. From inverted level flight, full throttle, elevator centered, observe possible positive or negative pitch:

   ❑ If Positive: CG too far back

   ❑ If Negative: CG too far forward

   ❑ If very slightly Negative: right CG
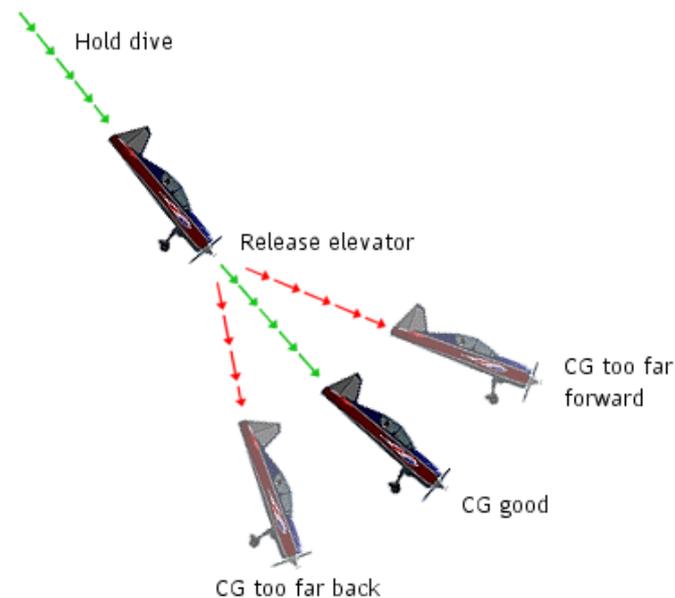
The outcome of these tests is determined by the trimming you introduced at step 1. in order to keep level light. The need for this trimming is significantly determined by the position of the aircraft's CG.

CONDUCT THE FOLLOWING THREE STEPS OF ANALYSIS

1. Before taking off, make sure that your elevator and rudder positions are perfectly centered versus the airplane's structure lines. Than, take off and do not introduce any trimming before conducting the following two tests:

2. Fly a vertical up-line at full throttle, rudder and elevator centered, leave controls and observe a possible significant right or left yaw:

   ❑ Modify engine incidence versus opposite angle.

3. Fly a vertical up-line at full throttle, rudder and elevator centered, leave controls and observe a possible significant up or down pitch:

   ❑ Modify engine incidence on opposite angle.
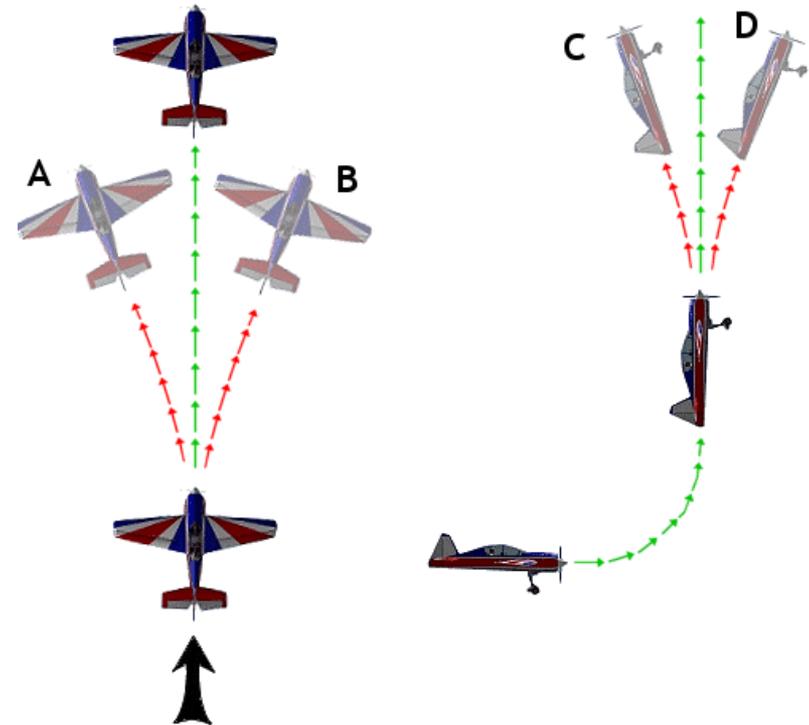
A moderate right yaw and down pitch should be expected and accepted. If their fix would require more than 5 pixel in trim change, as discussed later, than adjust engine incidence versus opposite side.

Introduce Permanent Radio Settings

- ❑ Tendency to right yaw under power

- ❑ Positive pitch on down vertical lines

- ❑ Loose flight path conducting rolls

- ❑ Non-perceived power progression

- ❑ Non linear knife edge

AFTER HAVING SET THE ENGINE INCIDENCE POSITION

❑ **Fly a vertical, 90°, up-line at full throttle and leave all controls during the climb. If you notice a left yaw tendency on the flight path:**

    ❑ **Introduce a master-slave permanent mix:**

    ❑ Master: Throttle

    ❑ Slave: Rudder

    ❑ After 90% of throttle movement versus the maximum, introduce from 2 to 5 points right rudder

    ❑ Check servo monitor to verify the activation of the mix

    ❑ If more then 5 points are needed in order to maintain a perfectly vertical flight path on your climb, than check again the engine position and increase the incidence to the left of one additional degree
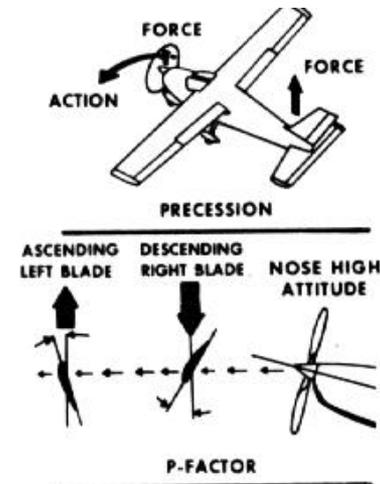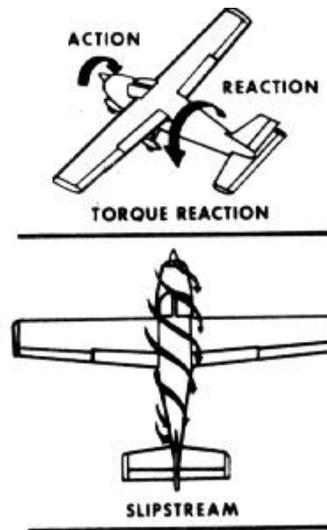
This tendency is originated by several aerodynamic factors that are often summarized as 'Torque Effect'

