Highlights and Margin Notes in
Wolfgang Langewieshe's

Stick and Rudder: An Explanation of the Art of Flying
Chapter 4 Notes

Perhaps my notes and observations will inspire you to buy your own copy and learn from this classic…or to take the copy you already own off the shelf and revisit its great lessons, just as I am doing again now.

FLYING LESSONS is an independent product of MASTERY FLIGHT TRAINING, INC. www.mastery-flight-training.com

Pursue ***Mastery of Flight***™

Continuing my notes on Wolfgang Langewiesche's essential classic, ***Stick and Rudder***:

Part I: WINGS

Chapter 4: "The Flying Instinct"

Page No.	Highlighted Text (Langewiesche's words)	My margin notes
56	Buoyancy…how it can be sensed…the flying instrinct	
	Most accidents happen only because the pilot's sensing of his buoyancy failed him.	Well, Loss of Control Inflight (LOC-I) accidents, anyway.
	Training manuals for pilots pay little attention to [buoyancy], and the Theory of Flight books none at all. This probably accounts for that vague feeling of frustration which bothers most students during training.	Developing "airmanship" is in part developing this "sense of buoyancy," and AoA awareness. It takes time and experience, and currency to maintain. With it the pilot is "in the groove" or "in the zone".
57	How does the pilot know how far he is from the stall?	
	Fast flight means flight at low Angle of Attack; slow flight means flight at high Angle of Attack	Only if at 1G
	Depends also on its load. If heavily loaded, it needs more Angle of Attack (at the same speed) than if lightly loaded	True for actual load (airplane weight) and also in the context of G load (actual load imparts more force)
	G load acts just as if it were real weight	What I just said!
	In straight flight, speed and buoyancy are the same thing; and if a pilot can sense his speed, he can thereby also sense his lift, that is, buoyancy	
	Speed through the air is what counts, of course, not speed over the ground. The pilot therefore cannot judge simply by looking at the ground, as one judges speed in a car by looking at the scenery.	Cues of wind; density altitude affects true and ground speed
58	On a takeoff and climb from a high-altitude…airport, wide open throttle will not produce the usual amount of thrust, because the air is too thin. A pilot who points his nose up at the usual angle, trusting his wide-open throttle, would stall.	
	The average small airplane, fully loaded and with its throttle set at cruising, is actually unable to hold *indefinitely* any turn banked at much more than 45 degrees! The effect just described will slow it down gradually, as it circles, so that the pilot's stick comes farther and farther back; until finally, after perhaps twenty turns have been completed, it will stall: stall, mark you, out of level flight with cruising throttle!	
	A good speed cue is the sound of flight.	
	Changes…indicating whether at the moment his speed in increasing or decreasing.	
59	It has been seriously proposed that airplanes be equipped with some musical instrument similar to an	Aural indication of Angle of Attack. Interestingly, something like this was playing

