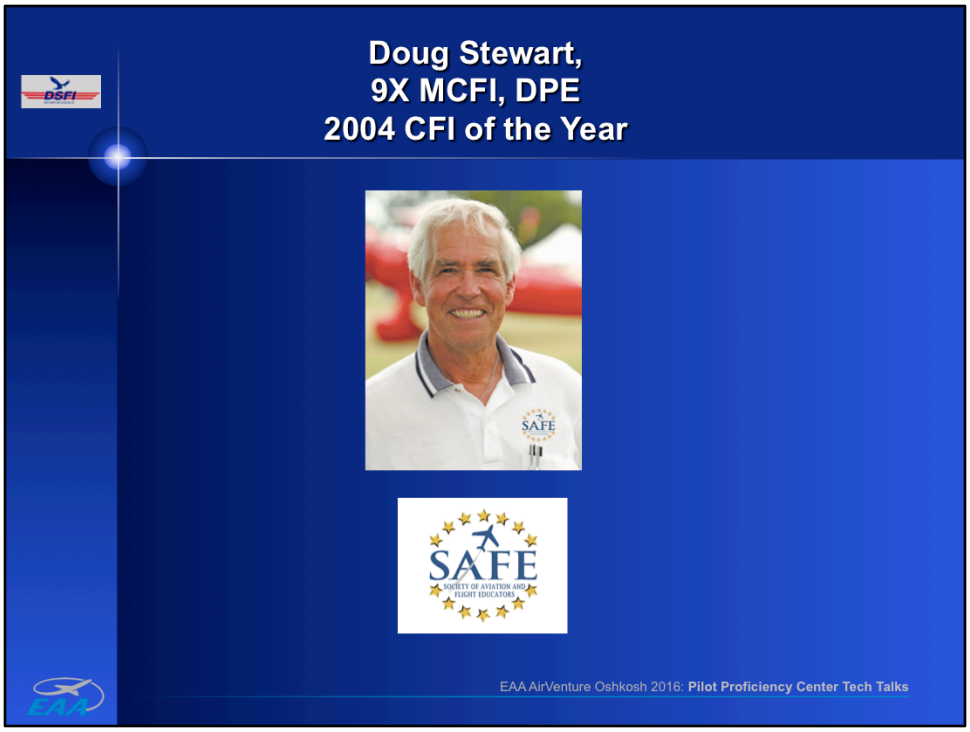

DSFI
DOUG STEWART FLIGHT INSTRUCTION, INC.
The Art of Instrument Flying :
Situational Awareness



With a total time of over 14.5K hours, 11.5K of dual instruction provided, and close to 5K of instrument instruction, Doug has learned a lot. In this presentation he shares his knowledge and experience of flying in the real IFR world.

IFR Flying Defined:

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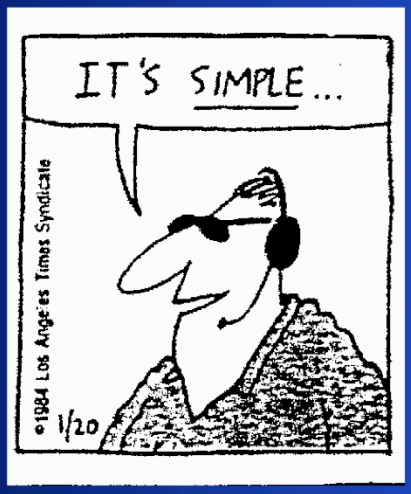

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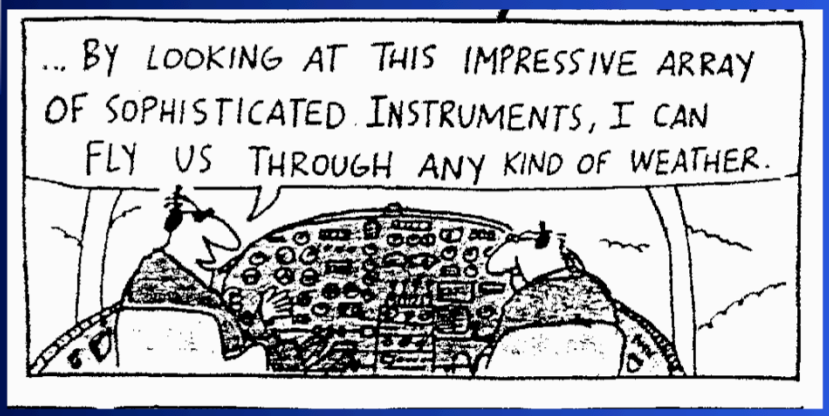

IFR Flying Defined:

