The Evolution of Descriptions of

Roll, Yaw, and Pitch Motions

Relative to the Pilot

Rich Stowell, December 2024

I began teaching the Emergency Maneuver Training (EMT) program in 1987. While developing the lesson plans, I came across a training manual from 1978. In it, air show pilot Debbie Gary described elevator inputs as moving the nose of the airplane toward the pilot's head or feet. That was a huge aha moment for me!

Head-to-feet. Easy to visualize. You could see it by looking over the nose of the airplane or at the wingtips. And you could see it regardless of the attitude of the airplane.

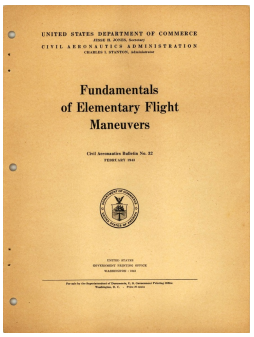
But the manual described aileron and rudder inputs merely as left and right. Motivated by the *head-to-feet* cue for pitch, I applied the same idea to roll and yaw. The result was *head-to-hip* and *ear-to-ear* motion cues. This pilot-centric language made sensing roll, yaw, and pitch more intuitive. Thus, it became part of the DNA of the EMT program.

Over the years, others have picked up on this approach to describing roll, yaw, and pitch as well.

Recently, I discovered that descriptions of airplane motion relative to the pilot date to at least 1943. The phrase, "toward your head" was even used to describe the result of applying aft elevator pressure. Why did that nugget disappear from government training manuals?

Following are examples of pilot-centric motion cues in training material published over the last 80-plus years. Motion cue language used in the EMT program is highlighted in yellow.

1943



CAA, "Fundamentals of Elementary Flight Maneuvers," CAB No. 32, 7

Effect of Controls: **Think of yourself as the point around which the plane pivots when maneuvered.**

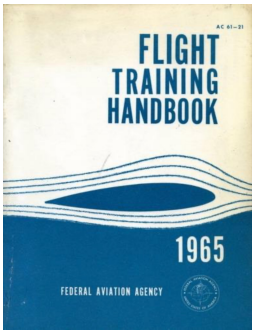
Forward pressure on the stick pushes the nose of the plane away from you, or toward the landing gear. **Back pressure on the stick** pulls the nose of the plane toward your head.

Side pressure on the stick…. to the right lowers the right wing…. to the left lowers the left wing…

Pressure on the rudder pedal causes the nose of the plane to swing in the direction of the pressure…right rudder pressure…toward the right wingtip. Left rudder pressure has the opposite effect.

These relationships hold irrespective of the position of the plane in relation to the horizon or ground.

1965



FAA, "Flight Training Handbook," AC 61-21, 23–24

Airplane Familiarization: In explaining the functions of the controls, the instructor should emphasize the following to prevent the erroneous belief that the controls at times change functions during certain maneuvers. The controls never change in the results produced in relation to the pilot. The pilot should therefore always be considered the center of movement of the airplane, or the reference point from which the movements of the aircraft are judged and described.

The following, then, will always be true, regardless of the position of the airplane with relation to the earth:

1. When…backward force [is] applied to the elevator controls, the nose appears to come toward the pilot.
2. When…the elevator control is pushed forward, the nose is pushed away from the pilot.
3. When the aileron control is pressed to the right, the right wing is…rotated toward the pilot's right.
4. When the aileron control is pressed to the left, the left wing is…rotated toward the pilot's left.
5. When the left rudder pedal is pushed, the nose is pushed to the left of the pilot.
6. When the right rudder pedal is pushed , the nose is pushed to the right of the pilot.

When the functions of the flight controls are considered in this manner, the novice pilot has no difficulty in keeping from thinking in terms of "up" and "down" in respect to the earth…and will make his understanding of the functions of the controls much easier, particularly in steep turns and the more advanced maneuvers.

The student will consequently be able to instantly determine and apply the proper control to put the airplane in any attitude that is desired.