	Aeolian harp, on which relative wind would play different notes at different air speeds!	in the cockpits of the snowspeeders in Star Wars: The Empire Strikes Back early in the movie.
	What [the pilot] needs most is a warning when he is slowing up too much; but as the speed fades, the sounds fade; and as the sounds fade, they also tend to fade from his attention.	This was written prior to the introduction of the stall warning light or horn.
	In ground life, silence tends to mean security; loud noise, danger. In the air, it's the other way 'round.	
	That's what learning to fly largely consists of: the pilot need not develop any new senses but must learn to use his old senses for new and different work.	Another element of developing "airmanship"
60	Unfortunately, the sounds of flight are not a good cue in the flight condition out of which most stall-spin accidents develop—flight with power on.	Even then, as it is now, stalls with power on, *not* the base-to-final turn stall, was the primary threat.
	The feel of the ailerons serves as a clue to air speed…. In very fast flight, the stick becomes quite stiff…in slow flight, the stick becomes soft.	Control feel and responsiveness
62	A really fast airplane, flown through ordinary rough air, gives you a continual hard spanking from underneath, and once in a while it tugs you down sharply by your safety belt. But fly that same airplane slowed up to near stalling speed through the same rough air, and you still get some sinks and rises; but the sinks are gentle and the rises have no force to them. That's why, in really rough air, a pilot of the usual civilian ship must slow down; at ordinary cruising speed the sudden sharp increases in lift, due to up-gusts, might put excessive stresses on the wings.	V_A
63	If the airplane is to fly at any higher Angle of Attack (any nearer the stall), it must be forced to that angle by brining the stick back, and must be *held* at the new angle ny *holding* the stick back, with continual back pressure. It me *be* slowed by the pilot.	For a wing to stall, the pilot *or* the autopilot *or* a runaway nose-up trim must *force* the wing into the stall. Left alone, a stable airplane will naturally pitch downward to reduce AoA—it may descend, and it may descend quite rapidly; it might descend all the way into the ground. But it will not be stalled.
	"Lift": the trim tab can falsify it.	
	Noseheaviness is a buoyancy cue only if a pilot remembers how the trim tab is set at the moment.	
65	A pilot, while holding constant back *pressure*, can nevertheless pull the stick gradually too far back and pull himself into a stall.	It's possible to stall in 1G flight by simply holding a constant pitch attitude as speed decelerates, until reaching critical AoA.
	Especially in a tense situation, the pilot will be wise to arrest his hand consciously once in a while to make sure that he is not allowing it to creep back. If the ship thereupon noses down, that is a sign that he was gradually pulling himself up into a stall…. The remedy is to hold the stick steady and let the nose seek its own level.	Don't tense up on the controls.
	The most correct way…of gauging one's buoyancy is by the *position*, rather than the *feel*, of the stick.	Paint the control arm green, yellow and red to indicate normal, maximum performance/caution, and stall ranges of elevator deflection.
	Stick position is a fairly precise indicator of buoyancy.	As modified by trim setting
66	The farther back the stick, the higher the airplane's Angle of Attack.	As modified by trim setting
	Stick position, since it *causes* Angle of Attack, also *indicates* Angle of Attack.	As modified by trim setting
66-67	One could actually label the various stick positions, fore and aft, in terms of buoyancy, "lift", or whatever the pilot may choose to call it. [A] certain back position would be labelled "stall". Another position, a few inches forward, could be labeled "very mushy." Another few inches farther forward could be the position "normal glide," with good healthy lift—also a good healthy climb. Still another few inches farther forward, another stick position could be labeled "cruising, very firm sustentation, lots of lift." Still father forward would be a position "very fast flight, sustentation so firm as to be	As modified by trim setting; the control arm painted ranges I mentioned earlier.

	actually hard; when in rough air watch out for the structure of wings."	
67	A training ship should have an indicator that would show, by pointer and dial on the instrument board, in what position the pilot is holding the stick—similar to the indicators that show trim-tab position.	Another form of Angle of Attack indicator
	The elevator…is the airplane's Angle of Attack control.	
68	Such an indicator could then be calibrated in terms of Angle of Attack.	As modified by trim setting
	The true purpose of the elevator is an Angle of Attack control, not an up and down control.	
	Test pilots, who have to really know what they are doing, use control position indicators; why not students and instructors?	
	Angle of Attack is *controlled*, true enough, but stick position; but it is haphazardly *influenced* also by throttle setting and (to a lesser degree) by the loading condition of the airplane.	As modified by trim setting
	Most of our civilian airplanes will not stall with power off unless the pilot holds the stick clear back against his stomach; with power on many of them will stall when the stick is held only halfway back. This is because propeller blast hits the upward-deflected flippers and makes them unduly powerful.	As modified by trim setting; so power on stalls are more of a threat than power off stalls.
	That is something to remember during a forced-landing approach: *if the pilot's hand is near his stomach, the airplane is near the stall.*	Engine failures don't kill pilots, stalls and poorly planned glides after engine failure kills pilots.
69	Testing the cushion: whether [the pilot] has a cushion of reserve lift. Pull back on the stick and watch how the airplane behaves.	
70	Many pilots "feel" for their lift [by easing back on the controls] almost continually during an approach—especially during the last stage where the approach glide blends into the actual landing, and during night landings. If you watch such a pilot, you see him every few seconds gently tugging back on the stick an inch or so, and then letting it come forward again.	
	Quite near the ground, this same clue works also via the eyes. If a small pull-back on the stick does not result in the visible ballooning, or at least in a visible checking of the ship's descent, the ship is on the very verge of a stall.	
71	We demand from the prospective student flier that he have perfect eyes, perfect sense perception in all respects. And we demand also a great natural aptitude in coordinating perception and action, an aptitude that he must prove…. But once we start the student on his training, we don't' teach him how to use his fine senses; we leave that to chance.	This is a major failing of flight instruction, then (WWII) and now.
72	Try…to maintain a steady gliding speed by ear alone, with your eyes closed. Or let the instructor glide the ship and try to guess the gliding speed…with your eyes closed.	
	There is a great difference between merely *perceiving* something and *noticing* it.	In all life, not just flying.
	Our difficulty in learning to fly is not sense perception, but interpretation of what our senses perceive. We tend to pay attention to the wrong things; we miss things that matter because we aren't looking for them, because we don't know what they mean.	Personality traits that limit acceptance; confirmation bias.
	For the dumb student flier—show him what the signs are and why they are important, and he won't be so dumb.	
	Once the correct response has been practiced formally a few times, it becomes almost automatic.	"Law of Repetition"
73	That's all the so-called "flying instinct" consists of: small clues, understood correctly and reacted to automatically.	

