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A PAPER ABOUT AIRCRAFT FLIGHT CONTROL

There is no one solution to the different kinds of incidents that lead to fatalities in aircraft. This paper describes how basic flight control works and how only with its proper use can we reduce the number of accidents or mitigate the fatalities from those accidents that do occur.

—Back to basics—

Most accident reports cite contributing factors such as procedural non-compliance, poor decision-making, poor monitoring, and inadequate training as leading causes to accidents.

Though many suggestions have been presented regarding risk assessment training, to date there is no indication that any organization has first defined the problems involved. There can be no solution without specific definition of a problem.

Discussion of flight training within the industry typically evolves the idea that it is bad. Most comment infers the Instructors don't really want to train but are just building flight time. I spent several years hiring and indoctrinating Flight Instructors for a large flight school. I never had the idea they were not trying their best to train…they just trained the way they had been trained...by those who were trained the same way by others, ad infinitum.

The basic conditions that lead to most fatal accidents are Stall, Loss-of-Control, Emergency off-field Landings, High Density Altitude flight, and Crosswind Landings. It is my contention many of these situations are the result of improper flight control training. The first need is for correct Basic Flight Control.

There are several separate problems to be solved for survival of incidents and emergencies. Through all kinds of training there can be awareness of how problems occur but there needs to be specific discussion and training of what actually can prevent stall, how to control in IMC, how to make spot landings, what takes place from touchdown to stop during an emergency landing, technique for operation in high altitude reduced thrust operations, and handling of crosswind for landings.

Basic Flight Control involves learning what controls there are, what they do, and how to use them. This may sound naïve but most Pilots I have interviewed cannot tell me specifically how they should be used. It's not easy for an experienced pilot to take the time to re-study basics, but this paper presents a different view of how control works that may interest them.

I first review basic flight aerodynamics in which I define some differences in how aviation could be taught. Following this I discuss how control can be used in the different circumstances that are known to lead to accidents and fatalities.

First, what do controls do? The aircraft was designed and built to fly all by itself. The pilot merely guides or steers the machine in a desired direction. If started and let go, it would attempt to fly without a pilot.

The elevator sets the angle-of-attack for the indicated-airspeed the aircraft will fly. Pulling or pushing the elevator pitches the nose to or away in the process. This changes the direction at which the thrust acts. We often teach using the elevator to pitch for altitude change in normal flight and that does work, but when doing this the pilot is really telling the aircraft to change indicated-airspeed while current momentum is causing the change.

The rudder yaws the aircraft side to side again changing the direction of thrust. Yaw is side-pitching the aircraft. In unusual banked attitudes over 45-degrees, rudder pitching relative the force of gravity becomes primary nose up/down pitch while elevator to/from pitch becomes side-pitching. Coordinating rudder input is a basic part of acrobatic flight. Upset training is merely learning acrobatic rolling flight.

The ailerons roll the aircraft attitude with unbalanced aerodynamic wing lift causing lift component-turn for changing direction of motion. Rudder yaw alone also changes the attitude causing unbalanced aerodynamic wing lift which results in attitude roll. Both aileron and rudder are required for initiating coordinated turn and roll maneuvering.

Thrust is the force causing forward motion in an aircraft and is controlled with throttle input from pilot or with descent causing gravity component-thrust. Engine thrust is generated from the reaction of large quantities of air-mass being moved by a propeller or in a turbine engine through the engine.

These four controls have always been the basis of flight training. However, a very basic fifth control force, never mentioned in any text, comes from the engine and acts at the engine attachment. This is a thrust component-lift force resulting from the angle-of-attack and caused by the engine thrust acting above the direction of motion.

The fifth flight control: Because the thrust force is acting at some small angle above the direction of motion there will always be a small thrust component-lift created at the engine attachment. Change in thrust will always make a small change in the total lift. Changed propeller blast is often considered the cause of this pitch effect and depending on the elevator attachment there can be some change of elevator load/lift, however propeller blast lift is minimal. Turbine engine thrust also causes lift at its attachment with its moment arm also to the center of pressure.

Controlling flight involves directing the machine in a specific direction. The direction of visual flight is attained by sighting a distant point or destination referenced to a spot on the windshield (similar to sighting a gun). This procedure is setting a collision course to the desired direction.

As long as the visual reference is not allowed to move, the aircraft will always fly to that targeted reference whether in the distance on the horizon or the end of the runway for landing. I like to call this type of flight “directed course” flight and reserve “collision course” flight to airborne sighting and maneuvering relative to another aircraft or airborne object. In any case, controlling to keep the target unmoving is maintaining desired directional control.

Now that we have defined the controls, and understand where to go, let’s see how Aircraft fly and are controlled.

—FORCES—

Motion for flight is reaction to applied forces. The direction of applied forces will often have reaction forces in different directions than the applied force. The forces acting on the machine then have the effect of two component-force reactions acting 90-degrees from each other.

I use slightly different terminology when discussing component vectors. Thrust is the direction the engine faces, thrust component-lift is the vector away from the top of the machine at the engine and thrust component-forward is the thrust vector in direction of motion. The aerodynamic lift

vectors of the wings and body have lift component-vertical and lift component-drag. Aircraft load has mass causing gravity component-load toward the surface and gravity component-drag in level and climb or gravity component-thrust in descent.

The aerodynamic lift in level or climb flight attitudes is often slightly aft from vertical so has a large vertical component-lift and a small lift component-drag and in descent a sustaining gravity component-forward acting at the center of mass.

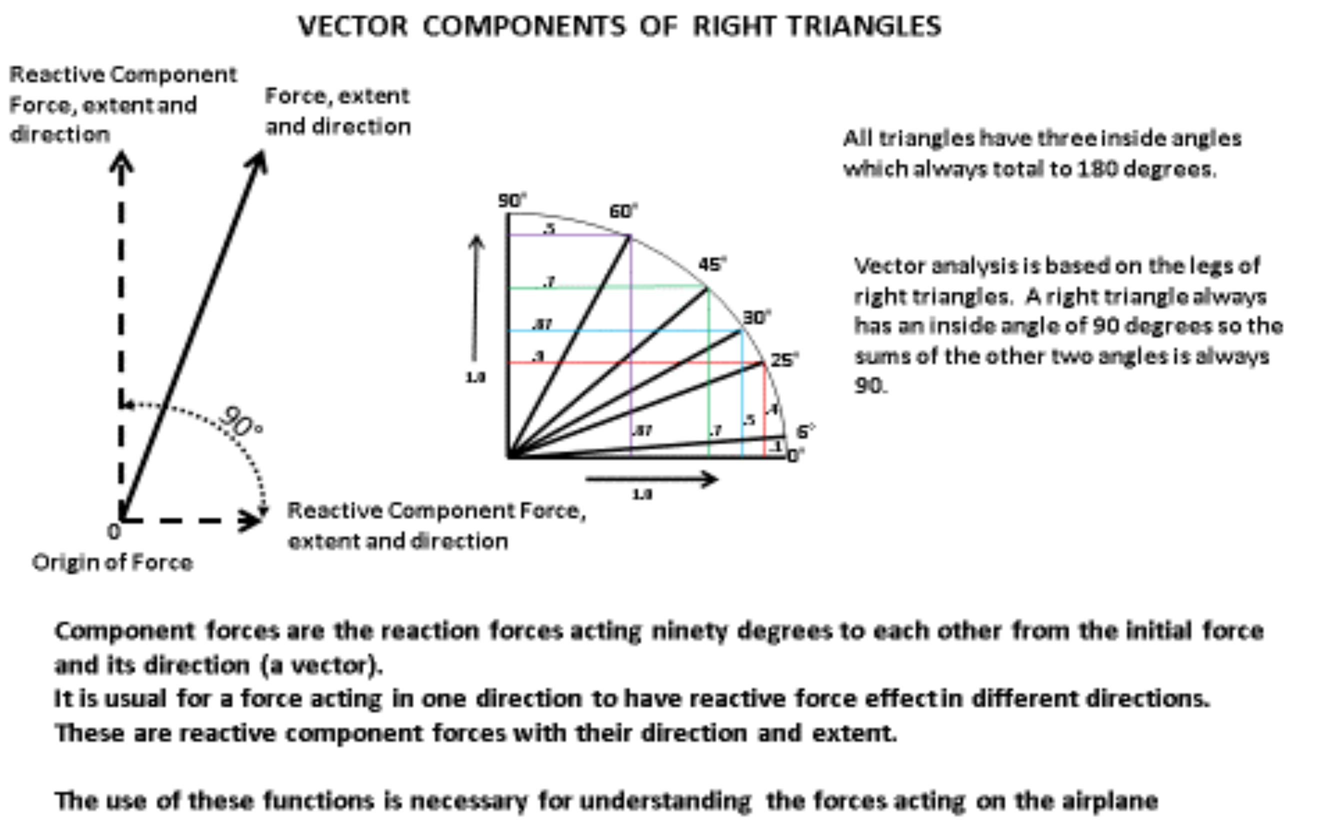


Fig: 1

The horizontal stabilizer and elevator cause aerodynamic lift or load as needed to maintain the balance for a desired indicated-airspeed angle-of-attack.

Additionally, there are different frictional forces from airmass displacement and flow of the aircraft motion causing a reactive drag force in the opposite direction of forward motion.

— Balance—

All forces within a system have moments acting through their moment arms to a center-of-pressure which is considered the center of lift, load, and rotation. Flight control is adjusting these forces for the balance to cause desired motion.

The difference with ground and inflight balance in an aircraft is that on the ground, the only lifting forces are the wheels and the only loading is gravity at the center of mass but when airborne there are additional forces acting at their different fixed positions.

An example 2,000 lb. aircraft at its optimum Vy indicated-airspeed and 200 pounds of sustaining thrust will be in motion at an air-encountering angle of at least a 6-degree angle-of-attack, so will have a continuous 20 or more pounds of thrust component-lift (sine 6°= .1) acting at the engine and contributing to the total lifting forces.

This engine-lift acts along the fuselage as its moment arm to the center of pressure. The engine-lift is coordinated with the elevator aerodynamic loading to maintain the balance for a specific indicated-airspeed angle-of-attack. A ten-foot moment arm from the engine will add 200 ft. lbs. of lift to the total aircraft lift.

When airborne, engine lifting at the attachment of the engine, and the aerodynamic loading of the elevator and horizontal stabilizer act at their fixed structural placement on the empennage. The center-of-mass (gravity) always acts at its current location.

Change of any one of the balance-control forces in its fixed location causes a change of the center-of-pressure fulcrum position, moving it slightly forward or aft. Acting at their attachments, the elevator aerodynamic lift/load forces combined with engine thrust component-lift set the balance for a specific indicated-airspeed angle-of-attack.

The basis of static loading is the designed aerodynamic load/lift limits of the stabilizer and elevator controls to maintain required balance. Loading is critical and not maintaining the loading limits could lead to loss of aircraft control. Manufacturer published tables and charts enable loading an aircraft within its design balance limits.