FROM 0 TO MAX 5 POINTS RIGHT RUDDER
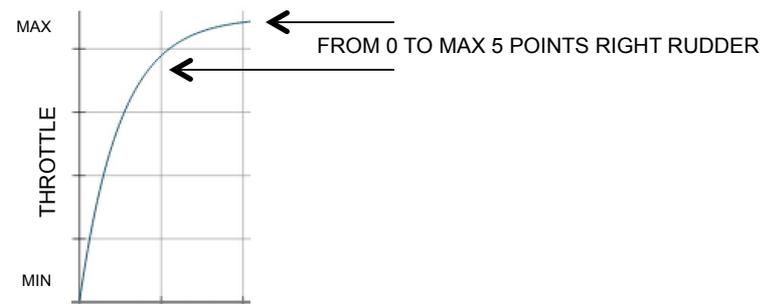
AFTER HAVING SET THE ENGINE INCIDENCE POSITION

- ❑ **Stall from vertical and then conduct a vertical down line, 90°, at zero throttle, leave all controls. If you notice a positive (or negative) pitch tendency on the flight path:**

  - ❑ **Introduce a master-slave permanent mix:**
  - ❑ Master: Throttle
  - ❑ Slave: Elevator
  - ❑ At minimum throttle introduce 2 to 5 points negative (or positive) pitch
  - ❑ Check servo monitor to verify the activation of the mix
  - ❑ If more then 5 points are needed to keep a perfectly vertical flight path, than you should check again your CG position and your elevator incidence versus wings.

NOTED MOSTLY IN THE CASE OF BIPLANES:

❑ **Climb on a 45° up line at full throttle. Then conduct a sequence of rolls to the left. If you notice the tendency of your flight path to turn right (or vice versa):**

    ❑ **Introduce Aileron Differential:**

    ❑ Reduce the down aileron throw versus up aileron throw by 5 to max 15%

    ❑ If more is needed check wings and elevators incidences
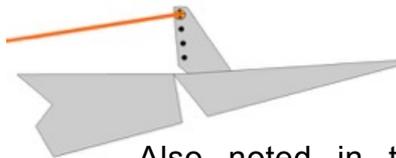
Also noted in the case of monoplanes with top hinged ailorance

Adverse yaw occurs because a downward deflected aileron causes more drag then the upward deflected aileron. This drag force drifts the airplane out of its flight path during rolls sequences, in a direction opposite to the rolling versus

- ❑ **Can you feel power progression after 70% of the throttle stick movement?**

- ❑ **Can you perceive a linear power progression between 30 and 70% of throttle stick movement?**

- ❑ **When landing, can you easily control throttle or you experience jumps from too low rpm to too high?**

PROGRAM YOUR THROTTLE CURVE

LINEAR GAS CURVE

PROGRAMMED NON LINEAR GAS CURVE
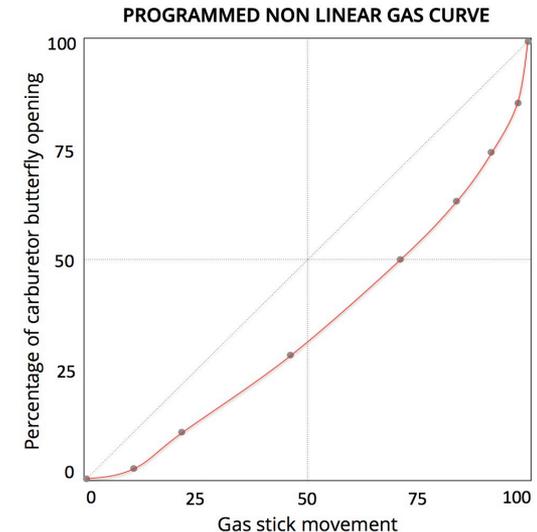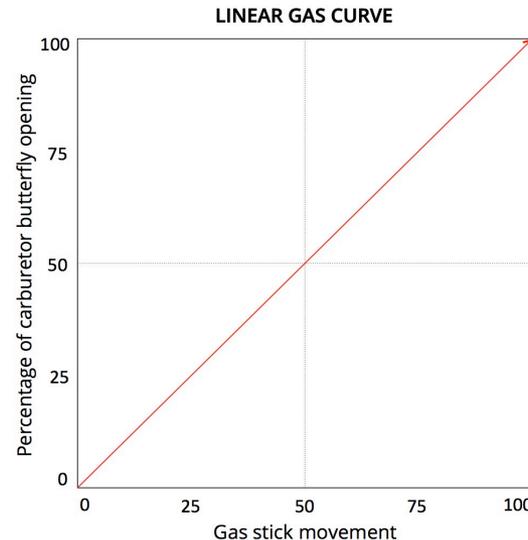
To improve all these feelings you need to program your throttle curve, from linear to non-linear, using the nine point curve programming facility provided by your radio:

- ❑ Most of our engines show not to be perfectly sensitive to the throttle stick movement because this is linear, while the power curve of the engine moves in a non-linear way versus the carburetor butterfly opening percentage. Therefore, by adjusting the relationship between 'throttle stick movement ' and 'power output' we can create the feeling of linear power trust that we expect when moving our throttle stick. This can be done utilizing the nine points curve programming facility as we will describe later.

MIXES TO BE PREFERABLY USED ONLY WITHIN A "ROLLING CIRCLE" CONDITION:

- ❑ From positive level flight, make ¼ roll and, with rudder support, keep the airplane on a knife edge for a long segment. If you note a tendency to pitch or roll:

- ❑ Positive or negative pitch on knife edge:
  - ❑ **Introduce a master-slave permanent mix:**
  - ❑ Master: Rudder
  - ❑ Slave : Elevator
  - ❑ Add positive or negative elevator in presence of rudder input

- ❑ **Right or Left Roll on Knife Edge:**
  - ❑ **Introduce a master-slave permanent mix:**
  - ❑ Master: Rudder
  - ❑ Slave : Ailorance
  - ❑ Add right or left roll in presence of rudder input

PITCH AND ROLL TENDENCY

Many Pilots prefer to introduce these corrections as part of a 'Rolling Circle' Condition, in order not to disturb normal precision flight

Set Airplane and Radio for IMAC Precision Aerobatics

Introduce Radio Settings that can be Activated

❑ To turn on the timer

❑ To turn ignition on and off

❑ To turn choke on and off

IT IS SAFE TO CONTROL THE TIMER WITH A SLIDER OR A KNOB

❑ **Activate a Slider or a Knob to turn on, off and reset your timer**

   ❑ Set your flight time in order to preserve at least 10-15% of your fuel at the end of the aerobatic flight, in order to safely manage the landing procedure.

