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COMMENTARY / LEFT SEAT

The Myth About Glass Cockpits

Making sense of modern avionics

THERE IS A MYTH that persists about flying with a flat glass primary flight display (PFD). The odd thing is that this is a multifaceted myth. One group believes it is harder to fly with reference only to a glass display and pilots transitioning to glass need lots of time and training. The other segment believes that flying with a PFD is so much easier that those who learn to fly instruments with a glass display can't be trusted to also fly with conventional flight instruments.

The common core belief of pilots who subscribe to this myth is that a PFD is simply different, very different, and too different for pilots to transition to or from easily. The myth is just flat out wrong.

As I'm sure you know, a PFD takes the six primary flight instruments and combines them on a single glass display. The actual glass displays are versions of displays used for consumer electronics such as smartphones, tablet computers, or even the flat glass televisions found in most homes. The displays have been adapted to the cockpit environment with brighter lighting and other modifications.

All PFDs have an attitude presentation that looks much like any artificial horizon gyro instrument. There is blue above to represent the sky, brown below to indicate the surface of the Earth, and a horizon line in between. Every artificial horizon gyro built in the past 50 years has looked pretty much the same. Earlier gyro horizons sometimes lacked the blue-brown color, but all had a line to represent the relative position of the horizon, the most essential piece of information to determine your aircraft's attitude.

PFDs also have a compass arc to indicate magnetic heading. Often the compass display is a full 360-degree circle, but on

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some displays only 90 or 120 degrees of arc ahead are shown. There is a course pointer and a course deviation indicator. There also are bearing pointers that can point at any airport or navaid information supplied to the PFD. Again, nothing very different than what is shown on conventional flight instruments.

VERTICAL TAPES VERSUS ROUND GAUGES

But what about airspeed and altitude indications on a PFD? They are vertical tapes, just like a thermometer. The people who say flying with a PFD is easier/harder usually point to vertical tapes as a big issue.

Do you know anyone old enough to fly who would need to be shown how to read a thermometer? I don't think so. The big numbers are at the top, small numbers at the bottom, and some sort of indicator moves up and down the scale. A vertical scale is pretty simple and intuitive to read.

Now, if you want to argue human factors—the study of the best way for people to interact with machines—the vertical tape display is not the winner. We humans can absorb and comprehend information displayed on a round clock type of display better than any other type of display I know of. Humans are analog machines, and we best understand information as an approximation. A round dial delivers approximate information perfectly. The best example of this is the Movado type of watch that has only a single index mark—often a diamond—at the 12 o'clock position. But without any other marks on the face of the Movado watch we can tell the time, at a glance, to within a minute or two simply by looking at the position of the watch hands.

A glance at the traditional airspeed indicator and altimeter gives us lots of information, too, simply by observing the relative position of the pointers on the display face. This is particularly true when looking for cardinal information on an altimeter. If the big pointer is straight up, we are on some number of thousands of feet of altitude, for example.

As good as the round altimeter and airspeed displays are, they are not perfect. For example, more than one pilot has misread a conventional three-pointer altimeter by 10,000 feet, and that's why three-pointer altimeters were banned from airplanes that fly at high altitudes and replaced with a "drum-style" display that uses numbers in addition to a single pointer.

There are those in the myth-believing group that really miss the turn-and-bank indicator or the turn coordinator when they think about a PFD. Those instruments use a gyro to measure rate of turn and a ball encased in a curved tube of fluid to show slipping or skidding. These are the most basic gyro flight instruments, and most of us have been taught to rely on them in an

emergency because they are almost always electrically powered, while the attitude and directional gyros are often powered by a not-too-reliable vacuum pump.

Because of its decades-long status as the savior for pilots who lose the vacuum pump while flying in the clouds, the turn indicator has special status for many. But when you really think about what the instrument is telling you, the information is very basic—the airplane is changing heading and in which direction, and the airplane is, or is not, in coordinated flight.

Most PFDs simply put a colored line on the compass rose showing that the airplane is changing heading and in which direction. Another mark shows what heading change equals the standard rate turn.

To show slip or skid many PFDs use a small box under the roll index pointer at the top of the bank angle scale. This little box moves left or right to show a slip/skid. Some other PFDs put an actual "ball in a race" type of slip-skid on the display that looks very much like an electronic version of the actual ball in the fluid. Either way, the information presentation is pretty basic and simply doesn't take time to learn to understand.

Granted there is the slight human-factors superiority of the round dial display, but how long does it take to adapt to a vertical tape display in place of the dials? Maybe a couple seconds, in my experience.

FLYING THE FIRST PFD

I had the unique opportunity to be a guinea pig with the first PFD certified in a civilian airplane. It was a little more than 25 years ago, and Gulfstream and Honeywell had created the first PFD with its vertical tapes for altitude and airspeed. There was no simulator operating when I got to fly the prototype, so my first takeoff would be on the glass and for real. And as luck would have it the weather was about 300 feet overcast. My transition time to a PFD for real would be a couple of seconds between rotation and punching into the clouds.