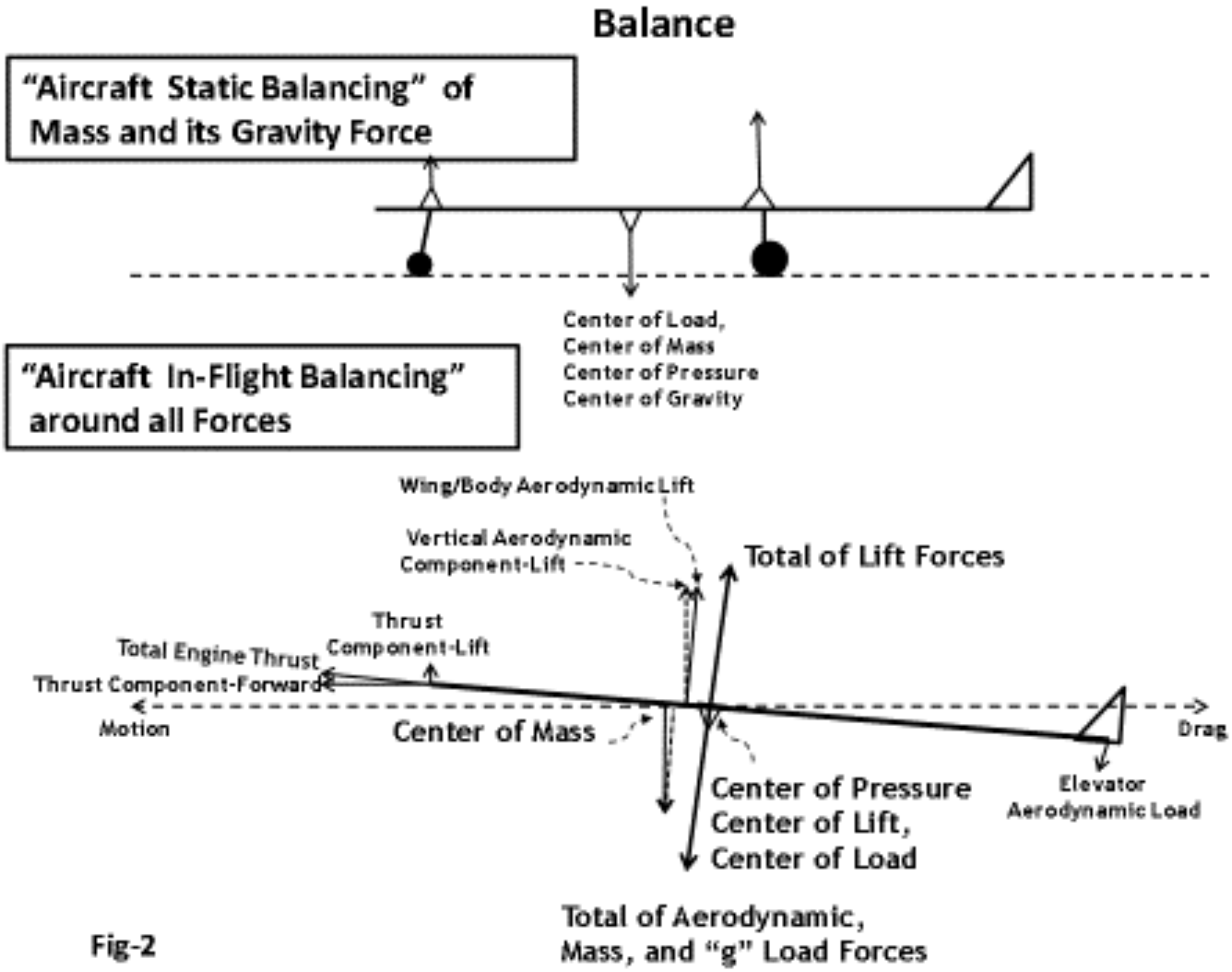


Fig-2

—LIFT—

There are three sources of lift in an aircraft, large aerodynamic lifting acting outward from the top of the wings and fuselage, a small thrust component-lift acting outward at the engine attachment and a small aerodynamic load or lift at the stabilizer.

Aerodynamic lift is reaction to displacement of mass-of-the-air by an airfoil. It requires an equivalent mass-of-the-air displacement away to cause the opposite reactive lifting of the aircraft load.

An aircraft load is the sum of all forces acting away from the bottom of the aircraft. This includes the mass weight of the aircraft always directed toward the surface from the center-of-mass, any aerodynamic load from the stabilizer/elevator acting away from the bottom at their attachment, and

any centrifugal maneuvering "g" loading acting opposite the current center of pressure.

An aircraft engine turning a propeller accelerates by blasting airmass rearward, to which the reaction force called thrust, propels the aircraft forward in a direction of motion. Accelerating to a velocity at which the aircraft fuselage and airfoils displace sufficient mass-of-the-air, there becomes reactive forces outward as aerodynamic lift, equal to the load of the aircraft.

When the lift becomes equal to the aircraft loading, acceleration ceases. There now becomes a sustaining thrust maintaining the velocity within the airmass causing the aircraft lift and any excess thrust at that moment becomes climb, motion angled (climb angle) away with increasing altitude, or if leveling, acceleration.

Thrust component-lift occurs when elevator pitching moves the direction of engine thrust above the forward direction of motion. Thrust component-lift is equal to the current total engine thrust multiplied by the sine of the angle of pitch so changes with thrust change. We call this pitched angle of the longitudinal axis above the direction of aircraft motion the Angle-of-Attack. It is causing the size of the frontal area of the machine that is encountering the airmass so determines the volume of deflected airmass.

With use of the mass-of-the-air, aircraft sustain the lift for flight with as little as one-pound of thrust for 10-12 pounds of aircraft load. Any potential thrust greater than current sustaining thrust is available as excess thrust for maneuvering. From level constant indicated-airspeed cruise, adding excess thrust will increase the thrust component-lift causing the nose to increase pitch while the added forward component of that excess thrust sustains the new direction of motion (climb angle) with increasing altitude, climb.

An aircraft with addition of sufficient excess thrust could continue pitching to an attitude that the nose would be as much as 90-degrees climb angle, climbing straight upward. At that time, the thrust would be equal or greater than the total aircraft load. This is an extreme example as few aircraft have sufficient thrust to fly in this manner. In this extreme situation, forward thrust would be zero and all motion would be vertically away. The power available in most aircraft will allow no more than 10 to 15 degrees climb angle at lower altitudes.

The pressure caused by impacting and displacing the airmass determines the reactive lift forces. Mathematically deducing the displacement pressures involves the load of the aircraft, the area of wing and fuselage bottom surfaces, and the pressure on the frontal area displacing the air. A small aircraft at its Vy indicated-airspeed will have approximately one-pound per square inch airmass encountering pressure and a resulting reactive aerodynamic lift pressure of approximately one-tenth pound per square inch. The wings have lots of square inches. (2 wings @ 14 ft. x 5 ft. ea. x 144 = 20,160 sq. in. x .1 lbs./sq.in. = 2,016 lbs., the aircraft weight).

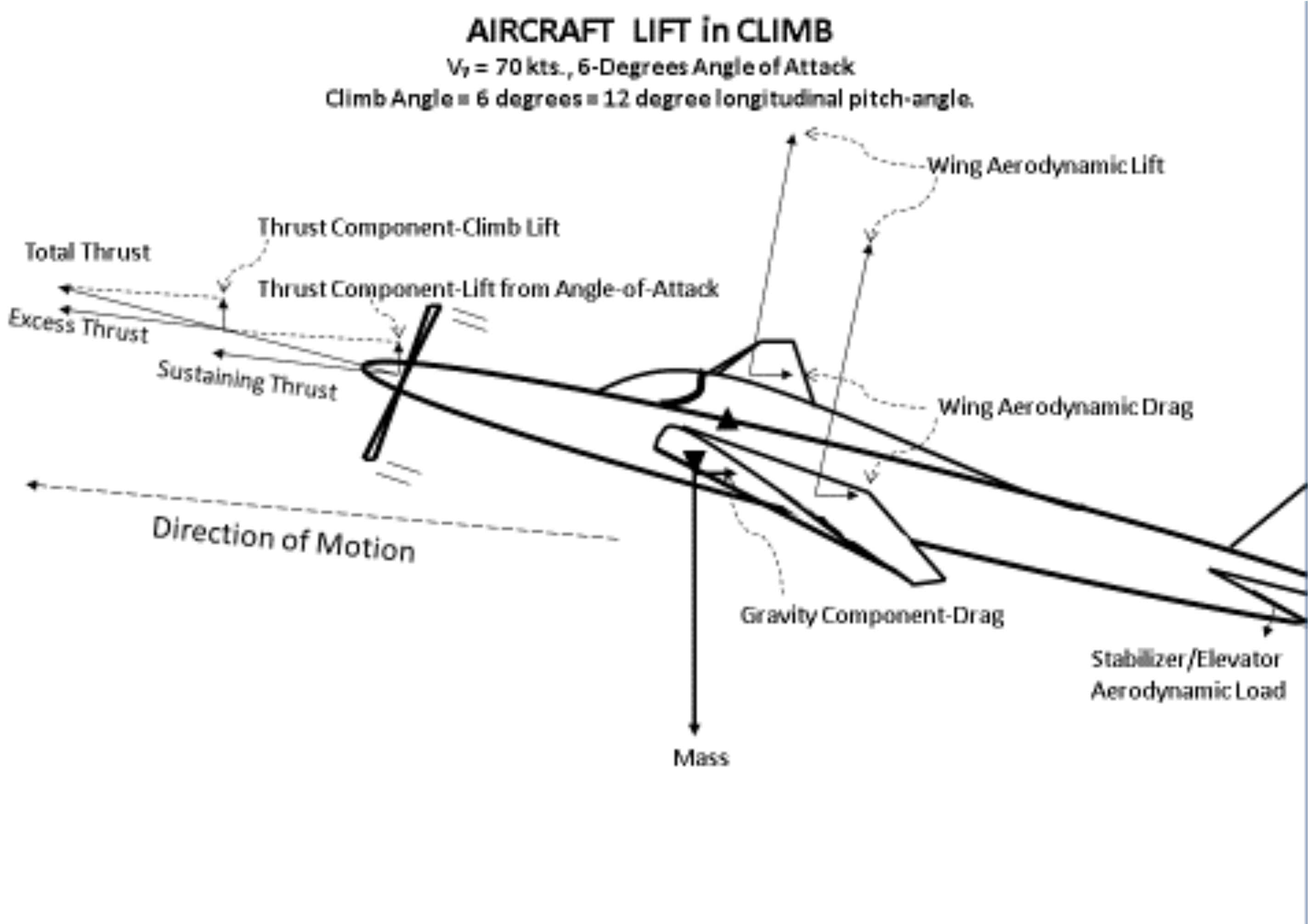


Fig-3

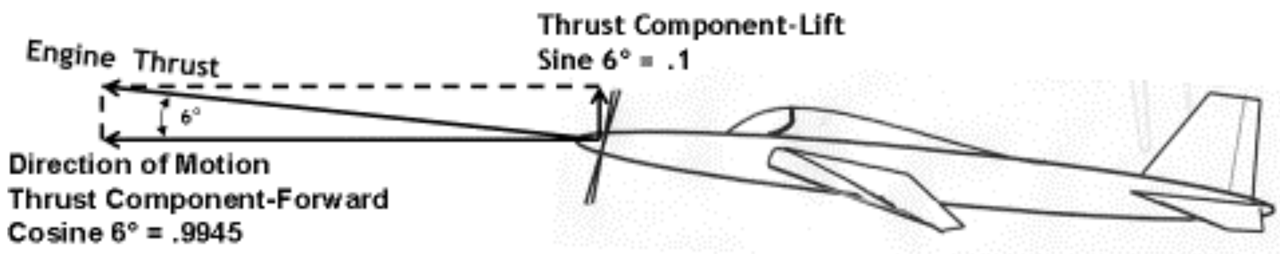
—ENGINE THRUST—

A method to determine approximate engine thrust output can be by use of the sine of a six-degree angle (sine = .1). If in hands-off trimmed level flight at a 6-degree pitched longitudinal angle as the aircraft angle-of-attack, the sustaining thrust will be approximately 10 to 12 percent of the gross

weight. The potential descending vertical thrust of gravity is the load of the aircraft. The 2,000 lb. aircraft requires the same amount of vertical lift plus any aerodynamic loading.