   ❑ Turn on the timer as soon as you turn on your engine.

   ❑ As soon as the timer rings, torward the end of your flight, immediately initialize your landing procedure.

   ❑ Set your slider or knob so that when you turn it off it will automatically reset your timer.

MAKE SURE YOU CAN KILL YOUR ENGINE AT ANY TIME AT YOUR WILL

❑ **Activate a Slider to control Throttle Cut.**

  ❑ Throttle can be cut by reducing gasoline injection below idle level, acting on your throttle servo using the "Throttle Cut" procedure provided by your radio. **However, this is not a safe procedure.**

  ❑ It is much better to control the ignition by installing an electronic kill switch. This will work even if your engine servo is not working properly or is completely out of order.

TO OPERATE THROTTLE CUT WITH A SWITCH IS DANGEROUS!

ELECTRONIC SWITCHES FOR ENGINE IGNITION CONROL

Set Airplane and Radio for IMAC Precision Aerobatics

SET UP A SLIDER OR A KNOB TO OPERATE CHOKE

- **Especially on large airplanes it is handy to install a servo to operate choke**
  - Many Pilots prefer a manual set up because it is lighter

CHOKE CONTROL ARM

Ensure a calm air intake by providing a remote intake. This avoids possible mid-range choking

INTERNATIONAL MINIATURE AEROBATIC CLUB

EUROPE
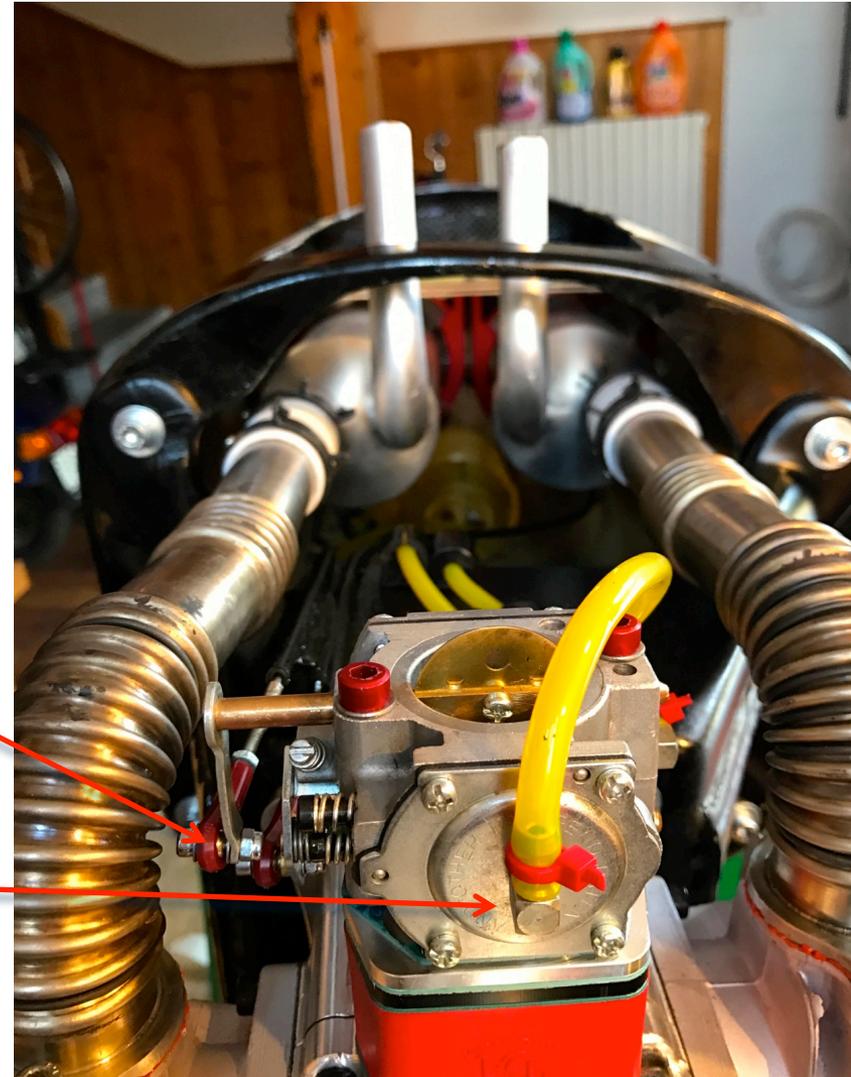
Program your Radio
for Precision Aerobatics

During the execution of an IMAC aerobatic flight, the activation of maneuver specific flight conditions can significantly facilitate the precise implementation of those maneuvers, since their execution benefits from specific throw settings.

However, in order to turn on and off a flight condition, the pilot has to turn on and off the relative switch. This mental and manual activity constitutes a significant element of distraction and implies a relevant manual ability, creating the conditions to seriously reduce the precision level of the whole flight.

For this reason, **we suggest to find the best way to minimize the use of flight conditions** when performing a complex aerobatic flight. We propose a possible solution to this problem describing the use of the nine points curve programming facility, provided by most radio systems available today.