	The airspeed indicator is indeed the pilot's most important flight instrument.	
74	The airspeed indicator is an ideal stall-warning device. It is a poor speed indicator but a good indicator of one's buoyancy. Regardless of altitude or air temperature, if the instrument shows a margin above stalling speed, you have that margin of buoyancy. If the instrument shows no margin, you have no margin.	*If* in coordinated, 1G flight
75	The airspeed indicator should be redesigned. By integrating it with an accelerometer…one could achieve an instrument that would always truly indicate how close the airplane is to the stall, and at what Angle of Attack it is flying—in short, it's buoyancy.	
	Too many pilots don't know what Angle of Attack is in the first place, and such an instrument's indications would be meaningless to them.	WWII pilots didn't know all this, and AoA awareness become a lost art. It has been lacking all along.
	The most important role of an Angle of Attack indicator would not be to give last-second stall warning; it would be to keep the pilot *continually* appraised of his Angle of Attack.	*If* the AoA indicator is properly calibrated.
76	A stall-warning indicator…is like a gasoline gauge that would indicate only when the tank is empty, or a bank that would send a statement only when you are overdrawn. What the pilot needs is a device that would warn him *early* that his Angle of Attack is *beginning* to increase.	…and only then, if the pilot is trained, able and willing to begin a recovery as soon as the AoA trend is toward critical…which is when conventional stall warning horns sound.
	The best use of an Angle of Attack indicator…would not be as a safety device for practical flying but as a training device.	
	A student can…never clearly realize the most important fact of all flight—Angle of Attack. He may not even know that there is such a thing! He misses the central idea of his whole art.	
	The accident record is one result. Another result is the rate of "wash-outs" from flight training.	Except in modern civil aviation there is no "washout". Pilots continue to fly and advance into more complex aircraft, as long as they pass a medical, don't run out of money, and don't crash. There is no real mechanism for deterring a pilot who does not have the skills or the attitude.
76-77	It is absurd that…only a tiny percentage of all human beings is considered fit to fly. Flying an airplane when you don't understand Angle of Attack is indeed an art of the very highest order. Under such circumstances, [a pilot] needs superior perceptions, and exceptionally stable personality, great presence of mind and all the rest. But with the idea of Angle of Attack once clearly understood, flying is simple, common sense, logical, nnot trying to the nerves; it is easy.	Interesting take of the idea of whether medical certificates have merit for civil aviators. [2017 comment]: The combination of BasicMed certification and Angle of Attack Indicators might make a good study of pilot physiology and even mental acuity requirements.
77	The Wright Brothers knew all this. The only flight instrument they ever designed was an Angle of Attack indicator…a piece of string tied to the nose of their airplane, so that its streaming would indicate the direction of the Relative Wind.	
	The same tuft also indicated skid or slip.	
	Perhaps every flying school ought to have at least one airplane fitted with a forward mast and pennant, and every student should perhaps have a chance to fly it once in a while and see what Angle of Attack really means.	

I'll add chapter highlights and notes until we reach the end of the book. If you're impatient—and I hope you are—you won't wait for my musings, but instead will secure your own copy of *Stick and Rudder* now. Beyond simply reading its words, you'll truly analyze, criticize, mark up and understand Langewiesche's teachings to, as Adler suggests, **make this book your own**.

I look forward to your comments on these notes and the larger work. Please send your thoughts

to me at mastery.flight.training@cox.net. Thank you.

Pursue *Mastery of Flight.*

Thomas P. Turner, M.S. Aviation Safety
Flight Instructor Hall of Fame
2010 National FAA Safety Team Representative of the Year
2008 FAA Central Region CFI of the Year