VECTORS AND COMPONENT-VECTORS
Engine Lifting

Right Triangles have specific relationships of the force direction, its extent and the related component forces.



Level flight horizontal motion with six-degree nose up angle of the aircraft attitude encountering the free stream air.
Two hundred pounds of engine thrust will have 199 pounds (200 x .9945) of horizontal thrust and 20 pounds of lift at the nose (200 x .1).
This lifting with the fuselage as its moment arm contributes to the total lift, a ten foot moment arm creates a 200 ft. lbs. lift effect at the center of pressure.

Fig-4

The 6-degree angle-of-attack level flight is close to Vx or Vy in most smaller aircraft. Similarly, an engine out 6-degree descent will be using sustaining gravity component-thrust of one-tenth the gross weight. A 2,000-pound aircraft will require 200 pounds sustaining thrust.

At a 12-degree (sine = .2) longitudinal pitched-up aircraft angle-of-attack, sustained level flight will require thrust equal to two-tenth of the gross weight. The two-thousand-pound aircraft will now require 400-pounds of sustaining thrust.

The six-degree aircraft angle-of-attack in a six-degree pitched climb will require 200-pounds sustaining thrust for indicated-airspeed, plus 200-pounds excess thrust to sustain the six-degree climb angle.

—THRUST COMPONENT-LIFT—

In level flight, the small angle of aircraft attitude above the direction of motion is the angle-of-attack that determines the indicated-airspeed (pressure-speed) within the atmosphere. Most small aircraft, traveling at Vy indicated-airspeed, require 10% -12% of the gross weight as thrust at an angle-of-attack of 6 to 8 degrees. The sine of 6-degrees is .1 so in level flight, a 2,000 lb. aircraft requires 200 lbs. thrust, and there is an associated thrust component-lift force at the engine attachment of at least 20 lbs.

Depending on the placement of the horizontal stabilizer, there may be a certain amount of aerodynamic loading created on the stabilizer from propeller blast. Elevator trimmed hands-off level flight will have aerodynamic loading on the elevator balancing the aircraft at a particular angle-of-attack for a desired indicated-airspeed.

The elevator-balancing load for the angle-of-attack of a given indicated-airspeed incorporates the level flight sustaining thrust component-lift. When set, adding thrust will add lift at the engine attachment so without changed elevator, causes a climb angle and directs the motion upward sustained by the added excess forward component-thrust. There is no change to angle-of-attack other than a possible small elevator loading from propeller-blast and its deceleration of the climb indicated-airspeed. Any deceleration noted will show the effect of prop-blast.

To level at the higher altitude, reduce the thrust to the previous sustaining thrust as used at the lower altitude. Though velocity within the airmass increases, the angle-of-attack and sustaining thrust will remain constant for the constant elevator-trimmed indicated-airspeed.

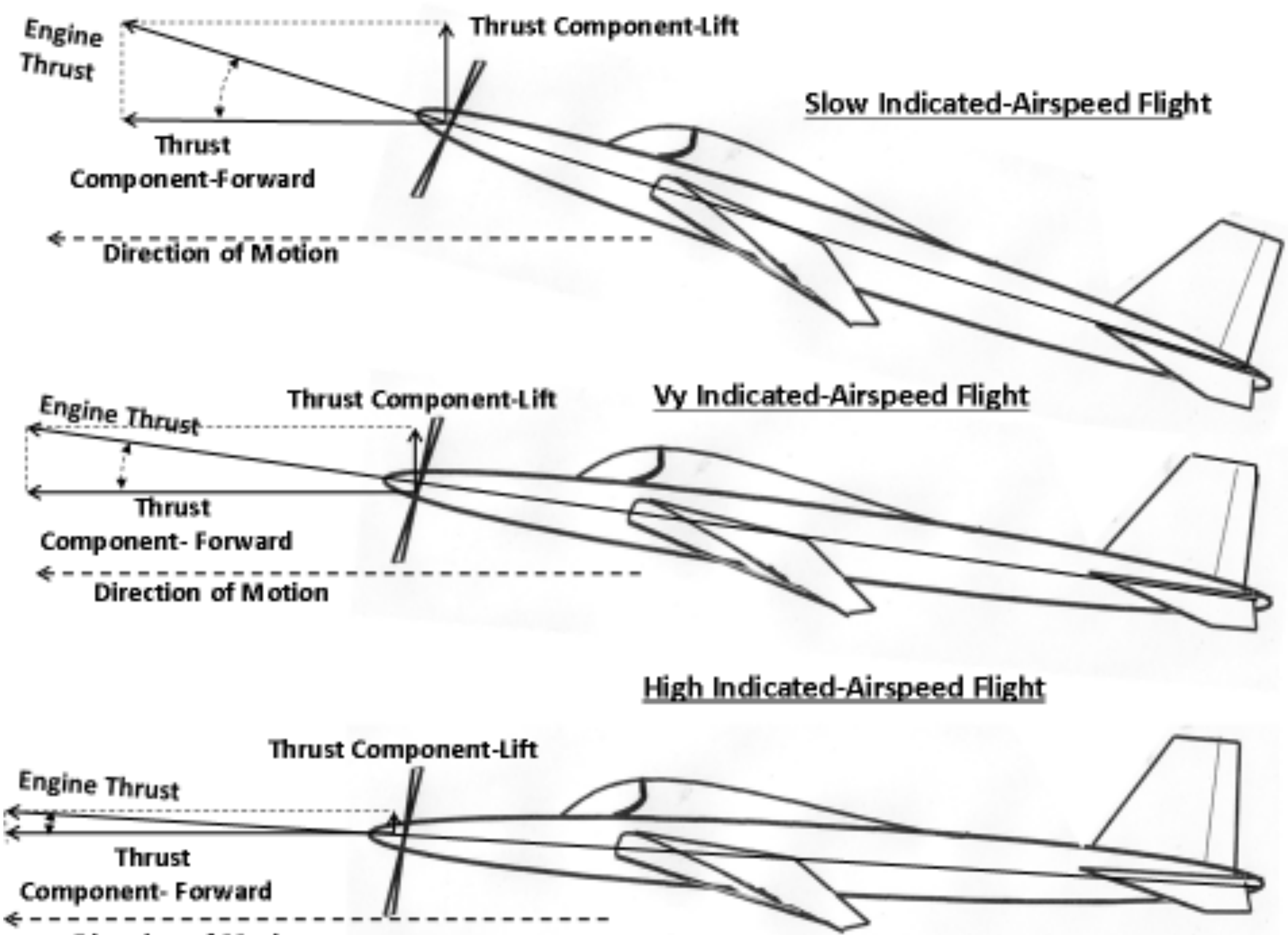


Fig-5

Descent is quite different! Any reduction of sustaining thrust reduces both a portion of the thrust component-lift and any prop-blast incorporated into the current angle-of-attack by the elevator trim. This will allow some acceleration by gravity component-thrust.

Now when in any descent, a change of thrust will change the thrust component-lift affecting the angle-of-attack until again maintaining level flight. All constant indicated-airspeed descent maneuvering will require re-trimming elevator with any thrust change.

—ANGLE-OF-ATTACK—

To maintain constant lift from the airfoils at different velocities, it requires coordination of the aircraft longitudinal angle above the direction of motion. This angle is the angle-of-attack and refers to the angle of wing encounter to the airmass or to the angle the longitudinal axis meets the airmass. This attitude of the aircraft directs the engine thrust slightly above

the direction of motion so there becomes a large thrust component-forward and small thrust component-lift occurring at the engine attachment.

Small angles of encounter require high velocity of airmass encounter (high indicated-airspeed) and larger angles of encounter at slower velocities generate the same constant mass-of-the-air displacement for the constant lift of the aircraft load.

For this reason, for acceleration, reduced angle-of-attack allows acceleration and either added engine thrust or gravity component-thrust of descent causes acceleration. Alternately, increased angle-of-attack allows deceleration and reduced engine thrust or gravity component drag of climb causes deceleration.

Change of thrust component-lift affects aircraft balance. You may even consider engine thrust component-lift a fifth control as thrust change causes a pitch change and can significantly affect the aircraft balance.

Longitudinal balance of the aircraft is by coordination of stabilizer/elevator position and thrust component-lift. Normal loading of aircraft places the static center of gravity forward of the center of aerodynamic lift. This allows positive dynamic stability of the aircraft but requires the stabilizer and elevator to cause negative aerodynamic lifting (loading) to maintain that balance for flight.

An aft loaded aircraft would require having the elevator cause aerodynamic lift which theoretically would be more efficient. However, as the aft loading goes further aft it can quickly reach the limit of the elevator lifting and lead to uncontrolled stall. Therefore, it is essential to understand keeping the loading within the published limits of the manufacturer's POH.

The coordination of stabilizer and elevator position with the sustaining thrust component-lift determines angle-of-attack. Elevator trim setting can fix the angle of attack to a neutral position of the elevator control and acts similar to a cruise control. Any time releasing manual elevator input, the aircraft will quickly resume that angle-of-attack as set with elevator trim. Thrust increase causes added component-lift to cause climb angle and if reduced for descent, thrust component-lift reduces the angle-of-attack with some acceleration.