❑ Minimize the use of flight conditions

❑ Introduce flight conditions

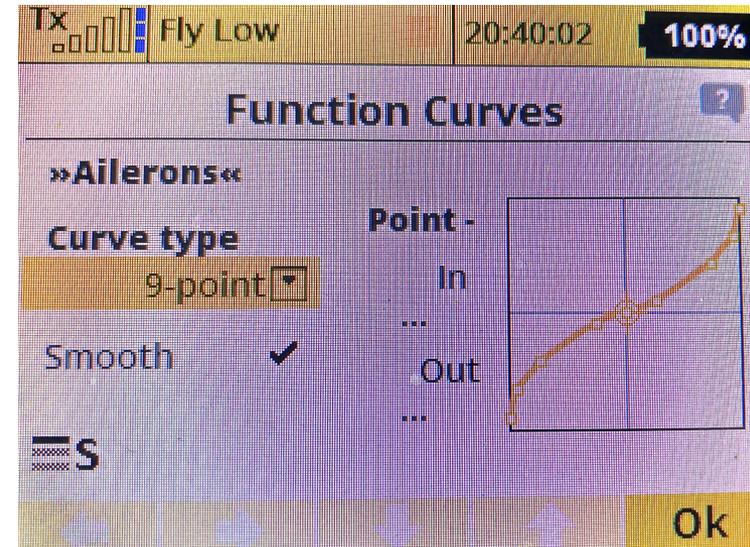❑ Organize your dashboard

Minimize the use of Flight Conditions

- ❏ Discover the 9-Points curves

- ❏ Introduce the curve

- ❏ Position the points of the curve

- ❏ Program your throttle curve

- ❏ Fly to find the perfect position of each point

Discover the 9-Points curves

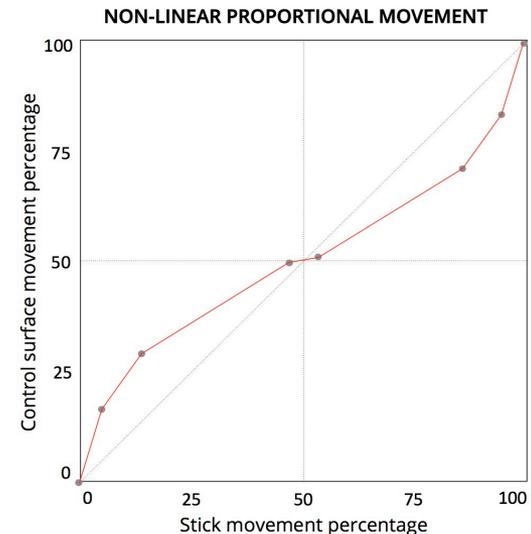**LEARN WHO TO USE 9-POINTS CURVES TO PROGRAM THE RELATIONSHIP BETWEEN STICK MOVEMENT AND THROW MOVEMENT**

❑ Almost all contemporary radios enable to program 9-points curves. Please consult your radio manual and find out how to introduce and program them on your radio system.

❑ You will be able to determine the position of each of the nine points, originating a segment curve which, if you will want, could then be interpolated (Smooth Function) creating a continuous curve.

❑ The personalized setting of these points completely substitutes the use of "Exponentials", enabling a quality of programming that will be able to perfectly interpret your habits and preferences.

Each radio offers its own 9-points programming procedure. In the above Jeti case, you will find this opportunity exploring the Functions Menu and than choosing to use the 9-points option.

❑ The use of these curves consent to effectively personalize programming of ailorance, elevator, rudder and throttle, by setting a non linear relationship between the movement of the stick and the movement of the relative function.

PROGRAM THE CURVE BY POSITIONING EACH OF THE NINE AVAILABLE POINTS

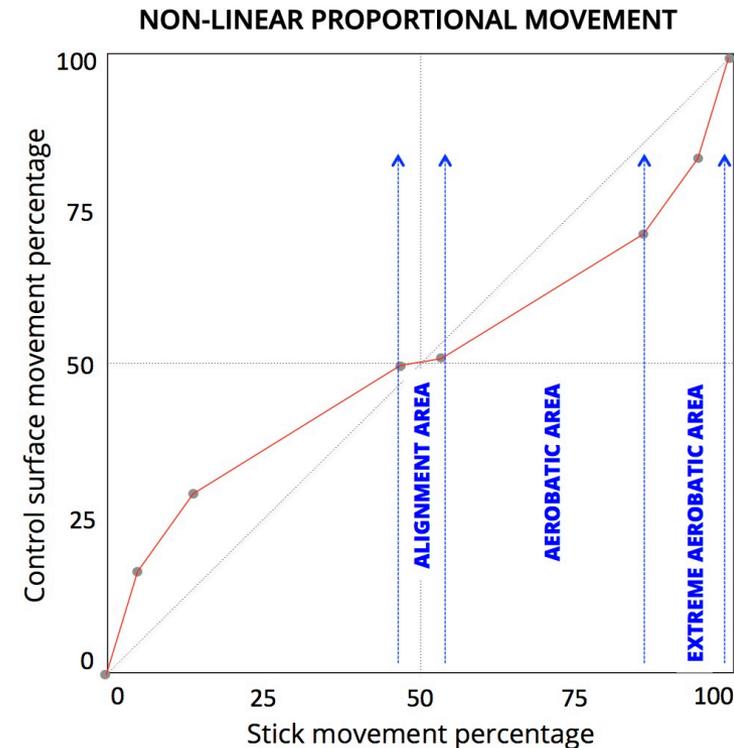❑ Your radio proposes, as default, a linear proportional movement relationship between the stick movement percentage and the control surface movement percentage. This relationship can be personalized.

❑ By programming a 9-points curve you will be able to set a non-linear relationship, adjusting the response of your sticks to your specific aerobatic needs.

❑ You will probably want to smooth the response of your sticks around the center, as shown here on the side, and to make if faster and stronger versus the end of the throw.

❑ After having defined the position of each point, if you like, you will be able to ask your radio to interpolate the points, creating a continuous curve instead of a segment curve. This will be your choice, some pilots prefer to maintain a perfect proportional relationship in the middle of each side and do not like to interpolate.

❑ The use of the so called "Exponentials", also implies the introduction of non-linear curves, but these are directly programmed by your radio in a symmetric way and therefore do not reflect the particular use of stick movement that you may want to introduce. This is why 9-points curves are more powerful than Exponentials.

