ON V_{mc}

BY

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There are various words in our language so widely misused that after a while nobody notices it. Their meaning actually changes, and dictionaries of the American version of the English language start incorporating the previously incorrect meanings into the official definitions of these words.

"Presently" is an example. That word originally meant, "in the near future." But through widespread misuse, it has come to mean "right now." "Unique" is another word that drives English teachers up the wall. It once meant "the only one." If that's what the word meant, then something would either be unique or it wouldn't be unique. It couldn't be "*very* unique." It couldn't be more "the only one" than something else. But folks started using the word as a replacement for "unusual," or "distinctive," and now, for all practical purposes, the definition has changed through the ubiquitous power of ignorance.

In aviation, we have some examples, as well. The word "contact" has come to be a verb, although it used to be a noun. Nobody thinks anything of it when approach control says, "Contact Lakefront tower, 119.9." *I* don't even think anything about it, and I'm a word nerd.

Anyway, "V_{mc}" is another of those flying terms whose meaning is being altered with continual misuse. It has come to mean "a speed below which a multiengine airplane is not directionally controllable when being flown with asymmetric thrust." How's that for a definition? I didn't even look it up. I pulled it right out of my ear.

But misconstruing this term might lead to some misconceptions about multiengine safety, so I thought I'd give it a go by writing an essay on the subject.

Let's suppose you were flying along in your Piper Seminole and you pulled the throttle of your left engine back to idle and left the other one at a cruise setting, say, 22 inches manifold pressure and 2300 RPM. Then, let's say you were to pitch up until you lost directional control. Would you then know what the V_{mc} is for the Piper Seminole? My answer would be, "probably not." Under those conditions in that type of airplane, the rudder would probably be effective enough to maintain directional control all the way down to stall speed.

So, maybe what the term has really come to mean is, minimum speed under which directional control can be maintained in times of asymmetric thrust *under a particular set of conditions*. Now we're getting a little closer.

As originally construed, V_{mc} was that minimum control speed under this set of conditions, and this set only:

The airplane would be loaded to maximum gross weight.

The center of gravity would be at its aft limit.

The landing gear would be retracted.

The flaps would be at their takeoff setting.

The cowl flaps would be in takeoff setting (presumably open)

The trim would be set for takeoff

The most critical engine would be the one to fail

The working engine would be producing its full rated power.

The propeller would be windmilling on the dead engine and would be set to flat pitch (highest RPM).

There were some other caveats having to do with test pilots' work, in some cases. For example, there had to be a sudden, catastrophic total loss of power on the most critical engine, making it necessary for the pilot to take aggressive action, applying up to 170 pounds of force on one rudder pedal to prevent a heading change of "X" degrees. (The one I read mentioned maintaining heading within ten degrees.)

So I guess you'd have to find a pretty cool day and fly out over the middle of Lake Ponchartrain at an absolute altitude low enough to produce a density altitude of zero. That's the only why you could get the maximum power out of that little normally-aspirated engine. How would you like to be the test pilot trying to find the airplane's V_{mc} under *those* conditions?

The point here is that V_{mc} used to be a figure arrived at by engineers and test pilots, not by flight instructors arranging conditions for training purposes, or by examiners and inspectors trying to test applicants for the multiengine class rating. Using this way of looking at the term, there was one, and only one, value for V_{mc} for a particular type of multiengine airplane, since that airspeed was defined for a specific set of conditions and no other. It would not be meaningful to say that the V_{mc} would be decreased when power on the good engine was reduced. If power on the good engine were less than its maximum rated horsepower, you wouldn't be experiencing V_{mc}.

Back in the day when men were men and a cigar was a good smoke, we used to do a maneuver in training known as a "rotational stall." This practice started, as do so many, with heavy aircraft (over 12500 pounds max. takeoff weight) and migrated down to us little guys. What you'd do is to retard power on all engines and, as the airplane slowed down, you'd pitch up to increase your angle-of-attack at just the right rate so that the airplane did not gain or lose altitude. When you got to some predetermined speed, or detected a stall buffet, you'd pour the coals to it and accelerate out of this condition, once again pitching down at just the right rate so that the airplane neither gained nor lost altitude. I have found that this maneuver fits very well into the second lesson of the private syllabus, where we are trying to get a student pilot to understand the pitch-power-altitude-airspeed relationship.

Trouble was that someone thought it would be a good idea, just as the pilot-flying got all that power in there and started gaining speed, suddenly to chop one of his engines. Imagine the hilarious hangar tales of the looks on students' faces as the airplane did a half-snap into the inverted position! Hardy har har. Those were back in the days when we seemed to kill more pilots in multiengine training than we did following actual engine-out mishaps.