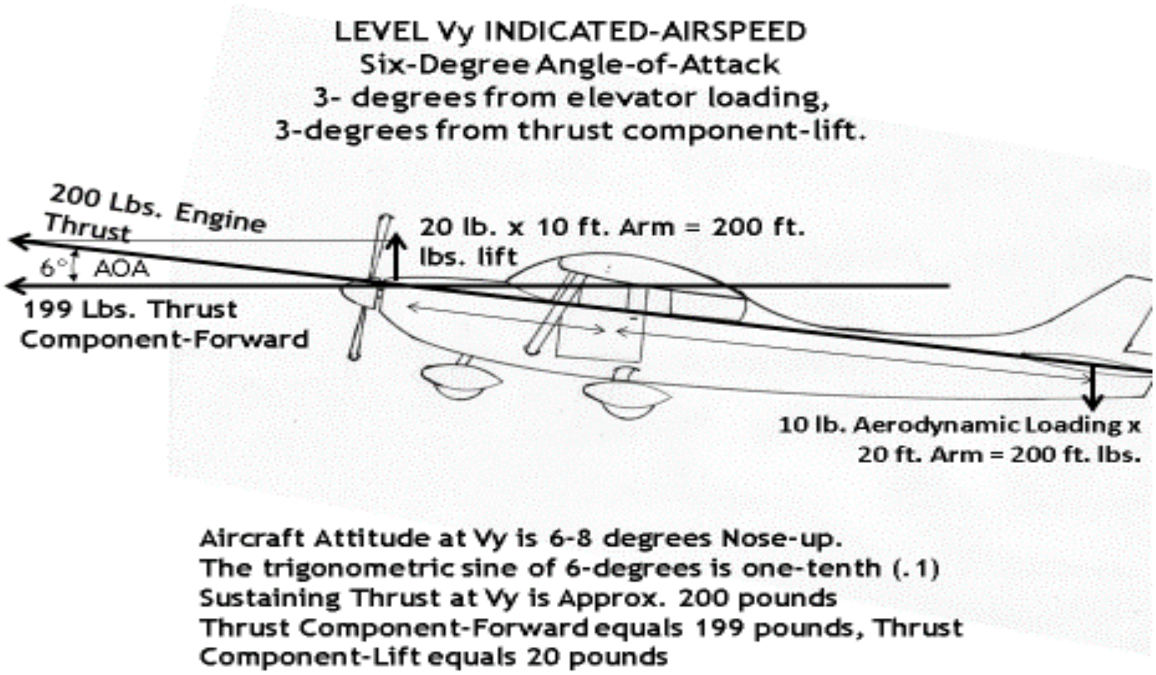

LEVEL Vy INDICATED-AIRSPEED
Six-Degree Angle-of-Attack
3- degrees from elevator loading,
3-degrees from thrust component-lift.
200 Lbs. Engine Thrust
6° AOA
199 Lbs. Thrust Component-Forward
20 lb. x 10 ft. Arm = 200 ft. lbs. lift
10 lb. Aerodynamic Loading x 20 ft. Arm = 200 ft. lbs.
Aircraft Attitude at Vy is 6-8 degrees Nose-up.
The trigonometric sine of 6-degrees is one-tenth (.1)
Sustaining Thrust at Vy is Approx. 200 pounds
Thrust Component-Forward equals 199 pounds, Thrust Component-Lift equals 20 pounds

Fig-6

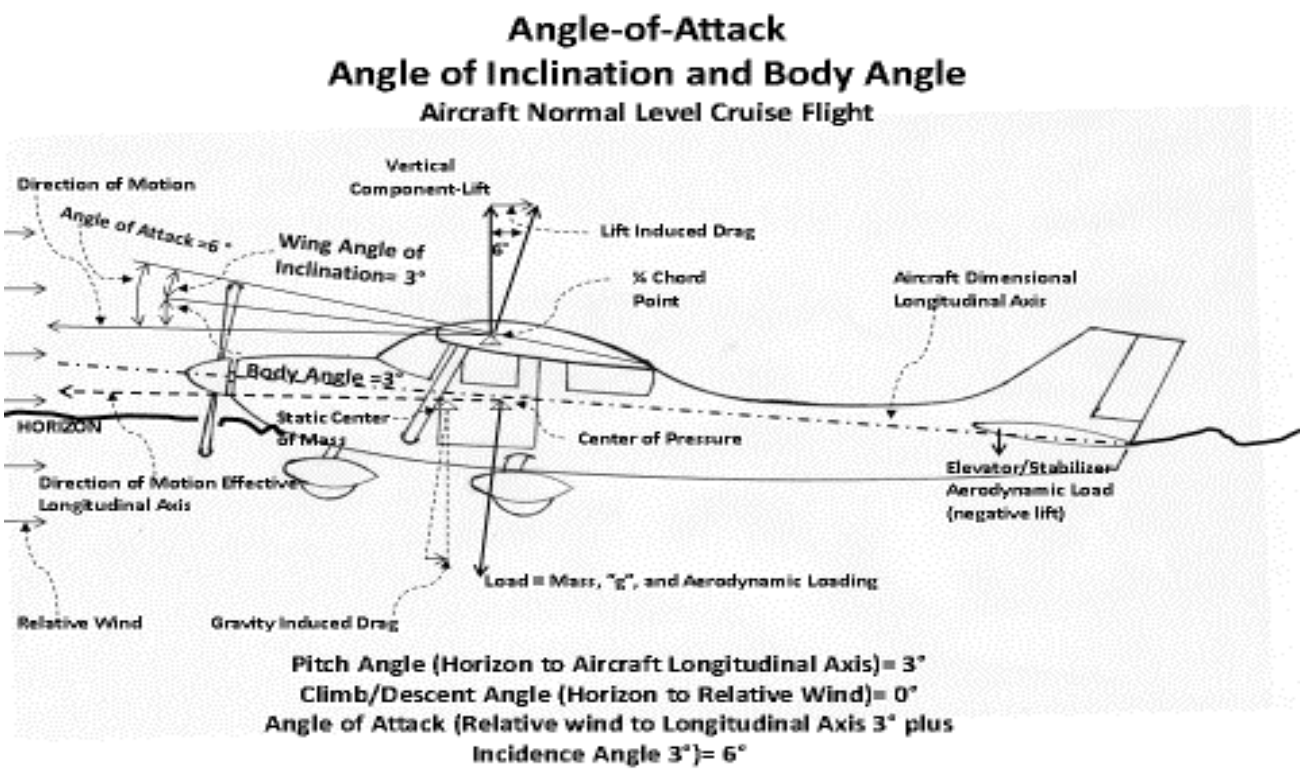

Angle-of-Attack
Angle of Inclination and Body Angle
Aircraft Normal Level Cruise Flight
Direction of Motion
Angle of Attack =6 °
Wing Angle of Inclination= 3°
Vertical Component-Lift
6°
Lift Induced Drag
¼ Chord Point
Aircraft Dimensional Longitudinal Axis
Body Angle =3°
HORIZON
Static Center of Mass
Center of Pressure
Elevator/Stabilizer Aerodynamic Load (negative lift)
Direction of Motion Effective Longitudinal Axis
Load = Mass, "g", and Aerodynamic Loading
Relative Wind
Gravity Induced Drag
Pitch Angle (Horizon to Aircraft Longitudinal Axis)= 3°
Climb/Descent Angle (Horizon to Relative Wind)= 0°
Angle of Attack (Relative wind to Longitudinal Axis 3° plus Incidence Angle 3°)= 6°

Fig-7

Indicated-Airspeed is the reading from the aircraft speed indicator. The indicated-airspeed indicator sensing comes from an open-ended tube (pitot tube) mounted facing forward into the oncoming airmass. The small pressure of this encountering mass moves the indicator needle. The instrument is calibrated in miles-per-hour and/or nautical miles-per-hour.

Indicated-airspeed then is a pressure reading and does not indicate a velocity across the ground (groundspeed) or velocity within the airmass (true-airspeed). It is only indicating the frontal pressures of airmass affecting the aircraft. The instrument calibration normally has areas delineated to show maximum, minimum, and different structural and operational indicated-airspeeds as pressure force limits.

Engine placement determines the effect of thrust component-lift. Engines placed aft of the center of lift push the aircraft while engines placed forward pull the aircraft. Thrust increase with aft engine attachment results in the nose pitching away while tractor-engine thrust increase pitches the nose to.

Aft attached, pusher-engines have the elevator and thrust component-lifting aft of the center of pressure so for constant angle-of-attack indicated-airspeed flight, if one changes the other must change in the opposite direction so requires continuous coordination of both controls.

Forward attached, tractor-engine aircraft have thrust component-lift acting forward of the center of pressure and stabilizer/elevator load is aft of the center of pressure. In this case, for constant indicated-airspeed flight, there will be a small thrust component-lift coordinated with an elevator load/lift causing the angle-of-attack balance.

Now throughout all descent, just as with the pusher-engines, to maintain constant indicated-airspeed, the elevator must be coordinated with any thrust change until again maintaining level flight.

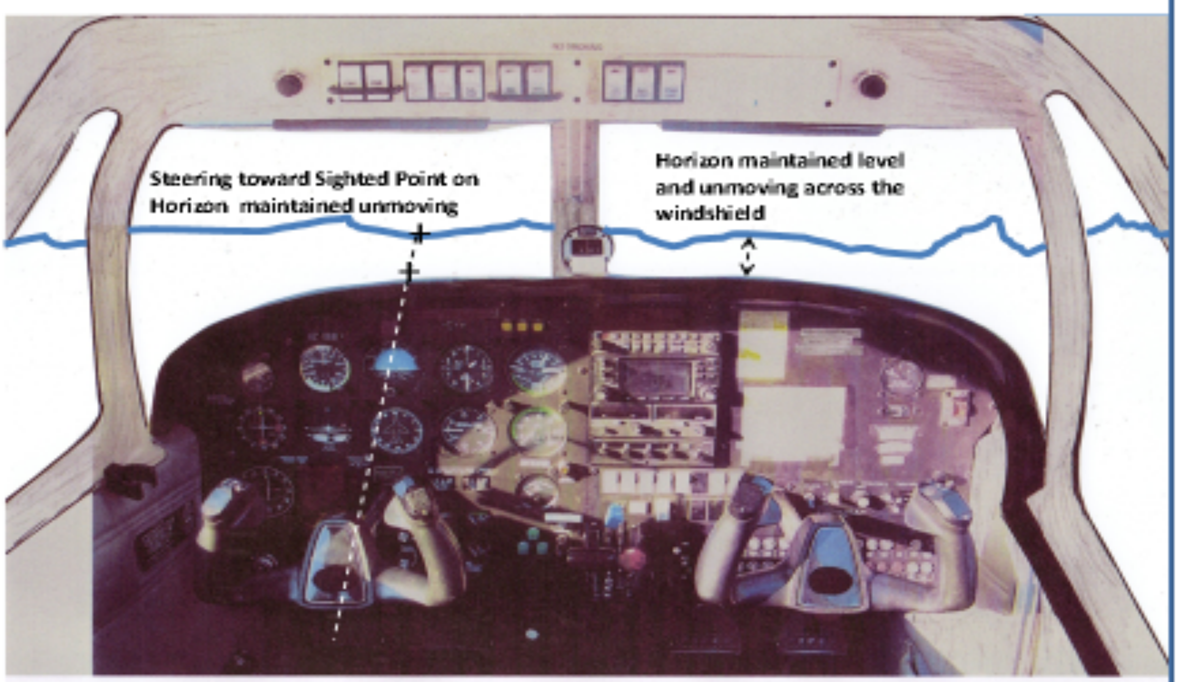
Vy is the most efficient indicated-airspeed for distance over time and Vme (loiter= .75 Vy) is the most efficient for time airborne. This means it requires additional thrust to sustain a greater or lower indicated-airspeed from Vme. Increased angle-of-attack slowing below Vme creates large induced drag forces so requires thrust increase (behind the power curve). This operation is close to the critical angle-of-attack and must be done carefully to avoid inadvertent stall.

