

OBJECTIVE

TO DEVELOP THE STUDENT'S SKILL IN THE PERFORMANCE OF THE FOUR BASIC FLIGHT MANEUVERS (CLIMBS, DESCENTS, TURNS, AND STRAIGHT-AND-LEVEL FLIGHT).

ELEMENTS

1. Pre-flight discussion.
2. Review.
 - a. Airplane Servicing.
 - b. Visual Inspection.
 - c. Engine Starting procedure.
 - d. Radio Communications procedures.
 - e. Taxiing.
 - f. Pre-takeoff Checklist.
 - g. Takeoff.
 - h. Traffic Pattern Departure.
 - I. Straight-And-Level Flight (VR and IR).
 - j. Medium Bank Turns (VR and IR).
 - k. Traffic Pattern Entry, Approach, Landing, and Parking.
3. Introduction.
 - a. Climbs and Climbing Turns (VR and IR).
 - b. Glides and Gliding Turns (VR and IR).
 - c. Torque Effect.
 - d. Level-Off from Climbs and Glides (VR and IR).
4. Post-flight critique and preview of next lesson.

SCHEDULE

Total Time 1:30

INSTRUCTOR'S ACTIONS

DEMONSTRATE AND DISCUSS LESSON OBJECTIVES:

1. Instrument Cross-Check, Instrument Interpretation, and Aircraft Control.
2. Instruments used for Pitch, Bank, and Power Control, and how those Instruments are used to Maintain Altitude, Heading, and Airspeed.
3. Trim technique.

STUDENT'S ACTIONS

Listen, Ask Questions, and Practice.

COMPLETION STANDARDS

THE LESSON WILL HAVE BEEN SUCCESSFULLY COMPLETED WHEN THE STUDENT CAN PERFORM, WITH MINIMUM ASSISTANCE FROM THE INSTRUCTOR, CLIMBS, STRAIGHT-AND-LEVEL FLIGHT, TURNS, AND GLIDES. DURING STRAIGHT-AND-LEVEL FLIGHT THE STUDENT SHOULD, WITH MINIMUM INSTRUCTOR ASSISTANCE, BE ABLE TO MAINTAIN ALTITUDE W/IN +/- 100 feet, AIRSPEED W/IN +/- 10 knots, AND HEADING W/IN +/- 10 degrees OF THAT ASSIGNED.

COMMON ERRORS

BASIC INSTRUMENT MANEUVERS:

1. "Fixation," "Omission," And "Emphasis" errors during instrument cross-check.
2. Improper Instrument Interpretation.
3. Improper Control Applications.
4. Failure to Establish proper Pitch, Bank, or Power Adjustments During Heading and Airspeed Corrections.
5. Improper Entry or Level-Off Technique.
6. Faulty Trim Technique.

Chapter 2

Control and Performance Concept of Attitude Instrument Flying

As pilots move up into higher and higher performance aircraft, their concentration on the aircraft's performance indicators—Mach indicator, VSI, altimeter, etc—seems to intensify. What must be remembered is that performance results from the timely and correct application of control and power, and here the attitude indicator is the key. It is the hub instrument; the rest are its spokes.

THE SUBJECT of instrument flying usually revolves around TERPS and regulations. The assumption is that professionals know how to fly instruments, so all they need is information on alterations to procedures and rules. That assumption is unfortunate because there is room for improvement in the way even the pros fly the gauges. Teaching the professional to fly instruments in high performance aircraft is not as redundant as one might think. This chapter might alert some that a change in their philosophy of instrument flight is in order. For others, it's a chance to do some fine tuning of instrument skills.

The Control and Performance Concept of attitude instrument flying is the foundation of all high performance instrument flight instruction. The idea is that an aircraft is flown in instrument flight by manipulating aircraft attitude and power as necessary to produce the desired performance. More specifically, aircraft attitude and power are terms synonymous with angle of attack and the thrust/drag relationship. How does it work? It works much the same as flying "angle of attack" with better results throughout a wider performance envelope.