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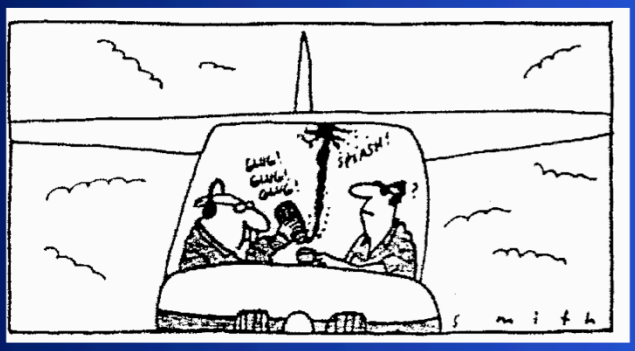
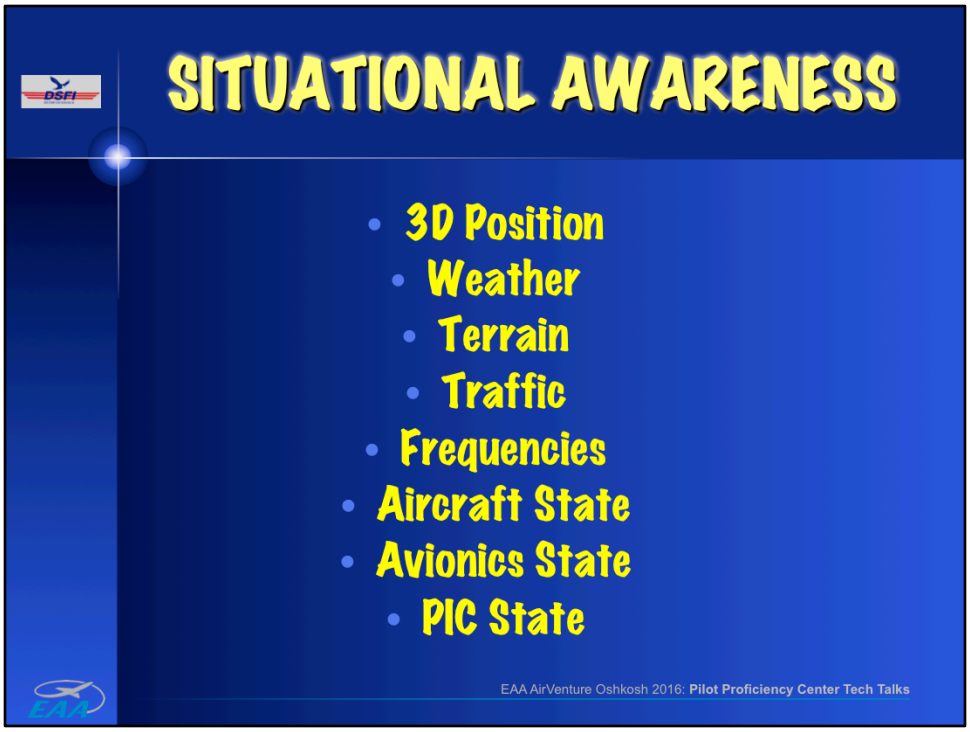
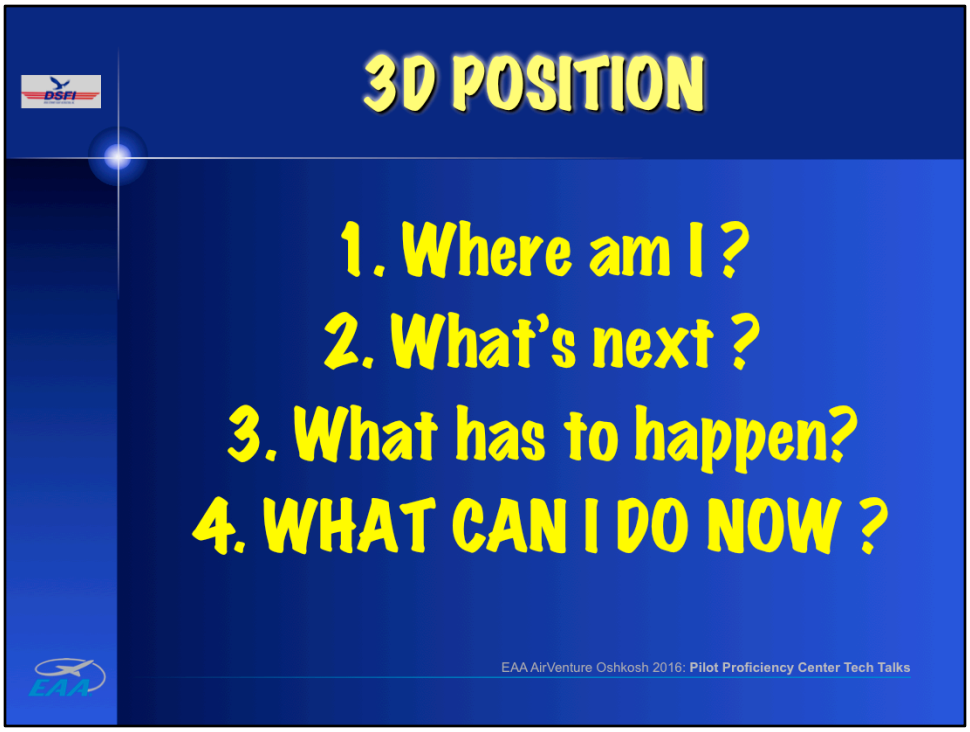
- Hours of boredom, punctuated by moments of sheer terror on either end!