The underlying reason for this explanation by the instructor is to simplify for the student a concept of the control functions and uses…

1978

Bellanca Aircraft Corporation, Pilot Proficiency Training Manual, 22

Pitch, Roll and Yaw: **Regardless of your attitude, the controls do not change their function**…. Think of their response in relation to your body, since your body's position in the airplane remains constant regardless of flight attitude.

[The elevator] moves the nose of the airplane toward your head or toward your feet, not necessarily toward the ground or sky.

The ailerons roll the airplane toward your right or left, according to which way you move the stick.

The rudder always yaws the nose in the direction that you move your foot—that is, either to your right or left.

1980

FAA, "Flight Training Handbook," AC 61-21A, 42

Use of Flight Controls: The following will always be true, regardless of the airplane's attitude in relation to the earth:

1. When back pressure is applied to the elevator control, the nose rises in relation to the pilot.
2. When forward pressure is applied to the elevator control, the airplane's nose lowers in relation to the pilot.
3. When right pressure is applied to the aileron control, the airplane's right wing lowers in relation to the pilot.
4. When left pressure is applied to the aileron control, the airplane's left wing lowers in relation to the pilot.
5. When pressure is applied to the right rudder pedal, the airplane's nose moves to the right in relation to the pilot.
6. When pressure is applied to the left rudder pedal, the airplane's nose moves to the left in relation to the pilot.

The preceding explanations should prevent the pilot from thinking in terms of "up" and "down" in respect to the earth, which is only a relative state to the pilot. It will also make understanding of the functions of the controls much easier…

1987

Rich Stowell develops, begins teaching Emergency Maneuver Training

1989

PLANE Truth

NO. 002 ☆ THE COMMON SENSE APPROACH ☆ JUNE 1989

PT GROUND SCHOOL

AIRCRAFT CONTROL AND AIRCRAFT ATTITUDE

Competent flying requires that pilots transition from the two-dimensional world of everyday experience to the three-dimensional realm of flight. This transition can be difficult, but it must be complete to pilot an airplane effectively. From birth, we learn to live on a flat earth bound by the horizon. We relate experiences as either "left", "right", "up", or "down". Sensory cues (e.g.: trees, mountains, walls, our sense of balance) reinforce this concept and define what is "normal".

Flying breaks our bond with the earth, challenges our normal view of the world, and provides three-dimensional freedom of movement. The airplane does not know what's normal, nor does it understand left, right, up, or down; these are man-made parameters used to describe events. The airplane is unaware that a horizon exists. All it can react to is the relative wind. All a pilot can see and react to is the horizon, or its artificial representation.

To communicate with the airplane, we must learn its language and adapt to a three-dimensional environment. We cannot impose two-dimensional thinking on an all attitude machine without risking miscommunication between pilot and airplane. Proficiency means thinking as an airplane might think.

UNDERSTANDING AIRCRAFT CONTROL

We describe the airplane's position relative to the horizon as its **attitude**. We deflect the airplane's ailerons, elevator, and rudder into the relative wind to **control** its motion around three axes: the **roll** axis, the **pitch** axis, and the **yaw** axis (Figure 1).

Figure 1

No matter what names pilots give to flight maneuvers, the airplane must be moving in roll, pitch, or yaw. All maneuvers are resolvable into these components.

Further study of Figure 1 reveals that the roll, pitch, and yaw axes pass through the airplane and intersect at its center of gravity (CG). The center of gravity defines the origin of roll, pitch, and yaw. The CG and the three axes move with the airplane, therefore they must be independent of the airplane's attitude. Roll, pitch, and yaw have nothing to do with the horizon outside!

Rich Stowell, Plane Truth (No. 002, June), 1–2

Understanding Aircraft Control: [I]t is important for the pilot to interpret roll, pitch, and yaw correctly…. Airplane movements must be viewed relative to the **pilot** and not to the horizon. This allows the pilot to make appropriate control responses during in-flight situations.

As the ailerons are deflected from side to side, the nose of the airplane rotates from the pilot's head to his hip. The wings rotate from head to hip as well. This head-to-hip movement defines roll.