Set Airplane and Radio for IMAC Precision Aerobatics

LINEAR PROPORTIONAL MOVEMENT

NON-LINEAR PROPORTIONAL MOVEMENT
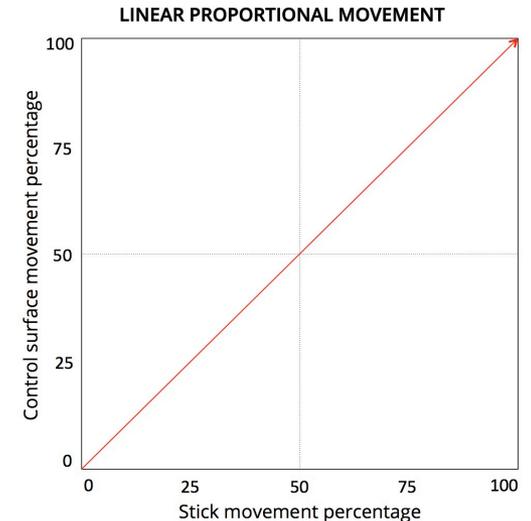
THINK ABOUT THE DIFFERENT REACTIONS YOU PREFER TO RECEIVE FROM CORRESPONDING STICK AREAS OF OPERATION

1. **Alignment Area**: to achieve maximum control around the center of the stick. Within a small area, maybe 10-15 pixels around the stick center, you can program a very small reaction of the relative moving part, to very precisely manage pitch, jaw and roll alignments.

2. **Aerobatic Area**: to manage all non extreme maneuvers with the level of authority that you prefer and to rely on a perfectly proportional movement. This avoids the possibility of non intentional over-corrections induced by the use of Exponentials.

3. **Extreme Aerobatic Area**: to rely on the maximum level of excursion that you prefer to apply when performing snaps, stalls and spins.

NON-LINEAR PROPORTIONAL MOVEMENT

Control surface movement percentage (y-axis: 0, 25, 50, 75, 100)

Stick movement percentage (x-axis: 0, 25, 50, 75, 100)

ALIGNMENT AREA AEROBATIC AREA EXTREME AEROBATIC AREA

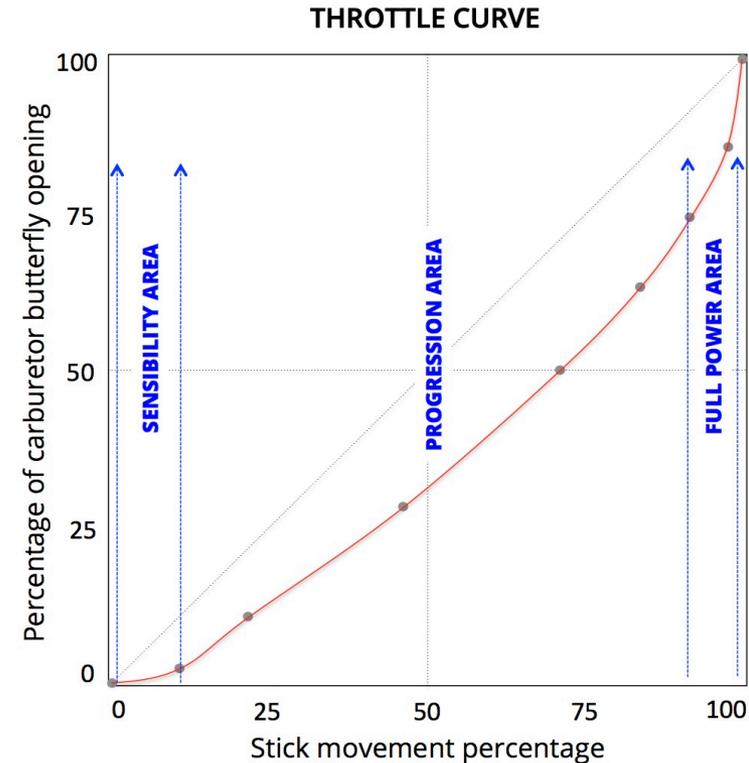**Three areas with different needs:**

1. **Alignment Area:** maximum sensibility for precision

2. **Aerobatic Area**: authority and proportional progression

3. **Extreme Aerobatic Area:** maximum excursion set to implement snaps, stalls and spins

FEEL A LINEAR THROTTLE PROGRESSION AS YOU MOVE UP YOUR GAS STICK

- ❑ Our carburetor engines do not provide a linear rpm curve, while our stick movement creates the expectation for a linear rpm progression.

- ❑ Programming the throttle curve you will be able to create the "thumbs" feeling of a linear rpm progression when operating the stick.

- ❑ In order to obtain maximum sensibility at low rpm, useful to facilitate landings, we will have to position the second point at about 10-20% of total throw and set it at a relatively low output value.

- ❑ To ensure linear progression in the middle of rpm range, we will have to adjust each intermediate point until we will obtain the right perception. For the purpose, it is advisable to measure rpm at each point.

- ❑ At a certain position, versus the end of the throttle stick throw, we will decide to just want maximum power.

THROTTLE CURVE

(Y-axis: Percentage of carburetor butterfly opening — 0, 25, 50, 75, 100)
(X-axis: Stick movement percentage — 0, 25, 50, 75, 100)

SENSIBILITY AREA   PROGRESSION AREA   FULL POWER AREA

Three areas with different needs:

1. **Sensibility Area:** feel minor rpm adjustments when landing and approaching the spin.

2. **Progression Area:** feel a linear proportional power progression through your stick.

3. **Full Power Area:** feel maximum power.

FINDING THE RIGHT PLACE TO EACH POINT IS NOT OBVIOUS, IT TAKES A FAIR AMOUNT OF TRIAL AND ERRORS WHILE FLYING AEROBATIC SCHEDULES

❑ When adopting for the first time the 9-points curves, you should create easy curves, not very far from a linear progression, without exaggerating any position of the points versus extreme or dangerous positions.

❑ Then fly some maneuvers and understand how you could fly them better if the response of your sticks was different. Introduce the envisioned change and fly again.

❑ To find the right position it takes some patience. You have to learn the mentality of the professional tester. You have to become the best tester of your airplane, finding the best solutions through trial and error. At the end of the process you will really "own" your machine.

A good programming of 9-points curves for ailorance, elevator, rudder and throttle, in most cases, effectively eliminates the need for setting flight conditions.