Here's how the multiengine Practical Test Standards read today:

NOTE: *Airplanes with normally aspirated engines will lose Power as altitude increases because of the reduced density of the air entering the induction system of the engine. This loss of power will result in a V_{mc} lower than the stall speed at higher altitudes. Therefore, recovery should be made at the first indication of loss of directional control, stall warning, or buffet. Do not perform this maneuver by increasing the pitch attitude to a high angle with both engines operating and then reducing power on the critical engine. This technique is hazardous and may result in loss of airplane control.*

Amen, Brother Ben! That sounds like one of those cautionary statements that was writ in somebody's blood.

Back when I was giving practical tests for the multiengine class rating, I knew I had to include in my test a task known as:

Task B: V_{mc} Demonstration (AMEL and AMES)

Objective #2 in this task tells the examiner and his victim what they are supposed to do:

2. Configures the airplane in accordance with the manufacturer's recommendation, in the absence of the manufacturer's recommendations, then at V_{sse}/V_{yse}, as appropriate – (run-on sentence theirs, not mine)

a. Landing gear retracted.
b. Flaps set for takeoff.
c. Cowl flaps set for takeoff.
d. Trim set for takeoff.
e. Propellers set for high RPM.
f. Power on critical engine reduced to idle
g. Power on operating engine set to takeoff or maximum Available power.

3. Establishes a single-engine climb attitude with the airspeed at approximately 10 knots above V_{sse} or V_{yse}, as appropriate.

4. Establishes a bank toward the operating engine, as required for best performance and controllability.

5. Increases the pitch attitude slowly to reduce the airspeed at approximately 1 knot per second while applying rudder pressure to maintain directional control until full rudder is applied.

6. Recognizes indications of loss of directional control, stall warning, or buffet.

7. Recovers promptly by simultaneously reducing power sufficiently on the operating engine while decreasing the angle of attack as necessary to regain airspeed and directional control. Recovery SHOULD NOT be attempted by increasing the power on the simulated failed engine.

8. Recovers within 20° of the entry heading.

9. Advances power smoothly on operating engine, and accelerates to V_{xse}/V_{yse}, as appropriate, +/- 5 knots, during the recovery.

Notice their use of the term, "V_{mc}" in the P.T.S. Notice that it does not correspond with the original definition of the term. I would rather they used some other term, such as "loss-of-control speed," that would somewhat unconfused the issue. In fact, I think the term "V_{mc}" could very productively be omitted from training and testing, except for the cautionary statement that anybody who is flying anywhere near that speed should be doing something promptly to make the airplane go faster.

Notice also the reference in item #3 to "V_{sse}." That's known as "safe single-engine speed." It was thought up during the era of high-fatality-in-multiengine-training by some smart airplane manufacturers. The idea was that nobody in his right mind should try to operate slower than that speed with differential thrust. When I'd brief my applicants for multiengine class ratings, I'd place emphasis on maintaining V_{sse} or better except for our so-called "V_{mc} demonstration." Life's too short already.

By the way, airplanes whose manuals do not specify a V_{sse} can be flown at the blue line, or V_{yse}, the single-engine best rate of climb speed, to provide about the same margin of safety. Since the ability of the plane to climb at any speed lower than the V_{yse} is questionable, I can't think of any reason why anyone would want to try to fly at an airspeed lower than that. When these piston-powered airplanes with low-horsepower engines are flown near V_{mc}, they are going to be so far into the area of reversed command that the wings are producing a whole bunch of extra drag, just to stay in the air. The only thing a multiengine pilot has to know about V_{mc}, in my opinion, is *not to go there!*

Now, training and testing are sometimes a little different. There are a couple of flies in the ointment of this maneuver. The first, and the scarier, is that item mentioned in passing in the NOTE: In a normally aspirated aircraft, the maximum available power an engine can produce decreases as you gain altitude. The result of this loss of available thrust bears a great deal of emphasis: *the indicated airspeed at which you lose control decreases*.

You don't have to be very high to lose a lot of your manifold pressure, which is an indicator of the power being produced by the engine. If the working engine is putting out less thrust, it stands to reason that the airplane can be flown at an increasingly low airspeed without losing directional control, since there is less horsepower trying to yaw you into the dead engine.

At the same time you are losing power because of increasing altitude, the *indicated airspeed* at which you stall stays the same, provided that you maintain a one G load on the wings.

Eventually, as you perform this maneuver at increasingly high altitude, the loss-of-control speed and the stall speed meet, and at a little higher altitude than that, the loss-of-control speed falls *below* the stall speed.