Those few seconds were plenty of time because the PFD is not really different than flying conventional instruments. The vertical tapes on nearly all PFDs have bugs you set for the target airspeed or altitude, and you fly to the bug instead of actually concentrating on reading the digits on the tape. PFD makers also use colors on the tapes to call your attention to the target altitude and airspeed. These devices make up for the slight "readership" advantage of the round dial.

That first PFD in the G-IV was one of a kind because the airspeed tape had the big numbers at the bottom and little numbers at the top of the tape. The logic was that if you pull the nose up, the airspeed numbers will get smaller so the traditional thermometer presentation should be turned upside down.

The G-IV airspeed tape is logical in an aviation sense, but in every other activity the big number is always above the smaller one on a vertical scale, so no other PFD makers followed the G-IV lead. But even with that unusual feature, it took no time to adapt to flying the G-IV glass.

When EFIS—electronic flight instrument systems—first appeared in the 1970s as individual television type displays of attitude and heading, many of us "knowledgeable" aviation types claimed it was the old guard with the fat logbooks who would be cautious and slow to accept the glass displays. With the full confidence of years of observing pilot behavior, we claimed the graybeards would demand conventional instruments on one side of the cockpit because they wouldn't trust, or learn how to fly, the new glass stuff.

I was in that group of "experts" and was just flat-out wrong. It never happened. Nobody kept conventional mechanical instruments on one side except for those who couldn't afford EFIS on both sides. Early on the glass was more expensive, but as costs dropped, pilots of all levels of experience embraced EFIS and the PFD as soon as they could get it in their cockpits, and the glass always went first in front of the command seat.

UNDERSTANDING THE FLIGHT MANAGEMENT SYSTEM

There are, I think, two reasons that the myth about PFDs and glass cockpits persist. One is that pilots who do not have experience with both imagine there must be some crucial difference in how you fly viewing one or the other so they project those concerns. The other, more important issue, is that many pilots confuse operation of the flight management system (FMS) with the glass displays. They are not at all the same.

The same electronic advances that made flat glass PFDs and multifunction displays (MFD) available for any level of airplane from homebuilt to the largest jet also brought along the FMS. As the name implies, an FMS can manage all aspects of cockpit operation from the basics of tuning a comm frequency, to detailed en route and terminal navigation, to showing you all sorts of new information on the PFD such as synthetic vision, traffic and terrain information, and charts.

While the basics necessary for flight information displayed on a PFD are essentially standardized, no matter what type of airplane you fly, every FMS can be, and is, different. Software makes it possible to customize FMS functions so that the same hardware system from the same avionics manufacturer will almost certainly not be exactly the same in different airplanes. There also will be operating changes and new functions added in the same type of airplane using the same basic equipment as time goes by and new capabilities become possible. You just can't generalize about exactly how an FMS, and thus the entire glass cockpit, functions in every detail.

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So, when you are flying your homebuilt or a large jet, should you worry about "learning" how to fly with a flat glass display? Absolutely not. Should you worry about learning thoroughly how to use the FMS in that airplane before flying, particularly in the system or in the weather? Absolutely yes.

As with many myths, there is an element of truth about the difference in flying with glass or conventional instruments. But the myth is incorrectly aimed at the PFD and MFD glass displays. The real concern is the FMS and all that it encompasses, and that we must be trained for. Flying the PFD will just take care of itself.

WIND SHIFT

Among the many "new" bits of information the FMS and glass cockpit can show us is real-time accurate winds aloft. The air data computer knows our indicated airspeed, our pressure altitude, and the air temperature and thus knows true airspeed. The GPS navigator knows our groundspeed, ground track, and magnetic heading. Put all of that info into the system and, presto, you see wind direction and velocity just like the system had a perfect E6-B whiz wheel running all of the time.

Often I find seeing the wind aloft as I fly to be depressing because head winds now seem to be bigger than when I was trying to estimate the wind based on crude DME groundspeed readings. But seeing what the wind is really doing is very revealing about what's going on in the atmosphere around you.

Not long ago I was flying home from Oshkosh to Muskegon on the other side of Lake Michigan. There were some heavy rain showers including embedded thunderstorms, but I found a nice wide path between those where the satellite Nexrad display showed only light rain.

As I neared the west shore of Lake Michigan the wind aloft was 010 degrees at 9 knots. The ride in the light rain wasn't bad. But then I noticed the wind arrow on the PFD start moving to the right, and the smooth ride turned into grab the seat bottom turbulence. In the span of 20 miles the wind cranked all the way around to 220 degrees and the velocity increased to 41 knots. Nothing that dramatic was in the forecast, but I had clearly flown through some kind of front that was kicking up enough wind shear to make me wish I were somewhere else.

The wind output from the modern avionics couldn't smooth out the bumps, but it sure did take the mystery out of what caused them. And not long after the wind settled on its new southwest heading I flew into the clear, and smooth, air. EAA

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