Introduce Flight Conditions

- ❑ Discover the conditions

- ❑ Program the throttle stick as a three points switch

  - ❑ Control snaps at different throttle output levels

- ❑ Suggested flight conditions:

  - ❑ Spin

  - ❑ Land

  - ❑ Taxi

- ❑ Non-suggested flight conditions, but possibly useful:

  - ❑ Rolling Circle

  - ❑ Snap

- ❑ Organize your dashboard

THE BASE CONDITION

It is the condition that is automatically activated when you turn on the radio. It is the content where your return when switching off all other activated conditions. You will be able to name it as you like.

CREATE A NEW CONDITION

- ❑ Add a new condition to your conditions' panel
- ❑ Name it and make it a "separate", not "global" condition
- ❑ Activate a switch to operate it
- ❑ Turn on the new condition and make it active
- ❑ Introduce all the maneuver specific settings that you wish
- ❑ Verify that, after switching off the new condition, all values will return to the content defined within the Base condition

SET THE CONDITION PRIORITY LEVEL

When activated, the content of the condition to which you will assign maximum priority will overrun all others, even if you forgot to turn other conditions off

- ❑ Therefore, it is a good idea to assign maximum priority to the Landing condition


Set Airplane and Radio for IMAC Precision Aerobatics
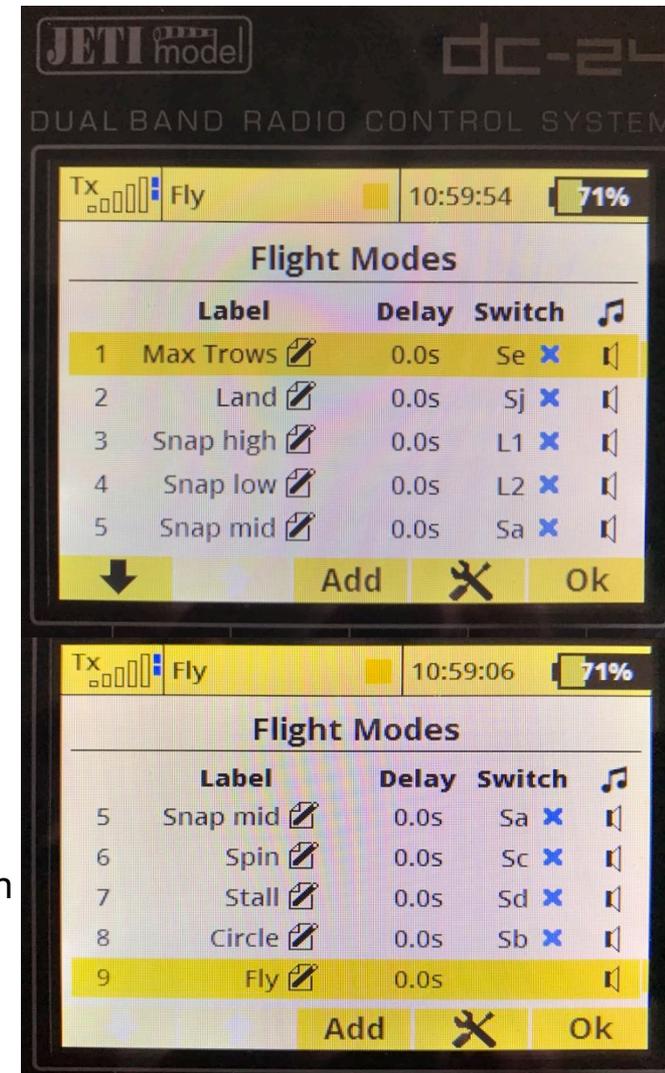
Program the throttle stick as a three points switch

On most radios, the throttle stick can be enabled to become a three point switch. A different flight condition can be assigned to each of these three positions and to be activated and deactivated by the movement of the throttle stick

❑ Consult your radio manual and find how to enable the throttle stick to operate as a switch (this can be done also with any other stick function for different purposes)

❑ Segment the throttle stick movement, creating three separated switch areas

❑ Create three different flight conditions that will be activated when the throttle stick will move within each of the three areas that you defined

❑ When the throttle stick will be in one of the three areas, it will automatically activate the relative flight condition, without requiring attention from the pilot
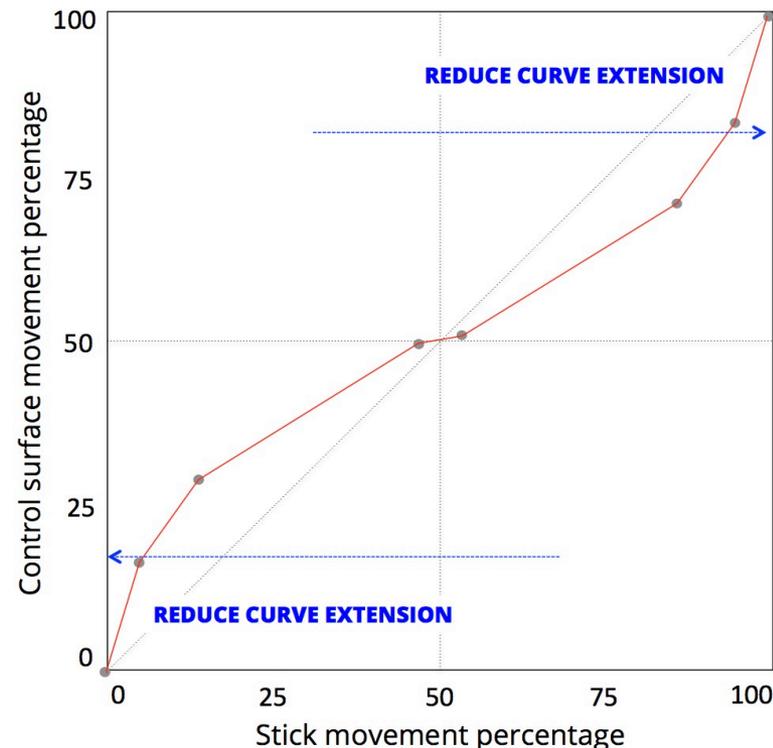
THROTTLE CURVE AS A SWITCH
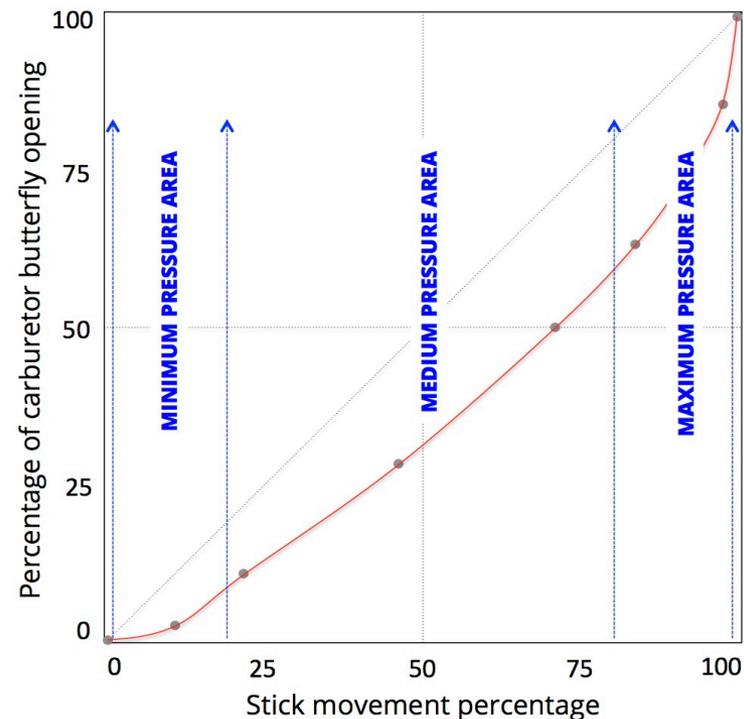
Determine three switch activation areas by setting the stick movement position that will activate the switch

