J. MAC MCCLELLAN
COMMENTARY / LEFT SEAT

What's Up With Heading?

Heading can mean different things when pilots and controllers talk

WE ALL LEARNED IN ground school that heading is a number on the magnetic compass. In strict navigation terminology the heading is where the airplane is pointed referenced to the magnetic field around it. Simple, right? Not always.

The problem is that sometimes when pilots and controllers talk, the word heading can mean the compass heading, but it can also mean desired track or course. Most of the time pilots know which information a controller wants or what instruction he is issuing, but not always.

HORIZONTAL SITUATION INDICATOR (HSI)

1. Heading Select Bug 2. Glideslope Pointers 3. Course Deviation Bar 4. Course Deviation Scale 5. Glideslope Deviation Scale 6. TO/FROM Indicator 7. Course Select Pointer

Not that long ago most of us could know only our mag heading with reasonable certainty. Unless we were flying along a VOR radial our actual track—path across the ground—was only an estimate. Remember the E6-B computer with its pencil dots and dials that made it easy to solve the wind triangle problem? All of that math was designed to convert a magnetic heading into a course corrected for wind drift—a desired track. Or more often we used the E6-B to transform a line on the chart—a desired track—into a heading to fly to maintain that track. But the key word here is "estimated" because the wind was always an estimate, so that made any solution to the wind triangle problem no better than a bit of a guess.

However, controllers had the opposite information based on their radar presentation. The radar can only show controllers an airplane's track over the ground, leaving the controller with no information on the heading the pilot is flying. Pilots knew heading, and controllers knew only track, so it was natural for controllers to ask for, or assign, heading because that's all a pilot could fly, and it was the information the controller didn't have.

Now with the proliferation of GPS navigators the navigation situation has been turned on its head. Controllers still only can see ground track and groundspeed, but in the cockpit we can see our heading, of course, along with desired track, cross track error, track angle error, wind direction, and speed and bearing to the waypoint, all with great precision.

NAVIGATION TERMINOLOGY

First, let's review basic navigation terms, because I don't think they are well understood by pilots. GPS terminology is certainly not completely explained in most

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training programs because the information needed to pass the pilot written tests is lagging far behind the reality of GPS in nearly every cockpit.

The most fundamental navigation term is track, sometimes called ground track, but the "ground" is really redundant. The term track has been around for a long time, but it didn't have much use in aviation because most of us had no way of knowing our track, which is simply our path over the ground expressed in degrees of magnetic direction. Track is not necessarily constant but is only a measure of your path over the ground at the instant it is observed by the navigation system.

It's important to note that GPS and other long-range navigation systems such as Loran C or inertial navigation systems calculate track as a true direction, not magnetic. However, the airspace system is designed around the compass, so the true track computations must be converted to magnetic by the navigation system. Each navigator contains a magnetic variation map and looks up the variation for your location and applies that correction to the true track to show you magnetic.

Magnetic variation is constantly changing at different rates at each location around the globe. The variation change rate is actually a forecast based on the recorded history of change. The variation maps stored in GPS navigators all use essentially the same variation change forecast as accepted by the FAA, but the FAA does not always keep up with variation change, so you can see differences.

For example, if you are tracking an airway between two VORs you may see a different magnetic desired track from your GPS than is shown on the chart for the VOR radial. The GPS is guiding you directly between the two VORs, but the VORs may not be set to the current magnetic variation. The FAA is loath to re-index a VOR station as the mag variation changes because the charting of every airway, intersection, or terminal procedure served by that VOR will have to be changed on charts. Why we don't convert to an air navigation system based on true direction is another discussion, but someday I'm sure we will.

When a controller tells you to fly a heading he wants you to maintain the assigned compass heading. ... But when a controller asks you for the heading to some point along your route, he wants you to tell him the desired track from your present position to that point.

The other key navigation term that is not new but was little used before GPS is desired track. The desired track is the path over the ground you need to fly to stay on course. In fact, before GPS the term most frequently used was course, not desired track. The terms mean essentially the same thing, which is a real or imaginary line on the chart that takes you directly from point A to point B.

If track matches desired track, you are flying your desired course. Make sense? If you are left or right of the desired track, the distance left or right is cross track error. If your track is not matching the desired track, the number of degrees of the track left or right of the desired track is the track angle error.

Bearing is often confused with track or desired track but is really a very different piece of information. Bearing is simply the direction in degrees to your next waypoint or destination. If you match the bearing with the desired track, you will stay on course. Or if you keep the nose of the airplane pointed toward the bearing to the waypoint, you will get there, though you may fly an arcing course as though you were homing in with an ADF.

Flying over a desired track is the shortest way to the destination, but it is also important for obstruction clearance. A desired track is charted in the form of an airway or, more importantly, an approach procedure, to keep you clear of

obstructions when flying the minimum charted altitudes. If you wander off the desired track, you are literally in uncharted territory and may not have the obstruction clearance you expect.