Fundamentally, elevator inputs rotate the nose from the pilot's head to his feet. The wings rotate from head to foot as well…. This head-to-foot movement defines pitch.

As the rudder is deflected from side to side, the nose of the airplane moves from ear to ear. The wings move from ear to ear as well. This ear-to-ear movement defines yaw.

Viewing roll, pitch, and yaw as described above reduces fixation on the horizon and preoccupation with the attitude. This allows us to identify the correct control inputs required to modify an airplane's attitude.

1990

Rich Stowell, Pilot's Video Guide – Emergency Maneuver Training

Aircraft Controls, 08:00–10:33: Let's define roll, yaw, and pitch from the pilot's point of view….

Ailerons control movement around the roll axis. And roll moves the airplane from the pilot's head to his hip. Rudder controls movement around the yaw axis. And yaw moves the airplane from ear-to-ear. Elevator controls movement around the pitch axis. And pitch moves the airplane from the pilot's head to his feet….

Ailerons control roll, and roll is a head-to-hip movement of the airplane. That's true regardless of my attitude…. Rudder controls yaw, and yaw is an ear-to-ear movement of the airplane. And again, regardless of my attitude, the nose will always move ear-to-ear. Elevator is my pitch control. And pitch is a head-to-foot movement of the airplane. And again, that head-to-foot movement is the same regardless of my attitude.

This concept works in a real airplane as well. Watch the engine cowl rotate head-to-hip as ailerons are applied. If you watch the wings, they rotate head-to-hip as well, giving the pilot two sources for the same roll information.

Look back at the nose and let's view yaw. Even though the airplane is banked to the left, rudder inputs will still yaw the nose from ear-to-ear.

Now let's look at pitch. With the same left bank and the same view over the nose, elevator inputs pitch the nose from head-to-foot regardless of the attitude of the airplane…

15:28–15:59: Roll is a head-to-hip movement of the airplane.

Yaw is an ear-to-ear movement of the airplane.

Pitch is a head-to-foot movement of the airplane.

1991

Rich Stowell, "Proficiency Maneuvers," FlightTraining (Oct), 24-26

Dutch rolls involve rocking the wings using coordinated aileron and rudder inputs. When properly done, the airplane moves in roll only (head-to-hip movement).... Coordinated aileron and rudder inputs make the wing move from head to hip only….

The nose should move from ear to ear only…. Slide the wing from ear to ear with the rudder…. concentrate on the ear-to-ear movement….

Put in ailerons and rudder at the same time in the same direction and make the wing move head-to-hip only….

Coordinate ailerons and rudder at the same time in opposite directions and make the wing move ear-to-ear only.

1996

Rich Stowell, Emergency Maneuver Training, 22–24

Chapter 3 – Roll, Yaw, and Pitch: Ailerons control movement around the roll axis. Deflecting them from side to side rotates the nose of the airplane from our head to our hip. The wingtip travels from head to hip as well. Although the airplane can be placed IN ANY ATTITUDE, roll will always appear as a head-to-hip movement relative to the pilot.

The rudder controls movement around the yaw axis. Deflecting the rudder from left to right slides the nose of the airplane from ear to ear. The wingtip moves ear-to-ear as well. Although the airplane can be placed IN ANY ATTITUDE, yaw will always appear as an ear-to-ear movement relative to the pilot.

The elevator controls movement around the pitch axis. Elevator inputs do not necessarily move an airplane "up" or "down". Fundamentally, the elevator rotates the nose from our head to our feet. The wingtip rotates head-to-feet in pitch as well. Back elevator pressure pulls the nose and wing toward your head; forward pressure pushes them toward your feet. Although the airplane can be placed IN ANY ATTITUDE, pitch will always appear as a head-to-feet movement relative to the pilot.

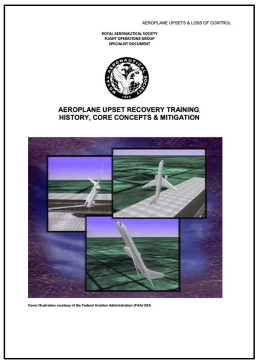
2004

FAA, "Airplane Flying Handbook," FAA-H-8083-3A, 3-1

Effect and Use of the Controls: In explaining the functions of the controls, the instructor should emphasize that the controls never change in the results produced in relation to the pilot. The pilot should always be considered the center of movement of the airplane….