Aircraft design usually allows hands-off, full power, maximum nose-up elevator trimmed flight without stall. Manually adding aft elevator in this slowed condition can easily attain the wing critical angle-of-attack…stall.

Vx is an indicated-airspeed that causes the greatest gain of altitude versus distance traveled and normally used for attaining obstacle clearance. Vx is slightly slower than Vy.

—VISUAL FLIGHT —

Visual flight is controlling the attitude of the aircraft toward sighted targets to make them unmoving relative a point on the windshield. This is flight by collision course. By maneuvering to cause a sighted object to be unmoving relative a point on the aircraft the flight would eventually reach that object. I call this "directed-course" flight.



"DIRECTED COURSE" VISUAL REFERENCE FLIGHT
NORMAL CRUISE SPEED, LEVEL FLIGHT

Fig-8

A point in the distance ahead or on the horizon held unmoving becomes a constant heading. The horizon held in a constant position across the

windshield maintains a constant pitch attitude. The wingtips held equal distance above the horizon is a wings level attitude.

When approaching a destination area, as that sighted area moves down the windshield toward the lower center of the windshield, beginning descent and maintaining the area unmoving causes the aircraft to descend directly to that area. This procedure, as a visual approach, will have the aircraft at approximately 1,000 feet AGL when 1-2 miles out.

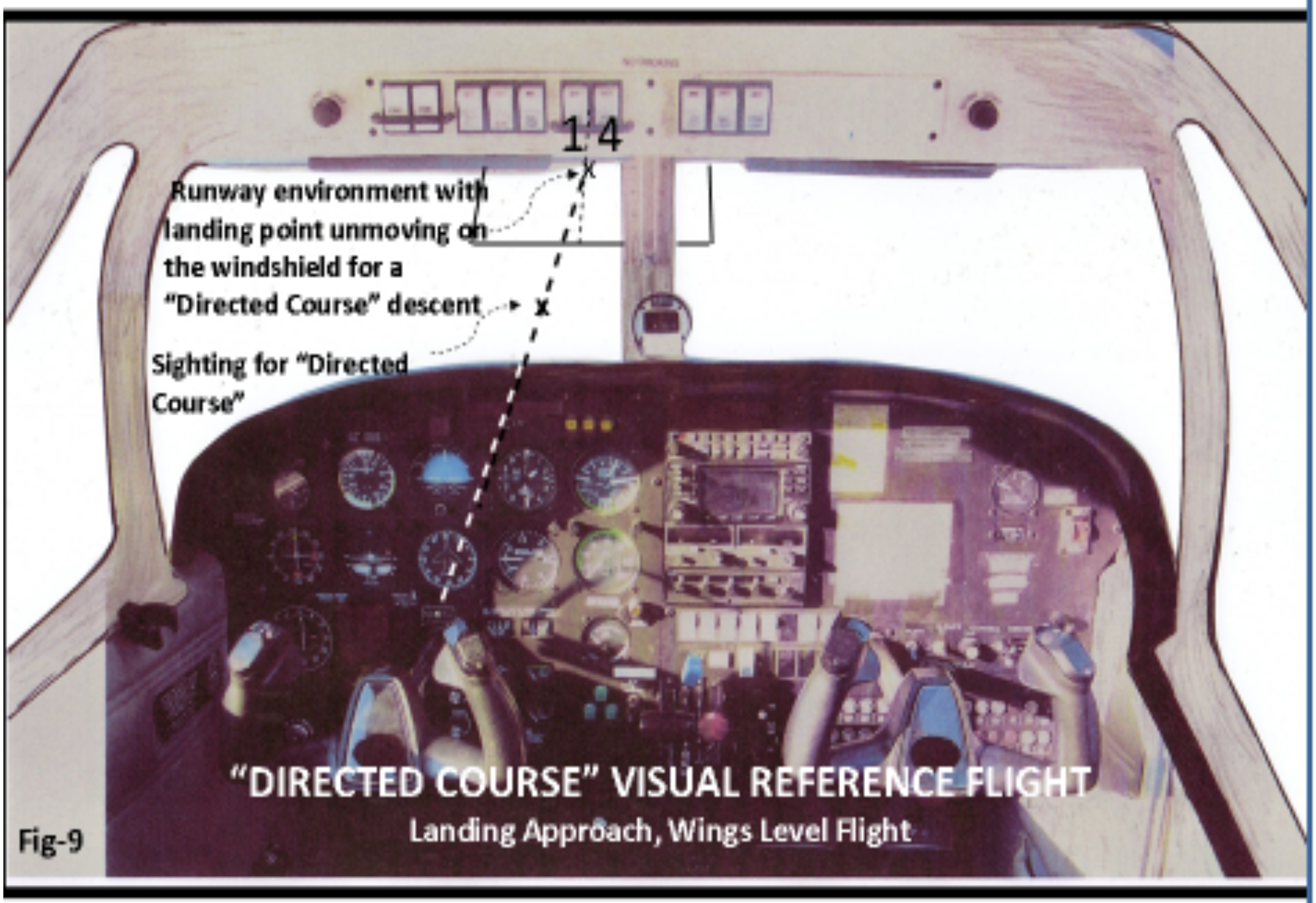


Fig-9

When flying an approach to landing, maneuvering to sight the approach end of the landing area as a targeted point, centered unmoving on the windscreen, will cause the aircraft to fly directly to that point allowing a controlled area landing.

This approach procedure if always maneuvered to be on a standard glide path results in every approach to landing being essentially the same.

—TURNING FLIGHT —

Flight maneuvering involves turning flight. Level constant indicated-airspeed turn involves aileron attitude roll with coordinated rudder input to a desired bank angle. The instant leaving wings level flight, the aerodynamic and thrust component lifts become angled causing reduced vertical aerodynamic component-lift. All texts describing turns suggest pulling the control wheel to maintain constant vertical lift. The problem is, pulling the control wheel causes increased angle-of-attack and slowing.

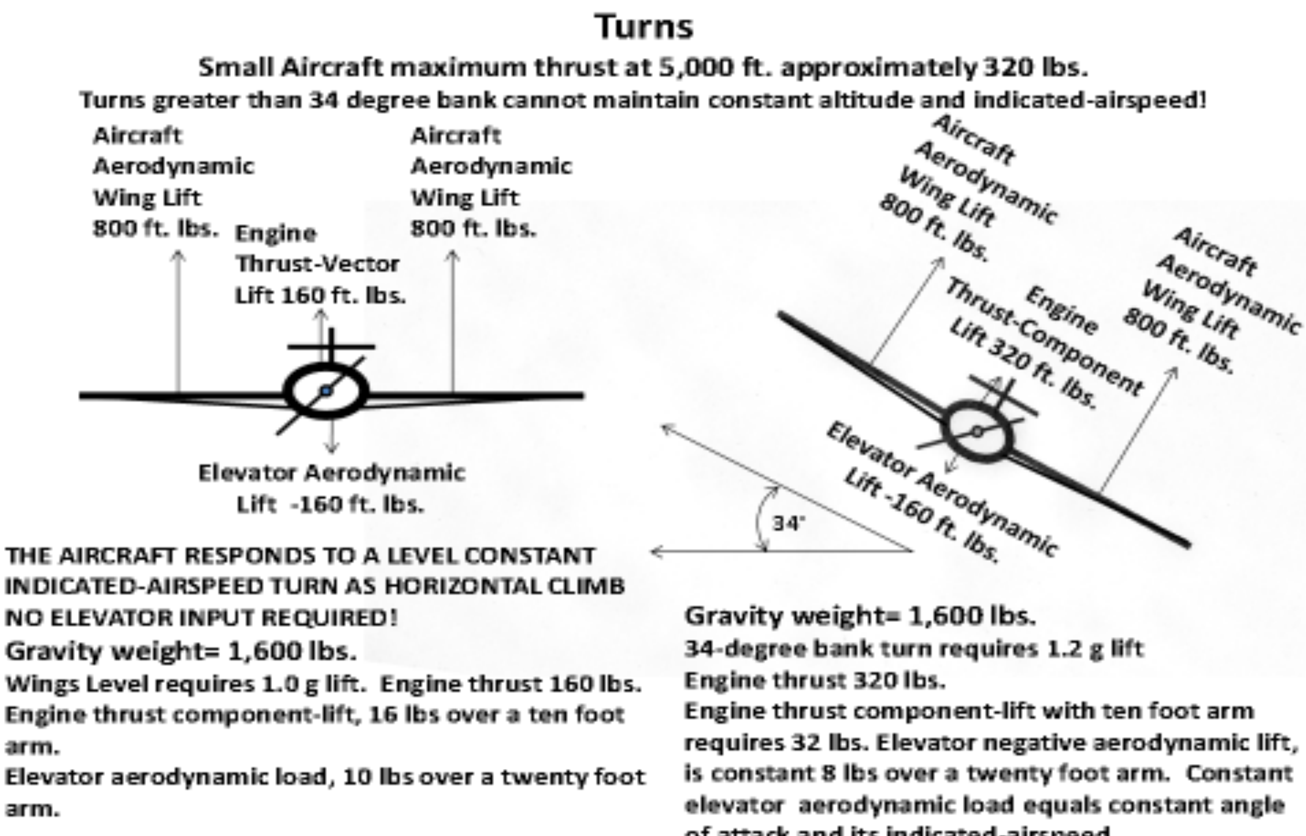


Fig 10

Flight technique of always flying elevator trimmed to the desired indicated-airspeed will allow continuous hands-off flight. Light rudder input will maintain heading control.

We learned we get added thrust component-lift with use of excess thrust. So now, in our turn, if we coordinate added thrust when rolling into the turn, we can cause the nose to track level along the horizon in the turn, without pulling the control wheel, a horizontal climb. We have a level, constant indicated-airspeed turn, without touching the elevator control.

This procedure works through all turns to a maximum bank angle at which the coordinated thrust has increased to maximum power. In most small aircraft, this is approximately a 30 to 40-degree bank angle.