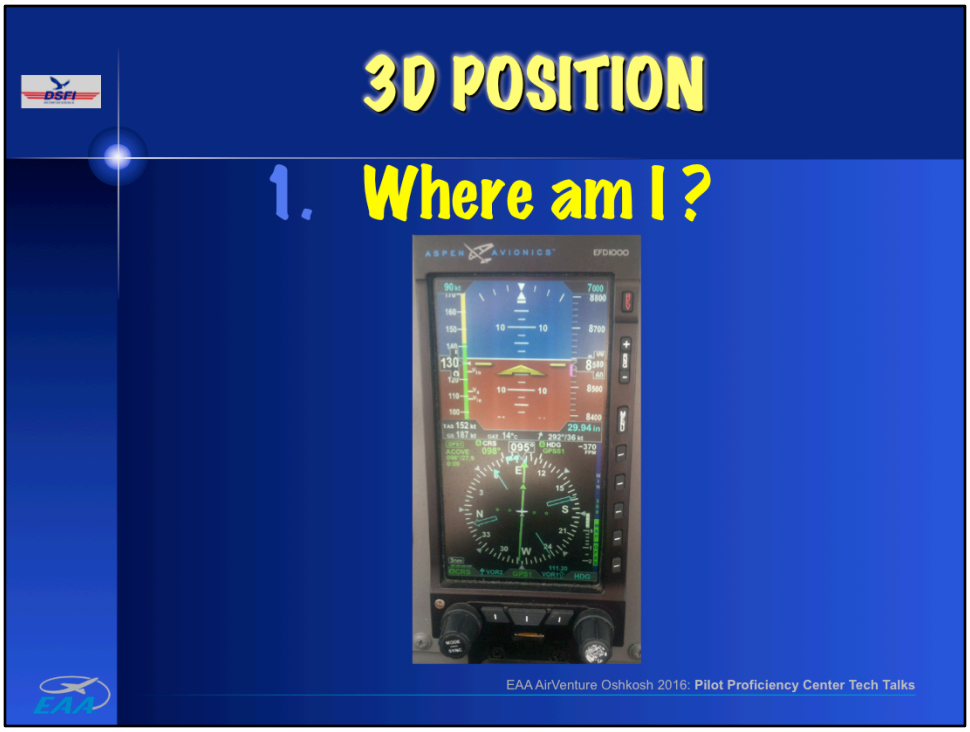




Situational awareness (SA) encompasses many different elements. It is not only about our three dimensional position, but also about our relationship to weather, terrain, traffic, ATC sectors, the state of our aircraft and avionics systems, and perhaps most importantly our own physical and mental state as pilot in command. In this seminar we'll discuss how having that awareness will allow us to stay ahead of the flight from the moment we start the planning until the aircraft has landed and it's back in the hangar.

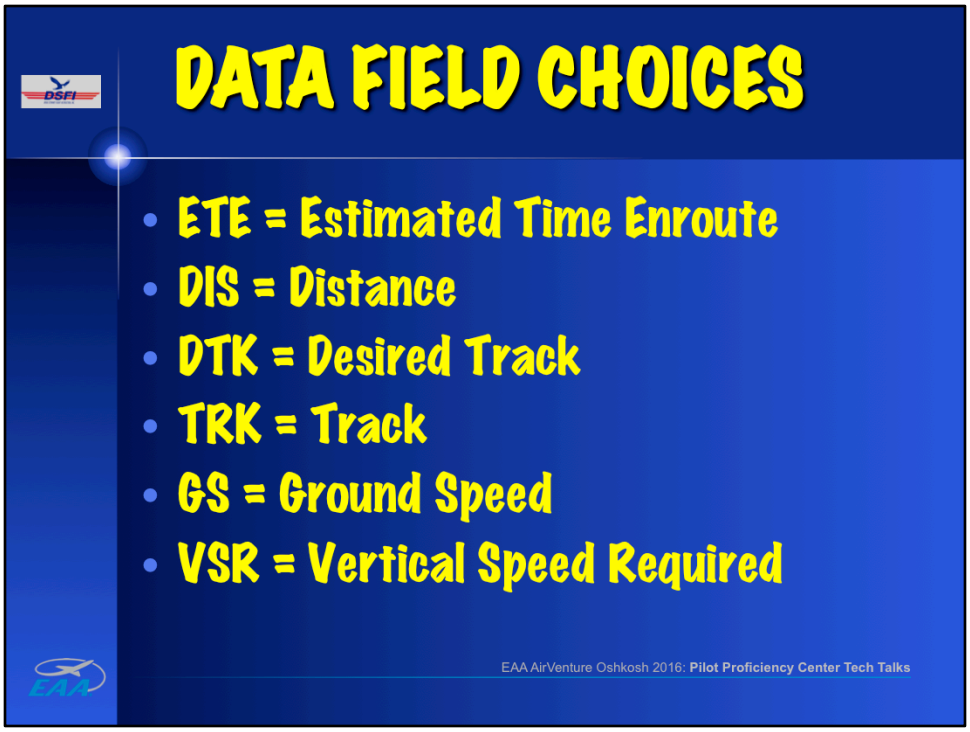


If we know our 3D position then we should also know what the next thing is that has to be achieved. It might be a level off from a climb or descent, or perhaps the start of either one; a turn at a fix; the interception of a course; a frequency change; a power and/or configuration change… the list goes on. And it's quite possible that several of these things might have to be achieved at the same time. Good SA will prepare us to be able to prioritize the proper sequence of what had to be done. Regardless of what it is that has to be achieved, if we don't know where we are it is likely that we will end up behind the airplane as we play catch-up making the changes.



SA relative our three dimensional position entails not only knowing where we are in a three dimensional sense, but also where we are going, what has to be done when we get there, and how we will achieve that.

In the Aspen display, information that is presented includes: Altitude and airspeed; the name of the fix to which I am headed; the course to get there; the distance and time to the fix; and further, identifies where I am through the use of not only the course arrow on the CDI, but the two bearing pointers tuned to VORs on either side of my course. Even if the GPS were to fail I would still know where I was through triangulation using the cross radials from the VORs as well as using those cross redials to determine an approximation of how far it was to the fix.



One of the most important data fields for me is the ETE. This is the information I need to be able to prioritize what I should be doing next. It might be that I have several minutes to brief an approach, or check the weather, but it also might be that I have just a few seconds before I will have to make a turn, or a power / configuration change.