CONTROLLERS AND HEADING

When I'm being vectored, usually in the terminal area, and the controller tells me to fly XX degrees, that means he wants me to fly that magnetic heading. The compass rules. If the wind is strong, the heading and track can be significantly different, but I know the controller wants me to maintain the assigned heading, not track.

The reason to fly the heading instead of track is because the controller is giving other pilots a heading. After a few minutes controllers figure out what the wind is doing and adjust their heading assignments to put airplanes on the track they want. If some pilots flew track instead of heading, and the wind was strong, the controller's plans for separation wouldn't work out.

When a controller asks for my heading I know he wants my magnetic heading, not track. He can see my track, but not heading. But there is a subtle difference when the controller asks what my heading is to some waypoint or the destination. In that case he wants to know the desired track to that point, not the compass heading. When I tell him the desired track—still using the word heading—he can see how my path over the ground will interact with other traffic or possible high terrain or regulated airspace. Actual magnetic heading can't give him that information.

I know the dual meanings of heading in conversations with controllers can be confusing, but I believe the dilemma can be resolved this way: When a controller tells you to fly a heading, he wants you to maintain the assigned compass heading. When he asks for your present heading, he wants compass heading. But when a controller asks you for the heading to some point along your route, he wants you to tell him the desired track from your present position to that point. Make sense? It does to me.

BUTTON BUMPING

The PS Engineering audio control panels have many convenient features and offer excellent intercom performance. One feature I use often and really love is the button mounted on the control yoke that changes the active transmitter from one radio to the other without reaching over to press a button on the audio panel itself.

But, it's possible to bump that transmitter change button accidentally and not notice it. The button is mounted on the inboard horn of the control wheel, so it's away from the hand you normally use to fly so you're not likely to hit it while reaching for the push-to-talk button, or the trim switch, or even the control wheel steering button many autopilots have. Those buttons are all on the outboard control horn to be near the fingers on the hand you normally use to fly.

So I'm not sure how I have mistakenly hit the transmitter change button, but I have. Maybe I hit it when reaching around the cockpit to dial a frequency or enter new data in the avionics. Or maybe I bumped it with a chart resting on the control wheel. However it happens, it has, and it can be hard to notice, particularly if the frequency is not busy.

The weight of unneeded fuel robs performance that may be more important than extra hours of fuel reserve.

I did it recently approaching Duluth. There was little traffic so pretty long silences on the frequency were the norm. My clearance was direct to the airport, which took me over several tall broadcast towers south of the airport that required a minimum altitude of 3,100 feet, which is what I had been cleared to. There was an annoying broken layer of clouds at that level, so I was getting only glimpses of the airport ahead but thought once past the towers I would be cleared to descend for the visual approach.

Finally, just a couple of miles from the airport I called asking for lower—and ground control answered. I had accidentally hit the button changing to the other radio that I had preset for ground control. I felt like a jerk when I got back on the correct radio. A 90-degree turn to the east took me out to fly the ILS back into Runway 27. It was embarrassing.

Now, for several months, I'll be very vigilant to make sure I don't accidentally switch radios. Vigilance will bring success. Success will breed complacency. Now that's something to watch out for.

LIGHT ON FUEL

Since moving back to Michigan last winter I have cut my average trip length dramatically. It is a long way from New York where I operated for 21 years to where most of the general aviation industry is located, so almost every trip required full tanks in my Baron, and often a fuel stop. But from Muskegon in western Michigan where I base now, nearly all trips are much shorter.

For example, it takes just 40 minutes on average to fly to Oshkosh. I flew from Oshkosh to Duluth to visit Cirrus in one hour and 30 minutes. The trip from Duluth back home to Michigan was only an hour and 35 minutes. The trip to the Stearman fly-in in Galesburg, Illinois, was only an hour and 15 minutes. And so on.

Because of the shorter trips I'm able to fly often with half-full tanks, or even less. Leaving that weight behind sure makes a difference in performance. Takeoff and climb performance improvements are the most dramatic, but the lighter gross weight even makes a noticeable cruise speed difference of a few knots at the same power settings.

The airplane has direct-reading mechanical fuel gauges that show partial fuel loads from 35 to 60 gallons. The purely mechanical nature of these gauges mounted in the wing makes them very reliable. When the normal electric fuel gauges in the instrument panel match the pre-takeoff readings of the mechanical gauges, I have high confidence in the actual fuel level onboard. The mechanical gauges are quite conservative by more than 5 gallons, which I have observed many times when fueling from a partial load to full tanks.

I also write down and keep in the airplane every refueling amount so that I can then compare fuel added to flight times and then crosscheck against fuel gauge readings. When all factors agree, I am confident in the amount of fuel in the tanks.

Flying with partial fuel is the norm in larger airplanes, and topped tanks is the rare event. In general aviation most of us were taught that full is always safest, and there is some merit to the certainty of overflowing gas caps. But the weight of unneeded fuel robs performance that may be more important than extra hours of fuel reserve, particularly if the runway is marginal in length and nearby obstructions are high. A big fuel reserve is essential, but it can be too big for efficiency or even safety if you are flying a shorter trip. EAA

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