- When back pressure is applied to the elevator control, the airplane's nose rises in relation to the pilot.
- When forward pressure is applied to the elevator control, the airplane's nose lowers in relation to the pilot.
- When right pressure is applied to the aileron control, the airplane's right wing lowers in relation to the pilot.
- When left pressure is applied to the aileron control, the airplane's left wing lowers in relation to the pilot.
- When pressure is applied to the right rudder pedal, the airplane's nose moves (yaws) to the right in relation to the pilot.
- When pressure is applied to the left rudder pedal, the airplane's nose moves (yaws) to the left in relation to the pilot.

2010



Captain John M. Cox FRAes, Aeroplane Upset Recovery Training, History, Core Concepts & Mitigation (02 Aug), 18

Attitude Control: How a pilot perceives the attitude of the aircraft, dictates his flying control inputs. Accurate perception helps to interpret roll, yaw and pitch movements correctly. Ailerons (and/or spoilers) control movement around the roll (longitudinal) axis. Regardless of what the pilot sees, manoeuvring the aircraft in roll can be thought of as *head-to-hip* or *hip-to-head* movement. Rudder controls movement around the yaw (normal) axis. Regardless of aircraft attitude, yaw will appear as an *ear-to-ear* movement to the pilot. The elevator controls movement about the pitch (lateral) axis and pitch will always appear as *head-to-foot* or *foot-to head* movement.

2016

FAA, "Airplane Flying Handbook," FAA-H-8083-3B, 3-1–3-2

Effect and Use of the Flight Controls: [T]he airplane controls always function the same relative to the pilot…. The pilot is always considered the referenced center of effect as the flight controls are used…. The following is always true, regardless of the airplane's attitude in relation to the Earth's horizon.

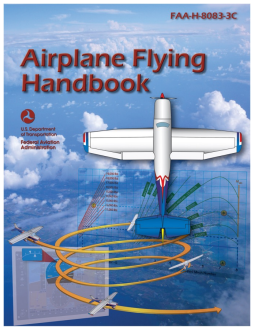
With the pilot's hand:

- When pulling the elevator pitch control toward the pilot…the airplane's nose will rotate backwards relative to the pilot around the pitch (lateral) axis of the airplane. Think of this movement from the pilot's feet to the pilot's head.
- When pushing the elevator pitch control toward the instrument panel…the airplane rotates the nose forward relative to the pilot around the pitch axis of the airplane. Think of this movement from the pilot's head to the pilot's feet.
- When right pressure is applied to the aileron control…the airplane's right wing banks (rolls) lower in relation to the pilot. Think of this movement from the pilot's head to the pilot's right hip.
- When left pressure is applied to the aileron control…the airplane's left wing banks (rolls) lower in relation to the pilot. Think of this movement from the pilot's head to the pilot's left hip.

With the pilot's feet:

- When forward pressure is applied to the right rudder pedal, the airplane's nose moves (yaws) to the right in relation to the pilot. Think of this movement from the pilot's left shoulder to the pilot's right shoulder.
- When forward pressure is applied to the left rudder pedal, the airplane's nose moves (yaws) to the left in relation to the pilot. Think of this movement from the pilot's right shoulder to the pilot's left shoulder.

2021



FAA, "Airplane Flying Handbook," FAA-H-8083-3C, 3-2–3-3

Effect and Use of Flight Controls: The following discussion considers the pilot's frame of reference with respect to the flight controls.