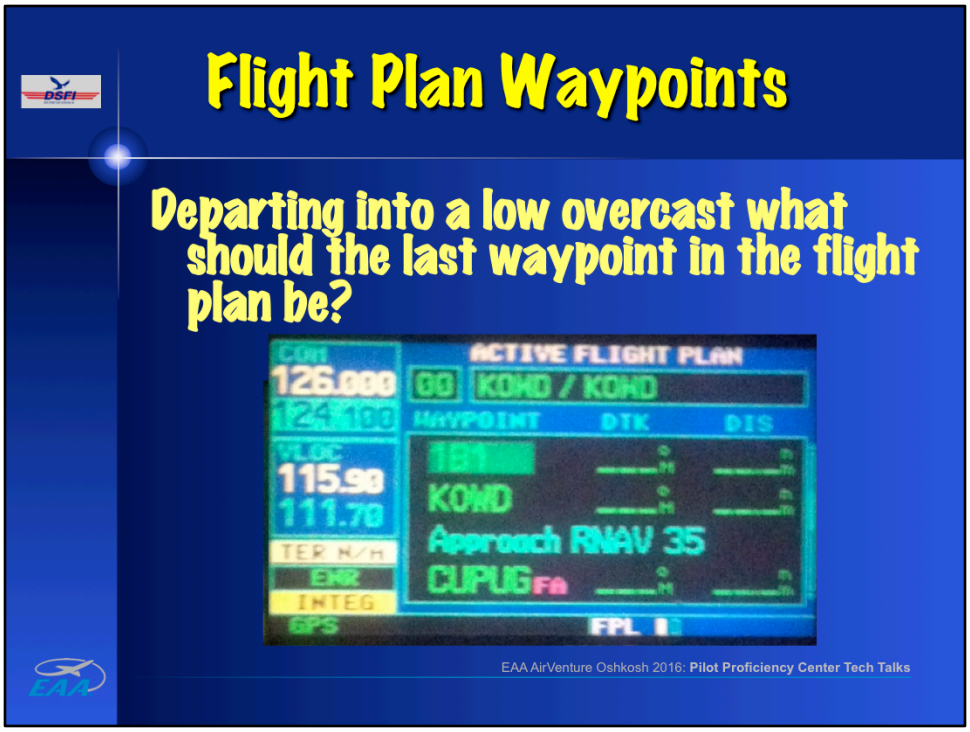
If the CDI needle is centered and the DTK and TRK are the same the CDI needle will not move. If on the other hand the DTK and the TRK are not the same the CDI needle will be moving, perhaps intentionally for an intercept, or perhaps unintentionally because you might have been distracted.

Since I am a right brain, numerically challenged person VSR makes descent planning a piece of cake for me.

Distance, combined with Ground Speed help me with a lot of SA analysis.

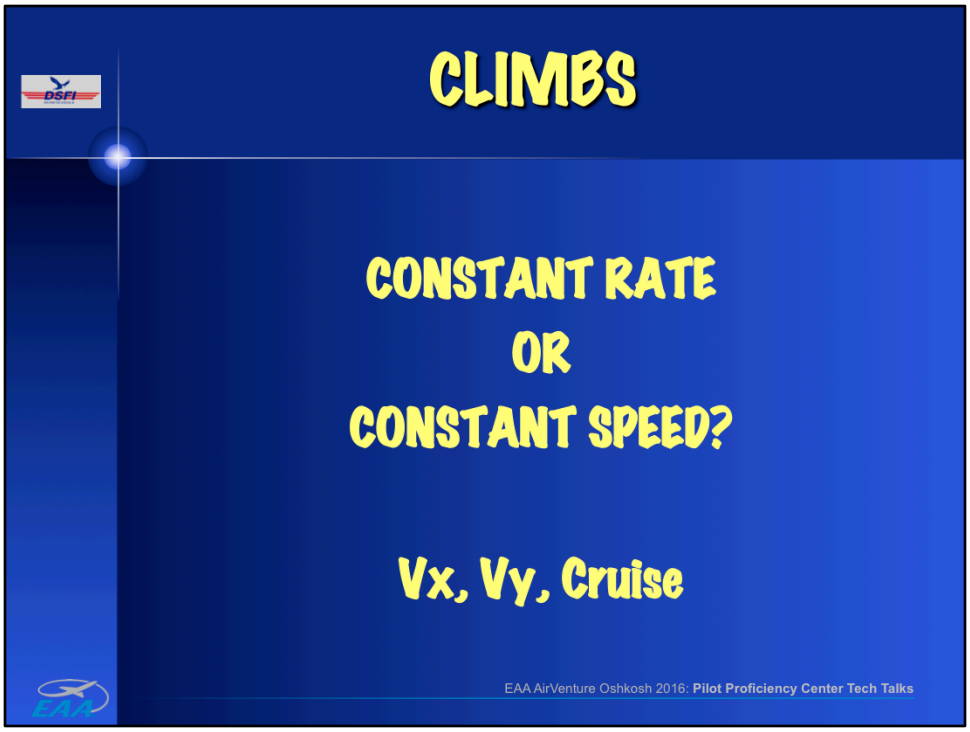
For more suggestions on Data Field usage see my suggestions in Max Trescotts book "GPS and WAAS Instrument Flying Handbook"

DATA FIELD CHOICES

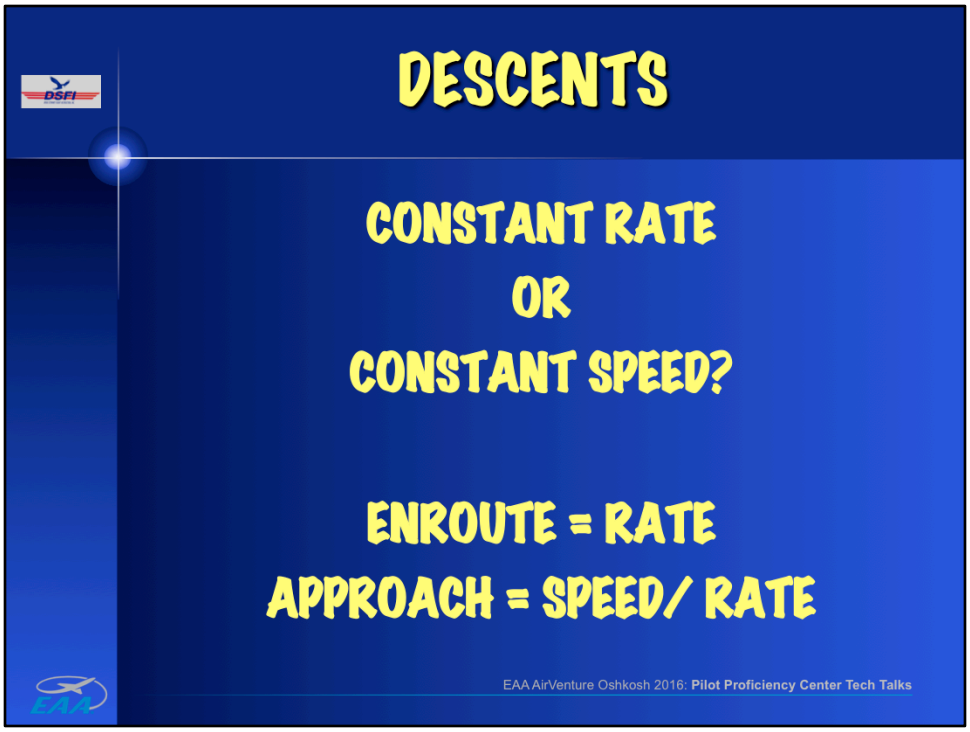


Whenever I am departing into IMC conditions I will always load an approach back in to my departure airport. Then in the event of an emergency or an anomaly I am already prepared for an immediate return with a push of the “PROC” button. If I were flying a slant A equipped (-/A) airplane I would have the LOC or VOR frequency set up in the standby of the NAV #1 receiver.