A turn continued beyond that held level with maximum thrust will begin descent or alternatively, coordinated aft elevator with acceptance of reducing indicated-airspeed to maintain level flight.

Usual flight is at indicated-airspeeds greater than Vy, which allows speed variations during maneuvering flight. However, landing approach maneuvering is typically at or slightly below Vy and requires consideration before inputting aft elevator and its slowing.

High angle-of-attack level flight requires significant increased power, can quickly reach maximum thrust, and with any manual aft elevator input, approaches the wing critical angle-of-attack and probable stall.

—INADVERTENT STALL—

Stalling an aircraft requires pitching the nose to the critical angle-of-attack. Remember, exceeding the critical angle-of-attack is <u>when</u> stall occurs. The aircraft pitched to an attitude that reaches the critical angle-of-attack <u>causes</u> the stall! There are only two possible ways to <u>cause</u> the nose to reach the critical angle-of-attack in a positive stable aircraft.

1. **Pulling and holding the elevator aft…the pilot <u>causes</u> stall.**
2. **Trimming nose up to a very slow indicated-airspeed at reduced power in descent, then increasing power causing thrust component-lift which could add back enough pitch trim effect to reach the critical angle-of-attack…the pilot <u>causes</u> stall.**

It is difficult to see that in minimum indicated-airspeed descending flight, adding power can cause stall. The fact remains it can happen. In descent, there is a substantial reduction of thrust component-lift normally contributing to angle-of-attack. To compensate, for maintaining the constant indicated-airspeed, added aft-elevator control and/or nose-up elevator trim maintains the desired angle-of-attack.

If a slowed, hands-off level flight is operating at 12-degrees angle-of-attack, the corresponding thrust component-lift is contributing as much as 6-degrees to that angle.

Reducing to idle thrust removes 4-5 degrees of the angle-of-attack, so allows acceleration. It requires adding aft-elevator or additional nose-up elevator trim to maintain the original constant indicated-airspeed. Now in a descent, the stabilizer is contributing 10-11 degrees of the angle-of-attack. Adding back the thrust toward level sustaining setting without forward elevator input may cause immediate stall.

—LOW INDICATED-AIRSPEED AND APPROACH STALL—

All low indicated-airspeed maneuvering flight is subject to inadvertent stall. A turn when in a slow indicated-airspeed situation requiring added power, while already holding the control wheel aft for altitude control, can potentially cause immediate stall.

When in a descending steep turn at reduced thrust with the elevator trimmed for very slow indicated-airspeed flight, the aircraft can be at a 12 to 14-degree angle-of-attack. Added thrust for reducing descent rate or leveling will cause considerable thrust component-lift, adding as much as a 3 to 5-degree angle-of-attack…immediate stall. It requires coordinated forward elevator control to avoid attaining critical angle-of-attack.

The increasing thrust will add back the thrust component-lift causing immediate increase of angle-of-attack by more than 4-5 degrees so is now 16-17 degrees nose-up…possibly exceeding the wing critical angle-of-attack.

A common condition where this occurs is the base to final VFR approach when overshooting the extended centerline. A pilot already in the trimmed, low-powered, landing configured slow-flight tends to increase the bank attitude and simultaneously pull the elevator attempting to correct back toward the extended centerline.

The increased bank reduces vertical lift and any added aft elevator causes more slowing from the added angle-of-attack plus increased “g” force. At this point, a power increase adding those 4-5 degrees to the angle-of-attack can cause immediate low altitude stall with no altitude for recovery.

Low altitude, slow indicated-airspeed flight maneuvering must be with minimum or no manual aft elevator input. There must be anticipation of applying forward elevator prior to or while adding thrust in this condition.

A pilot must understand how thrust component-lift affects flight. All flight instruction of level turns should be without elevator input but with coordination of added thrust for its thrust component-lift.

Descending turns use gravity component-thrust so will increase descent rate during the turn. It is impossible visually ascertaining a steep nose-up attitude when descending. Anytime using aft elevator, the increased angle-of-attack reduces indicated-airspeed.

In all flight, always trim to a hands-off condition with aircraft controls. "You will be surprised how the airplane just wants to do its thing without all the fussing with the control wheel". In slow indicated-airspeed maneuvering, always expect stall indication and if occurring, immediate forward elevator toward zero "g" with coordinated rudder and aileron leveling the wings for maximum vertical lifting.

—TAKEOFF AND GO-AROUND STALL—

Takeoff and go-arounds are situations where slow indicated-airspeeds are transitioning into increasing altitude and indicated-airspeed. Without using hands-off techniques for flight, a pilot will be manually holding aft elevator control for both altitude and angle-of-attack. Inadvertent increase of aft elevator input can lead to stall.

With the go-arounds, there is transition from trimmed slow indicated-airspeed descent to level for acceleration then climb. In this case there is simultaneous added thrust which adds back some nose up effect to the aircraft angle-of-attack trim and with any manual aft elevator to stop descent can lead to stall.

These situations require specific training in awareness of what is happening and again knowing hands-off flight control.

—INADVERTENT IMC—

A common cause of fatal accidents in aviation is inadvertent IMC. A non-instrument rated pilot can quickly lose control. Any encounter of weather and/or losing visual reference at night requiring instrument flight control requires knowing how to maintain that control to avoid becoming disorientated.

A pilot that has been trained to fly aircraft by continuous trimming to hands-off will be able to release the control wheel and by sighting the turn and bank or attitude instrument, using rudder steering only, establish a standard rate turn for one minute then reverse rudder to zero turn and fly out of the conditions.

We have now learned when trimmed hands-off aircraft essentially fly by themselves. If practiced as normal flight, safe control when encountering inadvertent IMC is by simply turning loose the control wheel, watching and believing the turn-and-bank or attitude instrument. Steer with rudder to attain and hold a standard rate turn on the turn and bank or attitude instruments. Hold the attitude one minute, and then reverse the rudder to attain and hold zero turn and fly out of the condition.

With practice, a pilot will quickly learn satisfactory control to fly safely back to visual conditions.

If the encounter is weather related, a small descent often aids in exiting the conditions, however adding a small amount of power would maintain a level turn and if deemed necessary to assure terrain clearance, even more power causing climb.

If losing visual reference in night VFR, again by turning loose of the control wheel and maintain zero turn on the turn-and-bank instrument, it is probable using excess thrust for climb will aid attaining distant lights or references. At the same time, climbing increases terrain clearance. The flight continues with reference to the turn-and-bank or attitude indicator for flight maneuvering or turning back.

This procedure is in the emergency section of some early model Cessna 150 and 172 POH's. I have questioned over 150 Flight Instructors and at least five Examiners who fly these particular aircraft and none had ever heard of this procedure! Who reads the POH emergency procedures of small aircraft?

—CROSSWIND LANDING—

When encountering crosswinds for landing, we need to consider a few basic criteria. Determine the approximate crosswind component. This is relatively easy. Any reported winds are subject to some change so by the time you get to final approach, it may be different, and by the time you get to touchdown again different. You will be flying visually with a heading

correction for tracking the extended centerline and can sense how close the reported information may be. With all winds, close is good enough. You just have to visually fly the airplane keeping the landing area unmoving.

If the wind direction is more than 50-60 degrees (sine 60 = .9) away from the runway heading, consider the total wind as crosswind. If the wind is 40-50 degrees (sine 45 =.7) away, three quarters (.75) of the reported wind is crosswind. A wind 20-40 degrees (sine 30 = .5) away, one-half of the reported wind is crosswind. Close is good enough.

Now maneuvering on final approach will require a heading correction turned into the wind. Your small aircraft approach speed minus any headwind component will have you in the vicinity of 60 knots…one mile per minute. Anticipate a heading correction of one degree for each knot of crosswind. Visually turn to stop any drift, whatever it takes.

Fly inbound and when on short final, you can begin rudder input for a sideslip maneuver to align the landing gear parallel with the runway, simultaneously roll into a banked attitude toward the wind to cause the aircraft to track the runway extended centerline. This slipping maneuver can be input according to pilot technique. Some start the slip on short final others input the slip during roundout or flare.

In any case, in this banked attitude the airplane will touchdown with the upwind main gear first. The momentum of the airplane is trying to continue down the runway as the other main gear and nose wheel complete the landing. At touchdown, immediately turn the control wheel into the wind and maintain directional control with rudder and nose-wheel steering.

In unusually strong winds, when slowing after touchdown, rudder control may become minimal. Anticipate adding power for propeller-blast while braking to allow continued rudder control and at the same time reducing the impact of the crosswind weather-vane of the aft tail area.

Handling extreme winds with up to full power landing and braking could be possible. Anytime wind gust or high crosswind don't allow maintaining positive control of the aircraft, consider immediate full power for directional control and possible rolling takeoff and go-around.

Extreme winds result in much reduced groundspeed so if unable to divert to a different airport, it requires declaring an emergency, find a runway,

taxiway, road, or field aligned into the wind. With a 40-60 knot headwind, the landing groundspeed can be close to zero.

—OFF-FIELD LANDINGS—

For whatever the cause, engine failures do occur. No amount of planning can prevent an eventual engine failure someday to someone.

There are standard procedures for initiating an emergency landing. The problem is that statistically, seventy-five percent of off-field emergency landings touchdown mid-field or beyond on the chosen landing site. One-half of the fatalities from these landings occur from overrunning the landing site.

The engine out landing approach requires maneuvering the approach end of the chosen site referenced unmoving on the windshield and keeping it there. This is early establishment of a collision course to touchdown and allows better control of the approach path and approach indicated-airspeed.

Mentally, it is difficult to convince oneself not to be a little high and a little fast. The only way to handle that is lots of prior consideration and use of idle-power approach landing technique of normal training that all approaches have the landing area unmoving. The constant indicated-airspeed gliding approach path is primarily controlled with forward slip and flap configuration change. The use of elevator control causes angle-of-attack change with associated indicated-airspeed change.

The accident does not occur until at or after touchdown. Soft or short-field procedures should be used attempting to touchdown at the minimum controlled indicated-airspeed possible.

The normal gliding indicated-airspeed is based on attaining a maximum distance. If the chosen landing site is closer, reducing toward Vme (.75 Vy, approx. 10-15 kts.) allows maximum time in the air and slower touchdown indicated-airspeed.

Occupant survival is the primary consideration from touchdown to stop. At some point, control may be lost. From that moment, protect the head in any way possible. It is imperative to be conscious when stopped.

—IN-FLIGHT ENGINE FAILURE—

An incident requiring immediate landing often requires touchdown into unprepared surfaces. Such an off-field landing can be into rocks, trees, gullies, and other kinds of obstacles. This may mean immediate dismantle of the aircraft at or shortly after touchdown and often the nose wheel will catch resulting in being upside down.

There is often little time to make decisions about what to do so it is imperative to have previously made a plan. This includes previous consideration of what it may look like and how you may feel when seeing probable obstacle encounter.