Friends and neighbors, it's not a good idea to stall an airplane with differential power out there on the wings. When you stall with the ball out of the center, whether it's in a single or a twin, the airplane is going to start to roll in the direction opposite the ball deflection. Yawing and rolling go right together when you stall, just like bacon and eggs, just like salt and pepper, just like Pat and Vanna. So if you don't want to induce an incipient spin, it's a good idea to have the ball centered when the airplane stalls. It's an even better idea not to try to fly the airplane anywhere close to stall speed with differential thrust.

In other words, it's desirable to get the airplane to lose control, during this demonstration, as far *above* stall speed as possible. That's why I used to train my students in this maneuver around fifteen hundred feet above the ground, back before the FAA told us not to do that. I wanted that good engine putting out as much as it possibly could, in order to induce loss of directional control at the highest possible speed.

For some reason, the FAA put forth a policy that we were not to conduct any kind of single-engine drills below four thousand feet AGL, particularly during practical tests. So that was bad news #1 for us poor examiners.

Bad news #2 is mentioned in item 4 of the OBJECTIVE. It says that the testee is to establish a bank toward the operating engine, as required for best performance and controllability. I don't think somebody was thinking clearly when they put that one in there. In the V_{mc} demonstration, you don't want the airplane's *best* performance. You want its *worst* performance. You certainly don't want to do anything to *reduce* the speed at which you lose directional control.

As a matter of fact, it takes considerable rudder throw to keep the ball centered, with one turning and one burning, when you are flying around the V_{xse}/V_{yse}. It nicely increases the loss-of-control speed if you instruct the student to keep the ball centered while performing this demonstration.

There are also a couple of other procedures that I think could promote safety in training and in testing. One is for the instructor or examiner to place his foot between the rudder pedal corresponding to the "good" engine and the floor, thereby limiting the travel of the rudder. If you can't get full rudder in there, you're going to lose directional control at a higher speed. Remember, losing directional control promptly, at a speed way higher than stall speed, is good. The idea is to get the student to experience that uncontrollable yaw, not to get him to see what a snap-roll-to-inverted-flight is like. And you're also trying to build into his reaction to that yaw, the response of reducing power on the good engine and reducing angle of attack, not performing a "split S" or an aileron roll from inverted to upright flight.

You can also try a trick that one of my instructor clients used with his students. You can set the maneuver up just as it is described, and then tell the student to hold the rudder right where it is. As you pitch the nose up for that one knot per second speed loss, the airplane will obligingly start its yaw into the dead engine, way above stall speed. The student will get to experience what this is like and the instructor doesn't have to mess up the nice spit shine on the toes of his shoes. The actions needed for recovery are exactly the same: *reduce power on the good engine and reduce angle of attack*. *That's* what you are trying to train him to do.

Finally, as an examiner, I glommed on to that business about recognizing "*indications of loss of directional control, stall warning, or buffet*." We'd talk about that quite a bit during the oral part of the test. "*Listen Mr. or Mrs. Applicant. You are going to have the controls during the* V_{mc} *demonstration. Therefore, you will undoubtedly feel any control buffet before I do. As soon as you feel anything like that, or hear anything having to do with a stall warning horn, or* ***ANYTHING*** *you think presages a stall, I want to see an* ***IMMEDIATE*** *recovery.*"

I am happy to report that nobody taking a multiengine ride with me ever induced an incipient spin during this maneuver. And I don't think I ever had anybody bust a ride because of inadequacy in performing Task B of Area of Operation X.

Anyway, getting back to the topic of this essay, the astute reader might have noticed that we are creating a loss of directional control, for the edification of the nascent multiengine pilot, that does not meet the original definition of V_{mc}. We don't go around collecting warm bodies or sand bags to load into the airplane to bring it up to maximum gross weight, and we certainly do not perform the maneuver with the good engine developing maximum rated thrust. And I hope the instructors and examiners do not load the bird to its aft C/G limit, which would destabilize the aircraft in pitch and make it less likely that recovery from a spin could be accomplished, even 4000 feet above the ground.

Lastly, modern Piper twins have counter-rotating engines and dual alternators and vacuum pumps so that there is no difference between the severity of the problem of losing one engine, compared to the other one. Both engines in these airplanes are equally "critical," unlike older models that would yaw a little harder when the left engine failed. And if I remember correctly, Piper also used to compound the problem by putting the generator and the hydraulic pump on the left engines of their Apaches. I guess they didn't want anyone to get into arguments about which of the engines was the more critical. So I give a big attaboy to whatever aircraft designer decided that they should spend a little extra money to enhance the safety of their twin-engine products.

Here's to the brave men and women who train, test, and fly in piston-powered twins. As one of my favorite controllers from Lakefront tower used to say, "*Y'all be real careful up there!*"