It is critically important for us to know the "numbers" of every airplane that we fly! What I mean by the "numbers" is that every combination of pitch, power and configuration will yield a known performance, be it a climb or descent at a rate and/ or speed, a cruise speed, or the bank angle required for a standard rate turn at any given airspeed. If we know these numbers we won't have to chase an airspeed, or rate of descent or climb. Set the "numbers" and you'll get the performance.

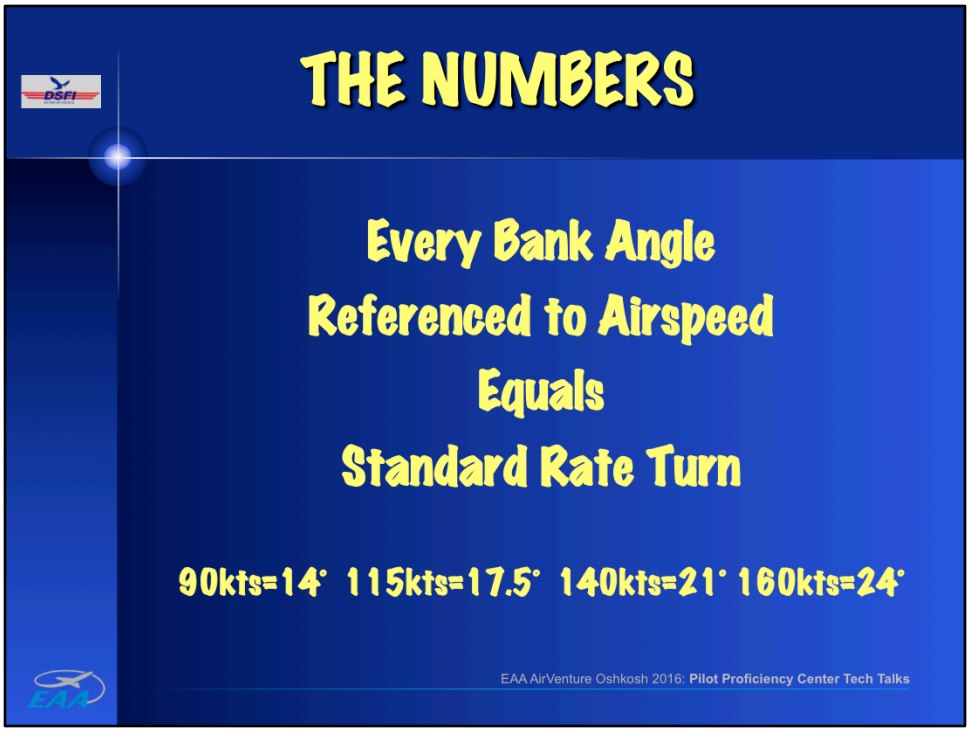


When it comes to climbs I always use full power. Since I know the speeds that will yield best angle (sometimes necessary for a crossing restriction on a SID), best rate (what I typically use for the first 1000' of climb, or if ATC requests my "best rate") and cruise climb (what I use for the vast majority of my climbs) all I have to do to achieve these speeds is set the pitch attitude. For example, in my Cardinal full power plus 12˚ of nose up pitch will yield my best angle of climb speed of 70 KIAS, 10˚ nose up yields best rate of 82KIAS, and 7.5˚ nose up yields my cruise climb of 90KIAS. So the bottom line is that virtually all of my climbs are constant speed. The speed will yield the desired rate (Vx, Vy, or Cruise).