Continued flight to a controlled area touchdown is paramount. Seventy-five percent of off-field landings touchdown beyond midfield on the chosen landing area as pilots feel they don't want to be low or slow so end up high and fast. Visually fix the approach end of the chosen site centered and unmoving on the windshield and keep it there.

Do not let the aircraft stall. The aircraft is gliding sustained with gravity component-thrust and normal control is available at least until touchdown. At or shortly after touchdown you will recognize when you can no longer control the aircraft. At that time, you are likely experiencing rapid deceleration and possibly dismantle of the machine.

Upon recognizing loss of control, you will think "I'm now a passenger, I have to be conscious when this thing stops!" At that time, you will be leaning forward against the shoulder harness and use whatever means possible to protect your head…you must be conscious when stopped, and when stopped, immediately leave the aircraft while helping any passengers.

Thinking of this basic procedure in advance allows you a plan. Innovation and invention during an incident is too late. Things will be happening very rapidly but if aware, you will think it is all in slow motion.

How much time does it take from touchdown to stop in rocks and trees? Maybe two, three…five seconds. How long is that? Count, one thousand, two thousand, three thousand, four thousand, five thousand…see, that can be a lot of time. You can likely do a lot of things during that time. Most importantly, you want to be protecting your head! Also if able to keep your

eyes open, you will be able to react. Once closing the eyes, it will become violent! This same procedure applies to car accidents!

—HIGH ALTITUDE FLIGHT—

The normal assumption as taught is that aircraft will not fly as well at high-density altitudes as at lower altitudes. This is a very broad generalization based on limited understanding of the physics involved. It is not the lift of the air (air has no lift!); it is engine power and propellers. The reduced availability of oxygen for burning affects all engines so in many situations there may not be sufficient excess thrust available for takeoff or safe maneuvering after lift-off.

With low-density air, the engine cannot produce the maximum rated power and rpm limitation of the engine will not turn a fixed pitch propeller fast enough to cause the normally expected mass thrust. These are huge factors against attaining required acceleration for takeoff and performance when airborne.

With combinations of high elevation, high temperature and/or high humidity, and there being no visual reference of reduced thrust during ground operation and takeoff, it requires very careful planning and consideration of all factors related to the aircraft performance to assure any safe takeoff. An understanding of the atmospheric density and the factors related to engine power is essential.

—AIR DENSITY AND YOUR AIRCRAFT—

Maintaining a constant indicated-airspeed pressure when climbing to higher altitudes into the gradual thinning air (reduced mass per volume of the air), it requires that the velocity (true airspeed) within the airmass must gradually increase to maintain the mass encounter pressure required for constant indicated-airspeed aerodynamic lifting.

Thrust available from an engine is dependent on the current density altitude. The power rating of a typical small aircraft engine/propeller combination may be 600-pounds thrust at sea level on a standard day. If it takes 200-pounds for sustaining Vy, then when becoming airborne, there will be 400-pounds excess thrust available for climb and maneuvering.

If this aircraft can fly only to 15,000 feet altitude, the engine will then be producing only 200-pounds thrust. This is a loss of 400-pounds thrust, 25-pounds per thousand feet altitude. This means for climb and maneuvering at 5,000 feet there is 275-pounds excess thrust available and at 10,000 feet only 150 pounds of excess thrust.

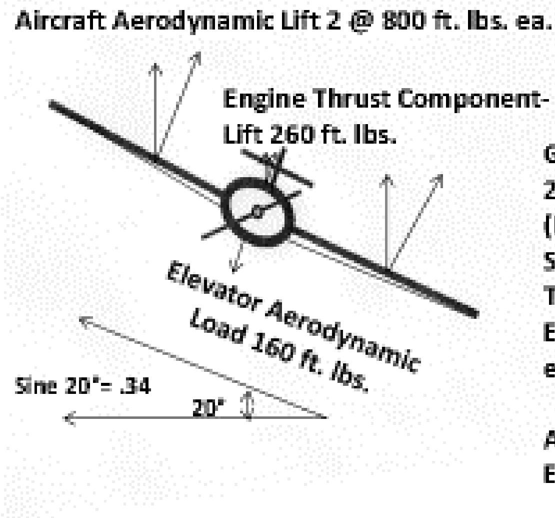
How this affects normal flight operations is that you don't have very much excess thrust for maneuvering at high-density altitudes. On a 6,000-foot elevation hot day, the density altitude can easily be 8-9,000 feet.

A landing in high density-altitude conditions will be normal but true airspeed and groundspeed will be significantly higher so requires longer rollout. The visual perspective of the ground when maneuvering low will show you are moving much faster. This is similar to the visual if landing with a tailwind.

How does this affect high altitude takeoff and maneuvering? You may have only 400 pounds thrust for takeoff with engine rpm limitations and reduced propeller efficiency; the acceleration will be slower requiring significantly more runway. Even with a long runway, it will be prudent to use short-field takeoff procedures. This means at liftoff, remain in ground-effect for acceleration, at least to Vy or greater. Obstacles that might exist require much consideration. Planning this low powered takeoff should include consideration of takeoff roll plus stopping distance for abort.

HIGH ALTITUDE TURNS

Example: Maximum Bank Angle for Level Constant Indicated-Airspeed Turn
9,000 ft. Density Altitude, 260 lbs. Maximum Thrust Available
Assumed 1600 lb. aircraft at 6-degree angle of attack (Vy IAS.)
requires 160 lbs. sustaining thrust. (10:1 weight to thrust ratio.)
100 lbs. Excess Thrust Available



Gravity weight=1600 lbs.
20-degree bank turn requires 1.065 "g" total lift
(Max. engine thrust available at 9,000 ft. altitude, 260 lbs.)
Sustaining Engine Thrust @ Vy, 160 lbs., Excess thrust 100 lbs.,
Total Engine thrust = 260 lbs.
Engine thrust component-lift 26 lbs. with ten foot arm from engine to effective center of gravity (load).

Aircraft Aerodynamic Lift 2 @ 800 ft. lbs.	= 1600 ft. lbs.
Engine Thrust Component-Lift 260 ft. lbs.	= 260 ft. lbs.
Total Lift	= 1860 ft. lbs.
Total Lift Required, 1600 lbs. @ 1.065 "g"	= 1700 ft. lbs.
Elevator load, 8 lbs at a twenty foot arm	= 160 ft. lbs.
Total Load	= 1860 ft. lbs.

Fig-12

Reduced thrust in this example means there will be limited maneuvering. At lift-off, the potential 400 pounds of thrust has become 200 pounds sustaining thrust and only 200 pounds for maneuvering. At this time, climb rate will be much less and a level turn will be limited to a bank angle of less than 25-degrees.

From this, you can easily see that high-altitude maneuvering, often called mountain flying, requires consideration of the much reduced excess thrust available. At 10,000 feet, maximum level-turn bank angle is approximately 20-degrees and the 150-pounds excess thrust limits climb to less than 4-degrees climb pitch…not both at the same time. Operation at high-density altitudes quickly reduces the excess thrust and may require descent for maneuvering.

Remember, on a hot day, a 12,000-foot density altitude may occur at 9-10,000 feet and you will have only 75-pounds excess thrust. That means the maximum bank angle for a level turn is less than 15-degrees bank. Climb pitch will be less than 2-degrees, again, not both at the same time.

—HANDS-OFF FLIGHT CONTROL—

A major purpose of initially learning hands-off flight control is to enable pilots to understand the techniques of fingertip control input. They will find properly trimmed flight allows satisfactory performance within the aircraft's design limits and is much easier and safer.

—PHYSIOLOGY OF MANUAL CONTROL—

From Page 13 of the 2014 March/April FAA Flight Safety-Brief

http://www.faa.gov/news/safety_briefing/2014/media/marapr2014.pdf

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Year after year, stall/spin events account for a disturbing number of general aviation accidents. According to the Air Safety Institute's Nall Report, "failure to maintain airspeed" appears as a proximate or contributing cause in roughly 40 percent of the fatal accidents. This statistic persists in spite of stalls, stall recovery, and stall prevention having been taught — ad nauseam — to virtually every candidate for every certificate, rating, flight review, insurance checkout, and type certificate over the last half-century, or more.

Someone once defined insanity as "doing the same thing over and over and expecting a different result." It is the opinion of this author — a long-time flight instructor — that the results demonstrate that we in the flight instruction profession are not giving our customers an adequate methodology for dealing with this problem. Specifically, we do not provide a sufficiently clear and effective means of preventing unintentional stalls. This article is an attempt to define such a methodology.

Central to the problem of the prevention of unintentional stalls is a general misunderstanding of how and why an aircraft will stall. Too often, we hear discussed the aircraft's stall speed; in fact, the aircraft stalls if, and only if, the wing exceeds the critical angle of attack. That this will

occur at a particular speed is only true given a closely defined set of conditions. Any stall speed is only valid at a particular combination of weight and load factor; the critical angle of attack does not change as long as the flap configuration is constant.

A second poorly understood concept is the issue of trim and stability. Pilots tend to think that the aircraft trims to an airspeed; this, also, is only true under particular circumstances. The static stability of an airplane tends to drive it back to a trimmed angle of attack. This will correspond to a particular airspeed only under steady-state conditions.

The stability of the aircraft can be used to the pilot's advantage with regard to stall prevention. In a nutshell, let go of the controls. Once releasing the controls, the aircraft will return to the trimmed angle of attack (regardless of the airspeed) within a little more than a second. Most aircraft will not trim to an angle of attack that exceeds the critical angle of attack; thus, with very rare exception, an aircraft loaded forward of the aft center of gravity limit cannot be stalled in hands-off flight.

Unintentional stalls, then, occur when the pilot applies enough backpressure on the yoke to overcome the natural stability of the aircraft, leave the trimmed angle of attack, and exceed the critical angle of attack. It would seem, then, that we could eliminate unintentional stalls by warning pilots to avoid applying excessive backpressure.

One would think this would work. History tells us, however, that it does not. Discovering the reason for this paradox requires bringing some outside knowledge into play. In particular, I find it helpful to consider the 19th century contributions of German anatomist and physiologist Ernst Heinrich Weber (1795-1878), and his student, physicist and philosopher Gustav Theodor Fechner (1801-1887).

These two scientists developed the theory of perception, defining the "just noticeable difference (JND)," or, in other words, the minimum change in a stimulus required to trigger perception.

With regard to pressure stimulus (such as force on the yoke), the JND is a change of approximately 14 percent of the pressure already present. Today, the relationships they defined are referred to as the Weber-Fechner law, or the W-F law. It is common knowledge in physiology but, unfortunately, not so well known in aviation.