An aircraft's flight instrumentation is divided into three basic categories (Figure 1). The control instruments display attitude and power indications, and must be calibrated to permit attitude and power adjustments in finite increments. Power indicators vary with aircraft and may include tachometers (rpm), exhaust pressure ratio (EPR), manifold pressure, fuel flow, etc.

The performance instruments indicate the aircraft's actual performance and they include the altimeter, airspeed/Mach indicator, vertical speed indicator, heading indicator and turn and slip indicator.

The navigation instruments indicate the position of the aircraft in relation to a selected navigational facility. This group of instruments includes various types of course indicators, range indicators, bearing pointers and glideslope indicators.

The Control and Performance Concept procedures are deceptively simple:

- 1) Establish an attitude and/or power setting on the control instrument(s) which should result in the desired performance.
- 2) Trim until control pressures are neutralized.
- 3) Crosscheck the performance instruments to determine if the established attitude and/or power setting is providing the desired performance.
- 4) Adjust the attitude and power setting on the control instruments if a correction is necessary.

Expanding each step takes us from the realm of theory into the practical world of operating high performance equipment in IFR conditions.

Attitude, power and trim

PROPER CONTROL of aircraft attitude is the result of maintaining a constant attitude picture, knowing when and how much to change the attitude, and smoothly changing the attitude a definite amount. The key is the attitude indicator, which provides an immediate, direct and corresponding indication of change in aircraft pitch or bank. The importance of the attitude indicator cannot be overemphasized.

Small changes in pitch and bank are often the order of the day; excess leads to complications in performance. For example, a 1° pitch change will produce a vertical speed of 100 fpm multiplied by the approximate groundspeed expressed as a function of nautical miles per minute. Thus, a 3° pitch change at 180 kts groundspeed will mean a change in vertical speed of 900 fpm.

There's a close relationship between Mach number and groundspeed. Therefore, a 1° pitch change at .8 Mach will produce approximately 800 fpm of change on the VSI; a 3° pitch change at .7 Mach means a 2100 fpm change in vertical speed. Small changes in pitch can produce large deviations in performance and it is all too easy to chase the performance gauges.

Bank control is no less critical. For the high performance aircraft, the angle of bank should approximate the number of degrees of turn, not to exceed 30° of bank. Small turns are quite common and large bank angles only aggravate the situation. Conversely, during the maneuvering for an instrument approach, the full 25°-30° bank angle may be required to effect the standard rate turns expected. Too little too late necessitates more pilot work.

Proper power control results from the ability to smoothly establish and/or maintain desired airspeeds in coordination with attitude control changes. Known power settings are the

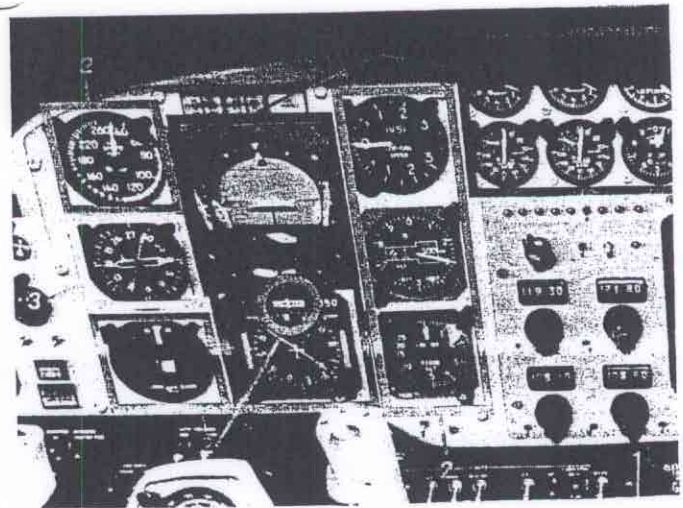


Figure 1—The total instrument display is divided into three groups: 1) control instruments, 2) performance instruments and 3) navigation instruments.

key. The pilot should at least know the approximate power settings required for a desired maneuver. Later in the maneuver, precision can be attained with small adjustments. Control then is a matter of establishing an attitude picture with predictable results and applying known power settings to achieve overall desired performance.