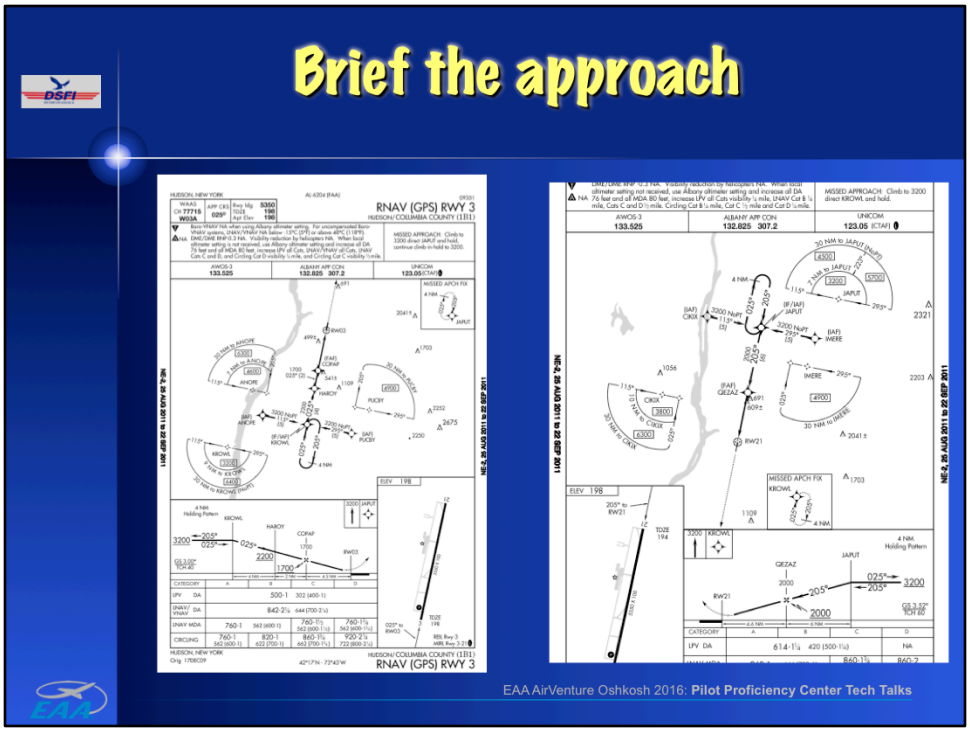


For enroute descents I always descend at a rate, not a speed. If ATC just says "descend and maintain…" I'll use 500FPM. I know that 2.5˚ nose down pitch will yield that rate. If they request me to "expedite my descent I'll pitch down 5˚ to yield 1000FPM. If they say "pilot's discretion" my SA will already know whether I want to start down immediately, and at what rate, or remain at my current altitude and determine not only when I want to start down but also at what rate. (I'll manage my speed on the descent with power, and typically above 6000' MSL I will have no need to adjust the power from my cruise setting unless turbulence requires a reduction of speed.) If descending to an initial approach altitude where I will want to level off at my approach speed I will manage my power, considering that I will gain 1" of MAP for every 1000' of descent, so that as I level off my power will already be at my requisite 20" to yield my known initial approach speed of 115KIAS.

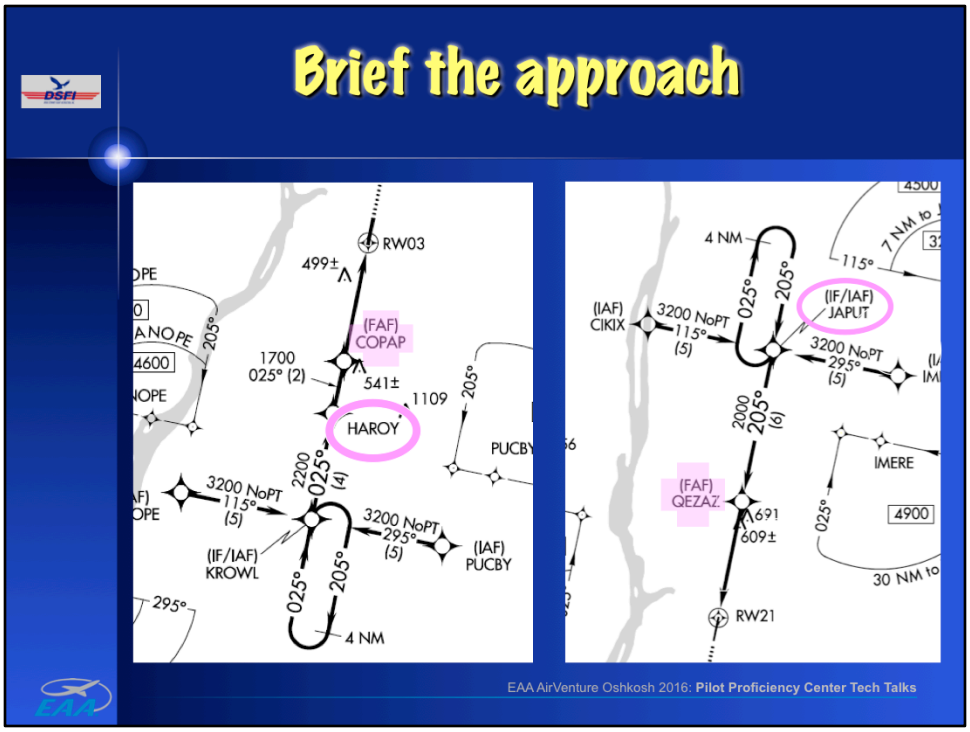
On approaches I will want to descend at my pre-determined approach speed, especially if timing is required (and rate if the approach has vertical guidance such as an ILS, LPV or LNAV+V.) Again I know the requisite combination of pitch, power and configuration (my gear comes down either at glide slope interception, or final approach fix) to yield a desired rate (which I have determined predicated upon my ground speed for the approach) AND constant speed.



For those pilots that fly with guidance from any of the Garmin IFR certified GPSs the algorithm built into the Garmin is designed so that it will compute the amount of time needed to transition from one leg to the next predicated on a standard rate (3˚ per second) turn. The bank angle required to turn at a standard rate is based entirely on the airspeed. So if you know the requisite bank, and you pay attention to your airspeed when the Garmin commands "TURN NOW", all you have to do is look at the attitude indicator and roll to the requisite bank. To nail the roll out heading plan to start the roll out (again at standard rate) when you have half the bank angle in degrees left to go to the required heading. Foe example if you're in a 14˚ bank, roll out 7˚ before the desired heading.