Different rpm levels determine different pressure forces on each moving part, making them more or less sensitive to their relative excursion

❑ Different amounts of airflow pressure on your moving parts can make your snaps more or less explosive and controllable.

❑ Through the automatic activation of the described three power driven flight conditions, you will be able to adjust the full extension of ailorance, elevator and rudder in presence of different amounts of pressure force coming from the propeller. This can be done by cutting the tails of the 9-points curves you have previously set.

❑ In this way you will be able to better control the execution of your snaps in presence of different levels of airflow pressure coming from the engine.

❑ These precision settings cannot take into account other variables, as for example the speed of wind. For this reason, several pilots do not to use these throttle related settings, preferring to rely entirely on their thumbs sensibility.

CUT CURVE TAILS

REDUCE CURVE EXTENSION

REDUCE CURVE EXTENSION
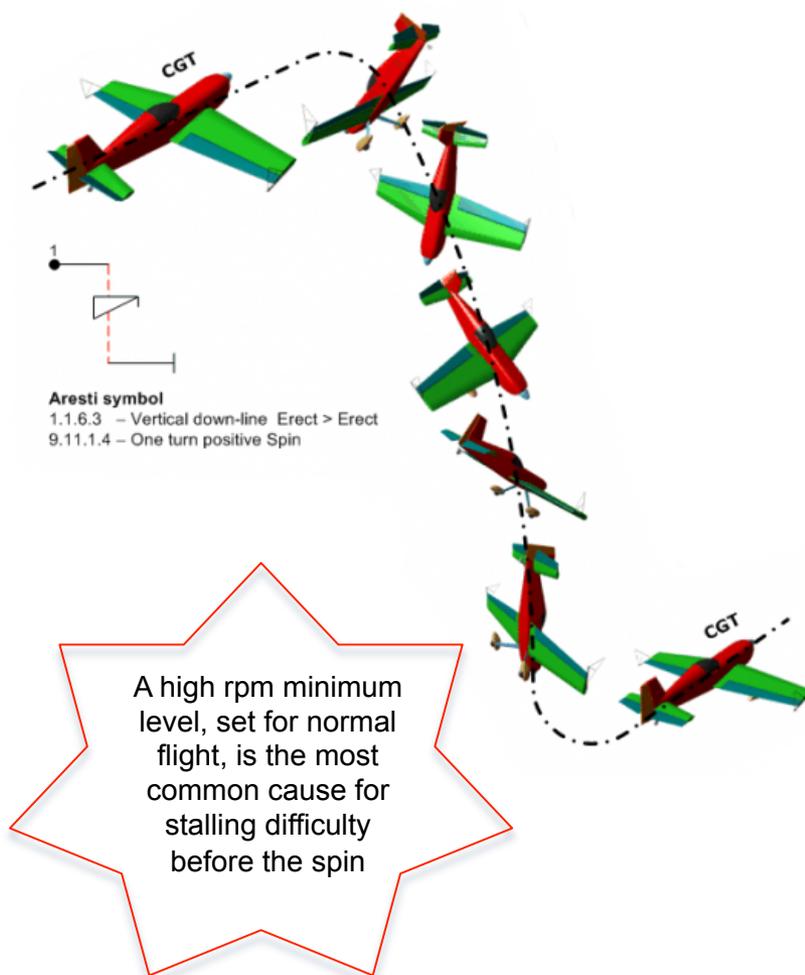
Control surface movement percentage

Stick movement percentage

To better control your snaps, regulate the full excursion of ailorance, elevator and rudder in presence of different throttle regimes.

Set Airplane and Radio for IMAC Precision Aerobatics

ACTIVATE THE SPIN CONDITION AND THEN:

- Set an rpm minimum level specific for the execution of the spin. This should be intermediate between the flight minimum (relatively higher) and the landing minimum (relatively lower)

- If you programmed the 9-points curves, you will probably not feel the need for any additional change. Otherwise, if you set relatively moderate normal flight throws, you should:

  - Increase elevator throw (+30%)

  - Increase rudder throw (+20%)

- Consider to introduce and experiment the butterfly function, in case you experience serious stalling problems introducing the spin.

Aresti symbol
1.1.6.3 – Vertical down-line Erect > Erect
9.11.1.4 – One turn positive Spin

A high rpm minimum level, set for normal flight, is the most common cause for stalling difficulty before the spin

ACTIVATE THE LAND CONDITION AND THEN:

❑ Set the minimum rpm level that you like for landing. It should be the minimum rpm level the engine is capable to handle without incurring in the risk of quitting.

❑ In most radios, the landing minimum level can be regulated also using the "throttle down" function that, if you like, you could activate within this condition.