Proper trim technique is essential for smooth and precise aircraft control during all phases of flight. By relieving all control pressures, it is much easier to hold a given attitude and the pilot can devote more attention to the navigation instruments, and any other cockpit duties. You've trimmed correctly when the aircraft maintains the desired attitude with the flight controls released. The high performance aircraft flies itself much better than you can white-knuckle it.

Trimming involves much more than just elevator trim. Coordinated flight is achieved by centering the ball of the turn and slip indicator using rudder trim. Aileron trim is used to establish a wings level attitude. One important note: differential power control on multi-engine aircraft is an additional factor affecting coordinated flight. Without balanced power settings, coordinated flight is difficult to sustain and the aircraft is never really trimmed. Likewise, independent use of trim to establish a change in aircraft attitude invariably leads to erratic aircraft control. To trim: 1) Apply control pressure to maintain the desired attitude. 2) Adjust the trim until the control pressure is relieved.

Instrument scan

INSTRUMENT CROSSCHECK or scan is divided into two essential elements: 1) proper division of attention and 2) interpretation. Attention must be efficiently divided between the control instruments and the performance instruments. The interpretation of various performance instrument indications is basic in understanding *when* and, for that matter, *how much* of a change is required on the control instruments.

Crosscheck or scan techniques vary a great deal and no one technique is everything to every pilot. However, these tips may improve your scan technique:

1) The attitude indicator is the only instrument which should be observed for any appreciable length of time. As an example, approximately 10 seconds may be needed to accomplish an attitude change required for a normal turn. During this 10-second period, attention is devoted almost exclusively to the attitude indicator.

The crosscheck technique may be compared to a wagon wheel, with the attitude indicator serving as the hub and the performance instruments as the spokes. The pilot glances from the attitude indicator to the airspeed indicator, back to the attitude indicator, then glances at the altimeter, returns to the attitude indicator, and so forth. Sometimes, comparing indications of one performance instrument with another is required before knowing when or how much to adjust the attitude or power.

2) Changes in the indications on the performance instruments will lag behind changes of attitude and/or power. This lag is due to inertia of the aircraft and the operating principles and mechanisms of the performance instruments. Since this lag is inherent, a preponderance of attention to the attitude indicator is normal and desirable to keep the fluctuations to a minimum.

3) Each performance instrument needs to be included "in the act" or the wagon wheel will break down. For example, during a climb or descent, pitch control becomes so important that an error in aircraft heading can go unnoticed. The indications on some performance instruments are not as "eye catching" as those on others. A 4° heading change is not as apparent as a 300-400 fpm change in vertical speed.

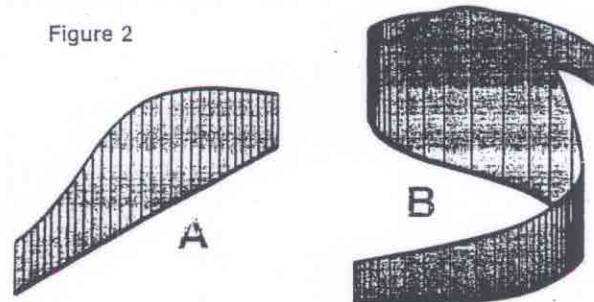
Except for possible fixation on power settings, the problem of too much attention being devoted to the control instruments is rarely encountered. A pilot who monitors control instruments and exercises smooth, positive, and continuous control, but at the same time permits large deviations to slowly evolve on the performance instruments has obviously left the performance instruments out of his scan altogether. This is rare indeed.

4) Adjusting aircraft attitude and/or power is the fourth procedural step of the Control and Performance Concept. Knowing what to change and how much pitch, bank or power change is required is essential. The "what" part is based on the fundamental understanding of pitch attitude control, which is used primarily to maintain an attitude or to control the rate of climb or descent. Bank attitude control is used to maintain a heading or a desired angle of bank during turns.

Power control is used for maintaining or changing airspeed. To climb, you should change the pitch attitude a specified number of degrees to closely approximate the desired vertical speed and set the power to maintain the desired airspeed. Adding power and accepting the resulting pitch change leads to a sort of uncontrolled reactionary instrument flight.