Several features of the W-F law are important to flight operations. <u>First, any stimulus (yoke pressure) which is constant will fade from</u>

***perception over a short time*. A pilot who is flying in an out-of-trim condition will soon lose the ability to perceive that he or she is applying any elevator pressure at all. The out-of-trim condition becomes the new zero; *the pilot cannot trim it off, because they do not perceive that it is there*.**

Second, a constant stimulus (i.e., steady backpressure to compensate for being out-of-trim) will elevate the just-noticeable-difference. If the pilot is holding a constant 20 lbs. backpressure, the minimum pressure change he or she can feel on the yoke is now 2.8 lbs., in any direction.

Every attempt to make a "small" input will become a "small" input plus 2.8 lbs. of additional pressure that the pilot has no way to know he or she is applying. The result is over-controlling; small, precise inputs are impossible.

Also, the pilot will tend to make unintended inputs, in pitch and roll, across a 5.6 lb. "dead spot" in his or her perception. This can be especially vexing when the pilot is attempting to accomplish non-flying tasks, such as reading a chart, or dialing a radio frequency; he or she will apply an unknown and unintended input up to the limits of the JND.

A pilot flying in this manner is much more at risk of inducing an unintentional stall. Too many pilots are in the habit of flying the aircraft with large control pressures, far away from the trimmed angle-of-attack. The elevated JND makes it easy to apply the control forces accidentally that are necessary to overcome the stability of the aircraft and drive it to and past the critical angle of attack.

What can we do?

To avoid the unintentional stall, we need to develop the habit of flying the aircraft in trim and hands off. An airplane which is in trim and flown hands off is (with rare exception) impossible to stall. The natural (static) stability will drive it to and hold it at the trimmed (not stalling) angle of attack; flying hands-off ensures the pilot will not force the aircraft away from the trimmed (not stalling) condition.

Getting into a perfectly trimmed condition is not always as easy as it sounds. For most pilots, it requires a change in the way we touch the controls. Due to the physiology, it is virtually impossible for pilots to trim an aircraft precisely if their hands are still on the yoke.

Trimming, then, requires that we trim the aircraft to the limits of our perception (trim off the pressure), and then let go. Only with the hands off the yoke can we observe the change in pitch attitude and vertical speed,

which is the clue to the remaining out-of-trim condition that existed below our ability to perceive.

Once observed, the change should prompt the pilot to pitch (with the yoke, not the trim) back to the desired pitch attitude and rate of climb, trim slightly against the error, and try again. Only when the aircraft will stay at the desired pitch attitude and vertical speed for five to 10 seconds in hands-off flight can it be considered to truly be in trim.

Once in trim, the pilot should endeavor to avoid violating that trim. That is, "if it ain't broke, don't fix it." Said another way, the pilot should not touch the yoke unless there is presently an error in pitch that needs correction. If the airplane is doing what it should, there is no need to touch it!

All transitions in airspeed, power setting, and configuration will induce some trim change. Immediately address any change in the trimmed condition to bring the aircraft back to the desired trim. Once regaining the trim, maintain it by flying hands off to the maximum possible extent.

It is important to realize that the oft-repeated advice "use a light grip" is, unfortunately, a misnomer. Another principle of physiology, the grab-and-grip reflex, makes this so.

Under stress, the reflex induces us to unconsciously grab hold (of the yoke) and grip with increasing pressure. Over time, the light grip will invariably escalate to the famed white knuckles condition we see so often, and create all of the same problems as an out-of-trim condition.

Thus, when a pilot does have to make a control input, it is important to avoid setting up a grip condition; it is better to touch the yoke, rather than to grip it. Use the minimum pressure required to achieve the desired correction, and then go back to hands off.

If you've developed the uneasy feeling that this methodology involves a radical change in the way we fly, you would be correct. It requires discipline, thought, and practice to achieve truly in-trim and hands-off flying skills, but the rewards are worth it: better stall resistance, smoother ride for the passengers, more precise control of the aircraft, and lower pilot workload.

—HANDS-OFF FLIGHT—

To enable understanding how an aircraft is controlled consider that the aircraft was designed and built to fly. The pilot only inputs control to specific headings and altitudes to accomplish a particular flight.

During ground operation, initial precise control input to the rudder can be done by wiggling the pedals back and forth as deliberate over control while learning the input feel for maintaining the taxi lines. Wiggling controls for precision is actually inputting too much control and immediately removing it by the reversing.

A sample initial flight will be to begin flight from start of taxi to landing roundout only touching the control wheel when changing elevator trim. This is accomplished by using normal flight procedures of pre-flight, engine start, taxi, and engine run-up.

Prior to takeoff, the elevator will be set at an expected Vx indicated-airspeed or other required lift-off indicated-airspeed. With clearance to takeoff, the power is set, mixture adjusted to maximum power, and brakes released. Steering is done normally with rudder input.

The aircraft will accelerate and upon reaching the indicated-airspeed as set with the trim, it lifts off, acceleration ceases, and climb begins at the trim-set indicated-airspeed.

Rudder input is continued for directional control toward a distant visually acquired target. Aileron input will not be used unless unusual conditions require more control than available with yawing by rudder. This yawing procedure also allows a new student to quickly become aware of the kinesthetic sensing through the seat.

When established in climb and clear of any obstacles, a slight push on the elevator control will allow acceleration and re-trim to Vy as a climb indicated-airspeed for this flight.

The flight will continue climbing until approaching a desired altitude at which the elevator is again gradually pushed to coordinate leveling at that altitude. The aircraft will now be accelerating to the desired cruise indicated-airspeed. Gradual power reduction will coordinate the thrust to this cruise indicated-airspeed. You are now cruising in level constant indicated-airspeed flight…still not touching the control wheel. Probable minor adjustments as necessary to attain the specific cruise criteria.

Additional understanding of flight control requires being aware that the aircraft flies at an angle-of-attack which means the direction of thrust is slightly above the direction motion. This results in a small thrust

component-lift at the engine attachment…essentially, a fifth control which causes pitch change with thrust change.

Throughout this flight, the elevator control is touched only to coordinate with thrust for changing indicated-airspeed. All level turn and climb maneuvering in this condition is by rudder yaw and coordinated thrust.

Descent is different. When reducing thrust from level flight, there is reduced thrust component-lift which is part of the elevator trimmed condition so allows some acceleration. Now throughout all descent for constant indicated-airspeed flight, it requires coordinating the elevator trim with any thrust change.

Visual sighting of the runway end as relative to a spot on the windshield (like sighting a gun at a target) and maneuvered to be kept unmoving is a collision course to the landing area.

If using the control wheel for maintaining a precise approach course, again the technique of wiggling the control wheel with fingertips allows learning the feel for that precise control.

—SUMMARY—

It should be noted when maneuvering with minimum or no manual control-wheel input, it is virtually impossible to stall the aircraft.

In the event of inadvertent IMC or any condition losing visual flight reference, turning loose the control wheel and with reference to a turn instrument, it is possible with rudder-only control to make a safe one-eighty turn and fly out of the conditions or with added thrust to climb to regain visual reference.

For precise idle-thrust and engine-out approaches use visual reference by sighting through a spot on the windshield aimed at the landing spot and keeping it unmoving. Remember you must be conscious when stopped!

In high altitude flight conditions, avoiding control wheel input limits in-flight maneuvering to the existing conditions thereby avoiding stall but requires understanding of the prevailing much reduced thrust performance and required fuel mixture adjustments available from the machine.

The lifting force occurring at the engine may seem small but considering in level flight the aircraft is balanced at zero weight so even a few pounds of lift one way or other will cause change.

A local Instructor using these techniques has found Students can be proficient for safe flight control to solo within five hours and completion of PPL requirements within thirty hours.

—HOW DID WE GET THIS WAY? —

There has apparently been a long history of flight without complete understanding of flight control. Errors in handbooks that have been pointed out to the FAA for years are unchanged. There is missing information and misinformation in all texts.

There are the professional pilots and instructors that figure some of these things out and likely teach their specific Students correctly, but it is never written down. Years and years of experience and experiences die every year with the loss of old pilots…we need a source for these things to be documented.

There are the flight training organizations that teach only to the minimum FAA requirement. There are the Flight Examiners certifying to these minimums when knowing it really isn't enough.

Original flight training was primarily in tail-wheel aircraft and evolved using idle-power approaches for all landings. This was desired due to possible engine failure when operating at idle for longer times.

Over time this procedure was attributed to the landing stall so training for landing was decreed to making longer approaches with partial power. However, the landing stall has continued.

The unintended consequence has been longer approaches which take more flight time for Students, no requirement for the PPL pilot to be proficient in idle-power (engine-out) procedures, or learning use of visual targeting to the landing area.

1. **The power landing is appropriate for most flight and to a Student proficient in idle-power landings quite easy to fly. But for more efficient use of flight time and the proficiency to be gained, idle-power approaches should be utilized during initial dual-flight training programs.**
2. **There has never been any discussion of how to maneuver with only power change. All texts state use elevator input to make level turns.**
3. **No book says the pilot causes stall but only that it is exceeding critical angle-of-attack. We teach stall and stall recovery as a procedure for**

passing a checkride. We seldom emphasize how not to stall in the first place.

4. The FAA statistics state over 75% of engine-out off-field landings touch down mid-field or beyond of the chosen landing site. 50% of the fatalities are from overrunning the landing site. In addition to the lack of proficiency in power-off landing, there has never been any requirement to be proficient in forward slipping often required in precision idle-power landings and especially engine-out emergency landing.
5. Nowhere in inadvertent IMC writing is there a procedure for making a safe turn to exit the conditions. However, in some early model Cessna 152 and 172 POH emergency procedures this method is a specific procedure. I have never had an Instructor or Examiner flying these machines able to tell me about this though it is in the aircraft POH as an emergency procedure!!
6. There are no texts that outline a procedure for surviving an emergency off-field landing. It is the landing roll that is the exciting part, when stopped the occupants must be conscious. There is no accident unless the airplane is damaged or an occupant injured.
7. No texts discuss the effect of maneuvering thrust loss to sustaining thrust when becoming airborne. In reciprocating engine aircraft thrust is not ever discussed, only power and power change or adjustment.

The solution to the problems outlined above are not going to come from the addition of additional gadgets on the aircraft instrument panel. There are of course things like stick-pushers, auto-throttles, and AOA indicators that can correct for some mistakes. These do not make a proficient pilot.

The training industry must become aware and utilize the solutions to produce competent pilots. To do so requires training the professional pilots themselves how to fly correctly.

This would be rather quick if the FAA were to become involved. However, this huge bureaucracy just can't do anything until prodded by Federal Legislature.

I guess I haven't solved the problem…maybe just defined it. I'm not sure this is the answer you were looking for but it's my outlook and from experience, it works!

I've been preaching this for eight years with little success. This includes several aviation magazines and their correspondents. My personal list of

pilots is only about 30,000. You have a much longer list plus the reputation to be considered expert and have access to the professional writers that can express it properly.

If more clarification is needed, please contact me at bob@safe-flight.net.

I have written an e-book "How to Fly Airplanes", basic flight control, which is available to anyone sending an email with subject e-book.

Best of luck with helping fix things.

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