❑ If you programmed the 9-points curves as described above, you should not feel the need for any further throw adjustments. Otherwise, you may consider to reduce the elevator sensibility around the center in order to facilitate smooth landings.
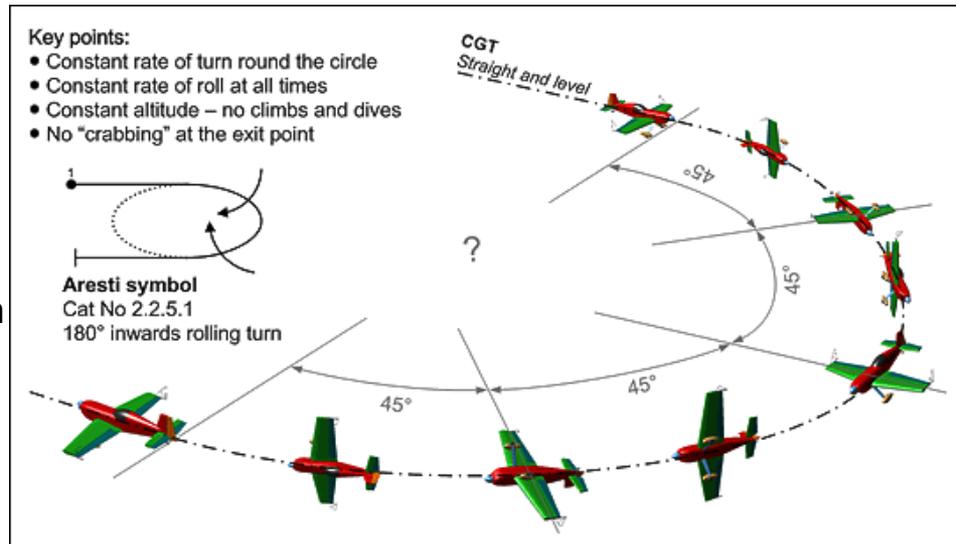
ACTIVATE THE TAXI CONDITION AND THEN:

- ❑ Enable the maximum possible throw of elevator and rudder, in order to maximize taxi control.

- ❑ Activate the "Land Minimum" level previously set within the land condition.

- ❑ Some pilots, who operate on particularly fast concrete runways, in order to better stop their airplanes after landing, like to activate the Butterfly function within this condition, using opposite elevator and both ailorance as airbrakes.
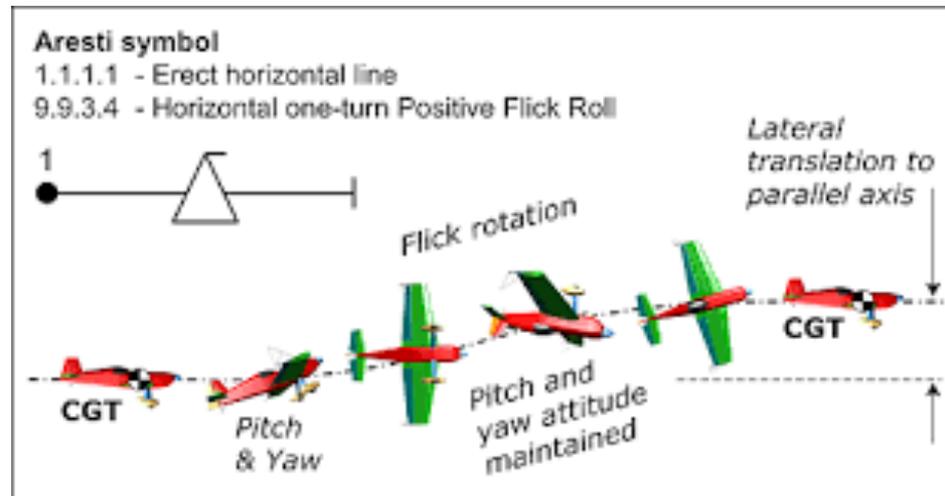
ACTIVATE THE ROLLING CIRCLE CONDITION AND THEN:

❑ Activate the knife edge settings discussed at the Knife Edge page, p.17.

❑ If you did not program the 9-points functions, in order to facilitate the execution of the rolling circle you will probably feel the need to:

- ❑ Reduce elevator throw (-15%) and introduce exponentials

- ❑ Reduce rudder throw (-20%) and introduce exponentials

- ❑ Reduce aileron throw (-10%)

Key points:
- Constant rate of turn round the circle
- Constant rate of roll at all times
- Constant altitude – no climbs and dives
- No "crabbing" at the exit point

Aresti symbol
Cat No 2.2.5.1
180° inwards rolling turn

CGT
Straight and level

ACTIVATE THE SNAP CONDITION AND THEN:

❑ If you did not program the 9-points curves and cut their tail in presence of different airflow levels, in order to properly perform the snap you will probably feel the need to:

   ❑ Increase ailorance throw

   ❑ Increase rudder throw

   ❑ Find the right elevator throw to perform your snaps

Aresti symbol
1.1.1.1 - Erect horizontal line
9.9.3.4 - Horizontal one-turn Positive Flick Roll

Lateral translation to parallel axis

Flick rotation

Pitch and yaw attitude maintained

CGT

Pitch & Yaw

CGT

Organize your Dashboard

- Activate your switches, sliders and knobs so that they all turn on and off in the same direction, in this way you will avoid any doubts.

- Position all the flight conditions switches in an area opposite to the elevator stick, which is usually the most sensitive to flight emerging problems.

- Place dangerous functions, such as engine ignition or choke only on sliders or knobs.

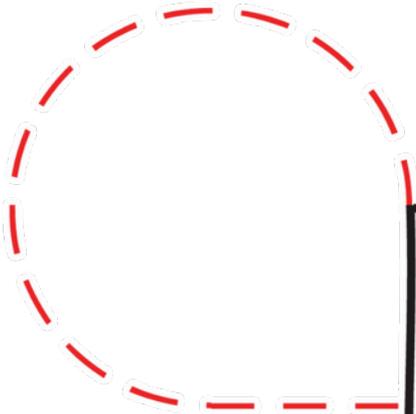- Make sure you will never feel the need to watch your dashboard during flight.

MIND SAFETY

SPIN

CIRCLE

CHOKE

VOLUME

ZERO AMP CONSUMPTION

SNAP

LAND

KILL ENGINE

TIMER

TAXI

TURN ON AIRPLANE

FLIGHT MODE 4

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