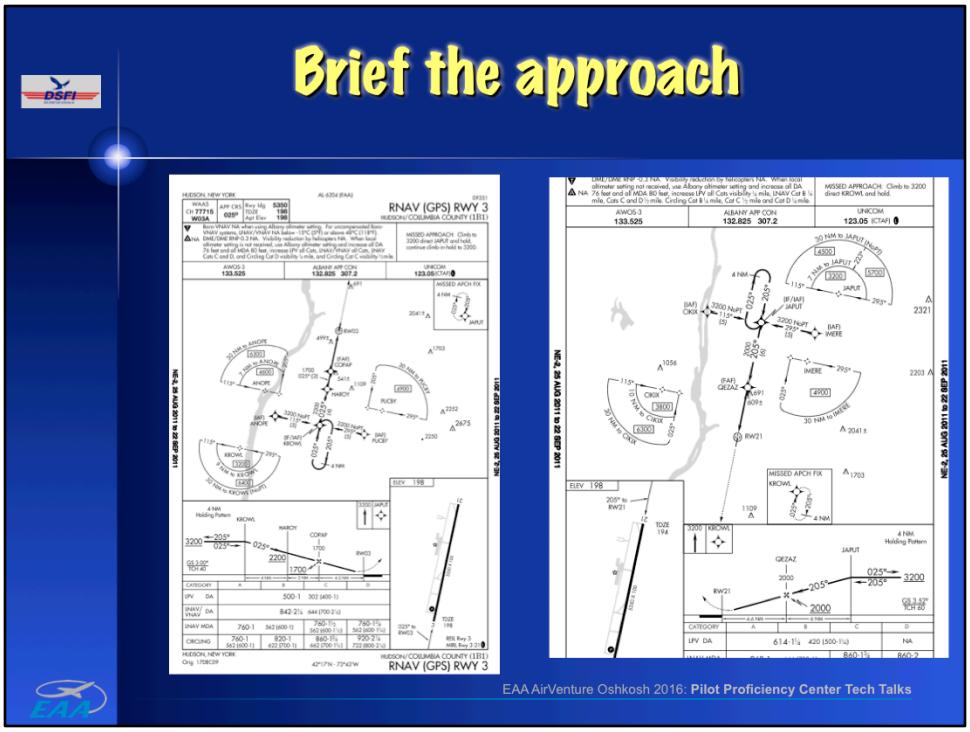


There are many resources available to pilots that discuss how to effectively brief the approach, They educate about the necessity of briefing frequencies, lateral plans and vertical profiles, along with the missed approach procedure. But hardly any of these resources (if any) incorporate SA into the briefing. The next 2 slides will discuss that.



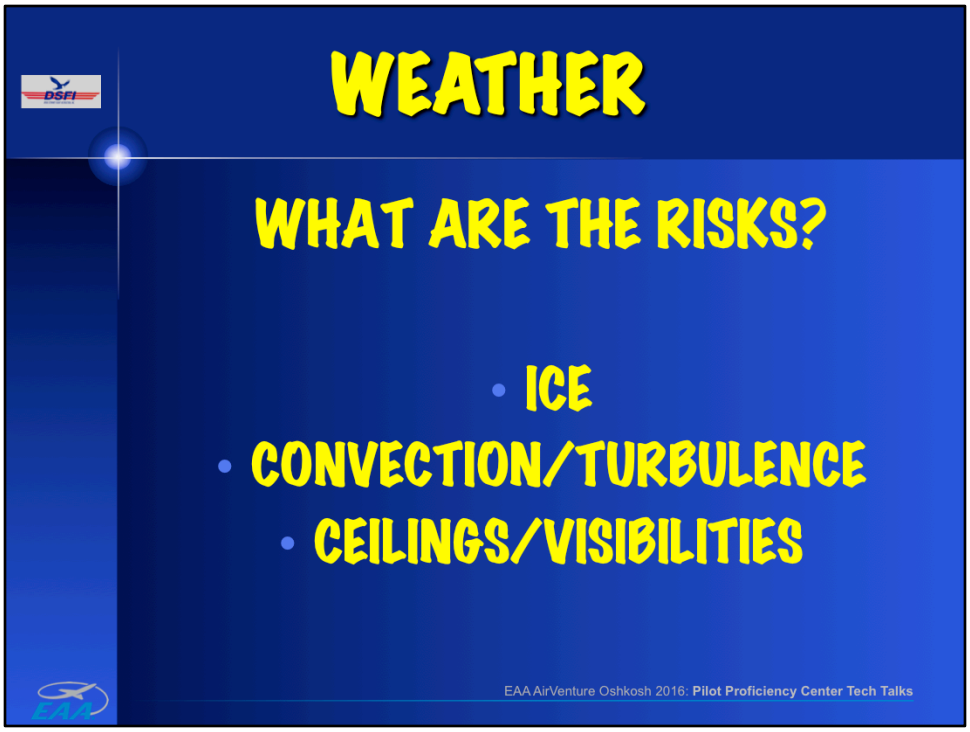
One of the most important pieces of information, relative SA, in flying a WAAS enabled approach is knowing when the GPS will switch from Terminal mode to Approach mode. **This occurs when the final fix becomes the active waypoint.** It is also when the vertical guidance for the approach will become available if there is sufficient RAIM. In the case of the RNAV 21 it happens as you pass JAPUT. In the RNAV 03 it happens as you pass HAROY.

When the final fix becomes the active waypoint the GPS will annunciate either: LPV; LNAV/VNAV; LNAV+V; or LNAV. (It might also annunciate APPROACH UNAVAILABLE) The importance of knowing when the change from TERMINAL mode to APPROACH mode occurs, is because it is at that point that the type of approach will be annunciated. You might have been expecting an 'LPV" and planning on maintaining your altitude until glide slope intercept. But if there isn't sufficient RAIM "LNAV" is annunciated and now you will have to commence a non-precision descent to the next step-down altitude.



In both of these approaches I want to slow to approach speed and initial configuration (110 KIAS and 10˚ of flaps in my C177RG) no less than a minute before crossing the IF.