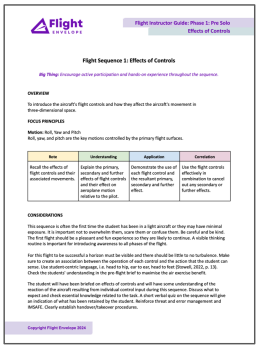
With the pilot's hand:

- When pulling the elevator pitch control toward the pilot…the airplane's nose will rotate backwards relative to the pilot around the pitch (lateral) axis of the airplane. Think of this movement from the pilot's feet to the pilot's head.
- When pushing elevator pitch control toward the instrument panel…the airplane rotates the nose forward relative to the pilot around the pitch axis of the airplane. Think of this movement from the pilot's head to the pilot's feet.
- When right pressure is applied to the aileron control…the airplane's right wing banks (rolls) lower in relation to the pilot. Think of this movement from the pilot's head to the pilot's right hip.
- When left pressure is applied to the aileron control…the airplane's left wing banks (rolls) lower in relation to the pilot. Think of this movement from the pilot's head to the pilot's left hip.

With the pilot's feet:

- When forward pressure is applied to the right rudder pedal, the airplane's nose moves (yaws) to the right in relation to the pilot. Think of this movement from the pilot's left shoulder to the pilot's right shoulder.
- When forward pressure is applied to the left rudder pedal, the airplane's nose moves (yaws) to the left in relation to the pilot. Think of this movement from the pilot's right shoulder to the pilot's left shoulder.

2024


Flight Envelope

Flight Instructor Guide: Phase 1: Pre Solo
Effects of Controls

Flight Sequence 1: Effects of Controls

Big Things: Encourage active participation and hands-on experience throughout the sequence.

OVERVIEW

To introduce the aircraft's flight controls and how they affect the aircraft's movement in three-dimensional space.

FOCUS PRINCIPLES

Motion: Roll, Yaw and Pitch
Roll, yaw, and pitch are the key motions controlled by the primary flight surfaces.

Note	Understanding	Application	Correlation
Recall the effects of flight controls and their associated movements.	Explain the primary, secondary and further effects of flight controls and their effect on aeroplane motion relative to the pilot.	Demonstrate the use of each flight control and the resultant primary, secondary and further effect.	Use the flight controls effectively in combination to correct out any secondary or further effects.

CONSIDERATIONS

This sequence is often the first time the student has been in a light aircraft or they may have minimal exposure. It is important not to overwhelm them, scare them or confuse them. Be careful and be brief. The first flight should be a pleasant and fun experience so they are likely to continue. A visible thinking routine is important for reinforcing awareness to all phases of the flight.

For this flight to be successful a horizon must be visible and there should be little to no turbulence. Make sure to create an association between the operation of each control and the action that the student can sense. Use student-centric language, i.e. head to hip, ear to ear, head to feet (Stowell, 2022, p. 13). Check the students' understanding in the pre-flight brief to maximise the air exercise benefit.

The student will have been briefed on effects of controls and will have some understanding of the reaction of the aircraft resulting from individual control input during this sequence. Discuss what to expect and check essential knowledge related to the task. A short verbal quiz on the sequence will give an indication of what has been retained by the student. Reinforce threat and error management and IMSAFE. Clearly establish handover/takeover procedures.

Flight Envelope, "Effects of Controls," Flight Instructor Guide, 1

Make sure to create an association between the operation of each control and the action that the student can sense. Use student-centric language, i.e. head to hip, ear to ear, head to feet…

Student pilots today have a mountain of material to learn. Yet our obligation as pilots-in-command hasn't changed. Above all, we must be able to aviate. That starts with better understanding of the effects and use of the controls.

Roll, yaw, pitch. Actions pilots take with the controls. *Head-to-hip*, *ear-to-ear*, *head-to-feet*. Consequences pilots can learn to see in any attitude. It's a first principle of light airplane flying. If we're serious about reducing fatal loss of control accidents, we've got to focus on the fundamentals on day one.

Grab a model airplane and play with roll, yaw, and pitch. Watch the nose and wingtips rotate *head-to-feet*, *head-to-hip*, and *ear-to-ear*. Do you see the *head-to-hip* motion as you roll the model into a coordinated, steep bank? Do you see the nose pitching *toward your head* as you pull the model around the horizon in a level turn? How about *hip-to-head* as you roll back to level flight? Look for these same motions next time you're flying.

For More Information

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