How much to change the aircraft attitude or power setting is a function of pilot education and familiarity with the aircraft. Usually, required changes are small and most inexperienced pilots over-correct because they make changes after reading the performance instruments alone. More precise changes can be made on the control instruments resulting in much better performance. Pilot ability is a factor, of course, and pilot education plays a big part.

Figure 2



- A** The most basic vertical S: Climb 1000 ft at 1000 fpm, then descend 1000 ft at 1000 fpm. Heading is maintained and the airspeed remains constant. The maneuver may be flown at 250 KIAS or at low altitude instrument maneuvering airspeed.
- B** The most advanced vertical S maneuver involves climbing 1000 ft at 1000 fpm while turning left 180° at standard rate; then descending 1000 ft at 1000 fpm while turning right 180° at standard rate. All this is done at a constant airspeed.

Keeping in shape

SOME SIMPLE instrument flight maneuvers will enhance any pilot's scan and increase familiarity with the aircraft performance capabilities. The vertical S maneuvers are perhaps the most helpful (Figure 2). Steep turns are good exercises to practice control and performance instrument flight. A few moments spent on these basic instrument maneuvers every six months or so will pay dividends some cold dark rainy 200 and ½ night when that efficient instrument scan means effective control. You stay ahead of the aircraft.

I can't help remembering one particular aircraft accident and how important the Control and Performance Concept of attitude instrument flying would have been to that flight crew. A B727 departed the New York City area at night with the crew only. Somehow, the pitot heat was never turned on, and in climbout the pitot tubes iced up. The airspeed indicator turned into something like an altimeter and as the aircraft altitude increased, so did the airspeed indications. The pilot flying responded by chasing the airspeed indications with pitch attitude to the point where the aircraft finally stalled and spiralled to the ground, killing the crew.

The absurdity of the aircraft pitch attitude in the later stages of the ill-fated climb would have alerted the attitude instrument pilot to the probability of an error in the airspeed indication. Proper airspeed control is critical in flying high performance aircraft, but it is not everything. The Control and Performance Concept of attitude instrument flying enables the pilot to fly a smoother, more precise instrument profile with greater confidence. ■

Basic Attitude Instrument

What: The ability to control the aircraft by instruments alone, with limited instructions from ATC, should an aircraft become inadvertently flown into IMC.

Why: The ability to handle the aircraft should it be inadvertently flown into IMC.

How:

1. Don't trust your senses rely only on your instruments
2. Using the primary and supporting concept
 - a. This divides the panel into pitch instruments, bank instruments, and power instruments for a given maneuver.
 - b. The primary instruments are the one that gives the most essential information.
 - c. The supporting instruments help to maintain the desired indications

3. *Scan Types* : ① Hub & Spoke ② Racetrack ③ Box or L Scan

1. Straight and Level

Pitch	Primary	altimeter
	Supporting	VSI, airspeed, attitude
Bank	Primary	heading indicator
	Supporting	turn coordinator, attitude
Power	Primary	airspeed
	Supporting	manifold, RPM

2. Standard rate turns

Pitch	Primary	altimeter
	Supporting	VSI, airspeed, attitude
Bank	Primary	turn coordinator
	Supporting	heading indicator, attitude
Power	Primary	airspeed
	Supporting	manifold, RPM

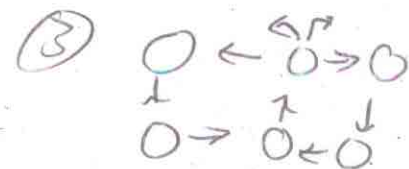
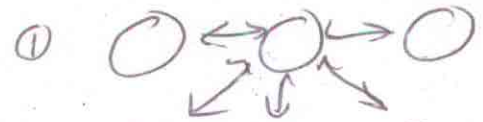
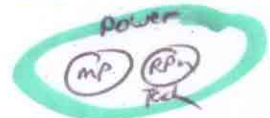
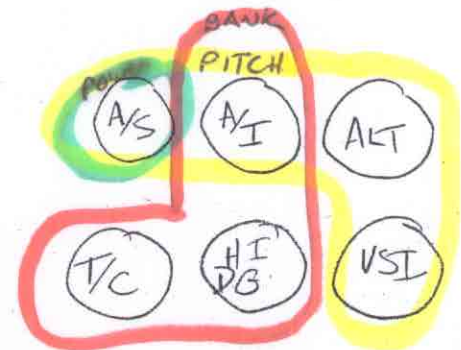
3. Climbs constant airspeed

Pitch	Primary	airspeed
	Supporting	altimeter, VSI, attitude
Bank	Primary	heading indicator
	Supporting	turn coordinator, attitude
Power	Primary	manifold, RPM
	Supporting	airspeed

4. Climbs constant rate

Pitch	Primary	VSI
	Supporting	airspeed, altimeter, attitude
Bank	Primary	heading indicator
	Supporting	turn coordinator, attitude
Power	Primary	airspeed
	Supporting	manifold, RPM

④ Inverted V



PFS
for all
Inst in
Private:
+200ft
+200
± 10 kts

5. Descents constant airspeed

Pitch	Primary	airspeed
	Supporting	altimeter, VSI, attitude
Bank	Primary	heading indicator
	Supporting	turn coordinator, attitude
Power	Primary	manifold, RPM
	Supporting	airspeed

6. Descents constant rate

Pitch	Primary	VSI
	Supporting	airspeed, altimeter, attitude
Bank	Primary	heading indicator
	Supporting	turn coordinator, attitude
Power	Primary	airspeed
	Supporting	manifold, RPM

OBJECTIVE

To Develop One's Ability to Recognize and Recover from Unusual Attitudes Solely By Reference To Instruments

ELEMENTS

COORDINATION OF:

- Pitch**
- Bank**
- Power**

SCHEDULE

ONE HOUR

INSTRUCTOR'S ACTIONS

ORAL DESCRIPTION OF THE ELEMENTS & COMMON ERRORS:

1. Conditions and situations that may result in unusual flight attitudes.
2. The two basic unusual flight attitudes - nose-high (climbing turn) and nose-low (diving spiral).
3. How unusual flight attitudes are recognized.
4. Control sequence for recovery from a nose-high attitude and the reasons for that sequence.
5. Control sequence for recovery from a nose-low attitude and the reasons for that sequence.
6. Reasons why the controls should be coordinated during unusual flight attitude recoveries.

STUDENT'S ACTIONS

Listen, Take Notes, and Ask Questions.

COMPLETION STANDARDS

Recognizes Unusual Flight Attitudes Promptly; Properly Interprets The Instruments; Recovers To A Stabilized Level Flight Attitude By Prompt, Smooth, Coordinated Control, Applied In The Proper Sequence; Avoids Excessive Load Factor, Airspeed, And Stall.

COMMON ERROR'S

1. Failure To Recognize An Unusual Flight Attitude
2. Consequences Of Attempting To Recover From An Unusual flight attitude By 'Feel' Rather Than By Instrument Indications
3. Inappropriate Control Applications During recovery
4. Failure To Recognize From Instrument Indications When The Airplane Is Passing Through A Level Flight Attitude

Unusual attitude is any airplane attitude not normally required for instrument flight.

1. WHAT CAUSES AN UNUSUAL ATTITUDE

- a. Failure Of The Attitude Indicator
- b. Spatial Disorientation
- c. Wake Turbulence
- d. Lapse Of Attention
- e. Abnormal Trim Conditions

2. THE TWO BASIC TYPES

- a. Nose High (climbing turn)
- b. Nose Low (diving spiral)

3. RECOGNIZING

- a. Airspeed -- increasing or decreasing
- b. Altitude -- increasing or decreasing
- c. Attitude -- turning left or right
- d. T/C -- Cross-Check

4. NOSE HIGH RECOVERY -- to prevent a stall from occurring.

- a. Add Power, Level Wings, and Lower Nose -- All at the same time.

5. NOSE LOW RECOVERY -- to prevent excessive Load Factors, and Airspeeds.

- a. Reduce Power, Level Wings, and Raise Nose -- All at the same time.

6. The Reasons why the controls should be coordinated during recoveries is to Avoid Aggravation the Critical Attitude with a control application in the Wrong Direction.