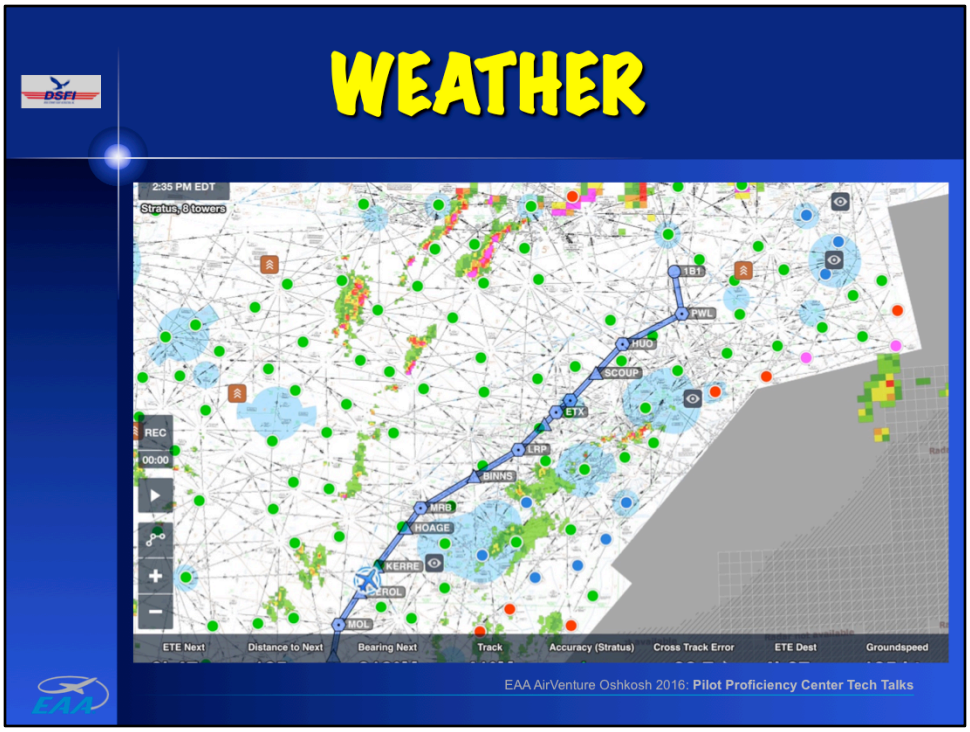
Let's say I'll be flying the RNAV 21 approach transitioning from the IAF of CIKIX. ATC will typically clear me to cross CIKIX at or above 3200'. Using the data fields (explained later in the presentation) of ETE and VSR I plan to reach 3200' 2 nautical miles before reaching JAPUT. I have managed my power in the descent so that as I pass through 4200' MSL my power has been set to 19" MAP. Thus as I reach 3200' MSL all I have to do is raise the nose to slightly above the horizon on the attitude indicator. My power will already be at 20" MAP and I know that the airplane will slow to my initial approach speed of 115 KIAS. I then add 10˚ of flaps which will slow me to 110KIAS .When the GPS annunciates "TURN NOW TO 205˚" I know that I will need a bank angle of 16.8˚ (close enough to call it 17˚) to get a standard rate turn. As I make the turn at JAPUT I watch to see whether the GPS annunciates LPV or LNAV (dependent upon RAIM) If it annunciates LPV I will be well below the glideslope and thus will maintain my altitude until GS interception. Intercepting the GS I will lower my gear, pitch nose down to 2.5˚, and reduce my power to 14" MAP which will bring me down the GS at 90 KIAS, 5 knots below the VFE of 95 KIAS for any flaps beyond 10,˚ if needed, for landing. If I don't have the runway in sight by the DA I will go missed approach by adding full power, pitching up 10˚, raising my gear, cleaning up flaps, TRIMING for the pitch, and climb out at my VY speed of 82 KIAS.



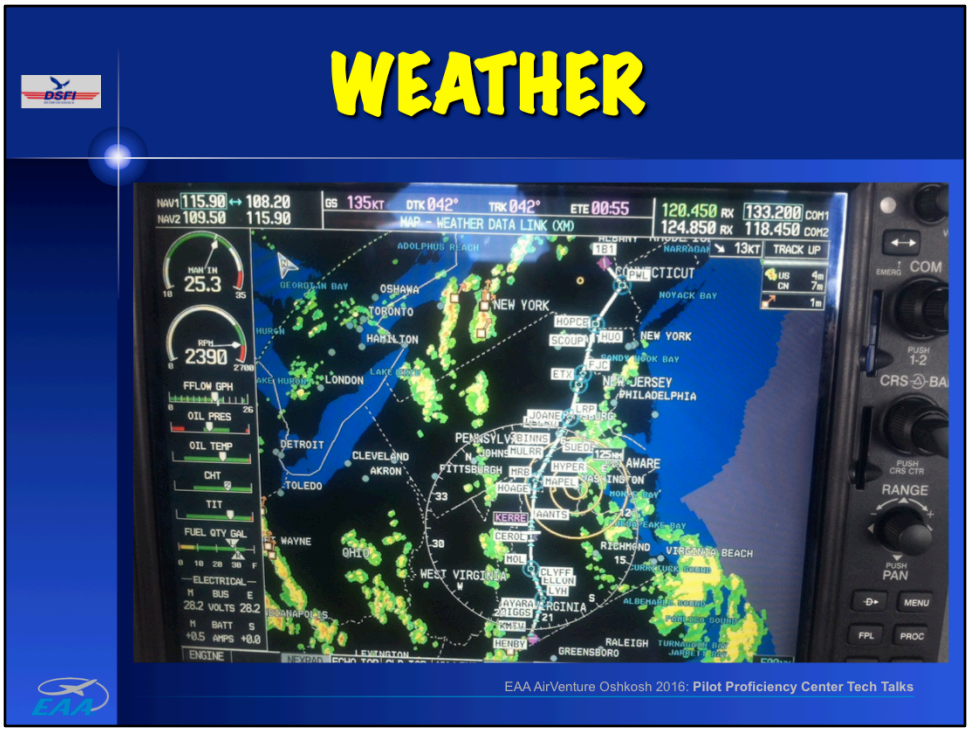
There are three main areas of risk related to weather when it comes to flying IFR: Ceiling and visibilities; convection; and icing. Our SA relative these three things begins before we ever get in the airplane. There are numerous internet and app resources that we can use to determine where and when these risk factors might impinge on our flight, and we can thus plan our route so as to avoid, or at least minimize, our exposure to these risks. However we are all aware that the weather is just like the opposite sex… totally unpredictable…and so it behooves us to constantly monitor the weather as we fly.

Before the days of data-link weather, and for that matter stormscopes and strikefinders, the best we could do would be to monitor ATIS frequencies along our route and see if the METARS were matching the TAFS. But now, with the vast amount of information we can get in the cockpit (WITIC – Weather-in-the-cockpit) there is no excuse to be caught unawares of what the weather is doing.

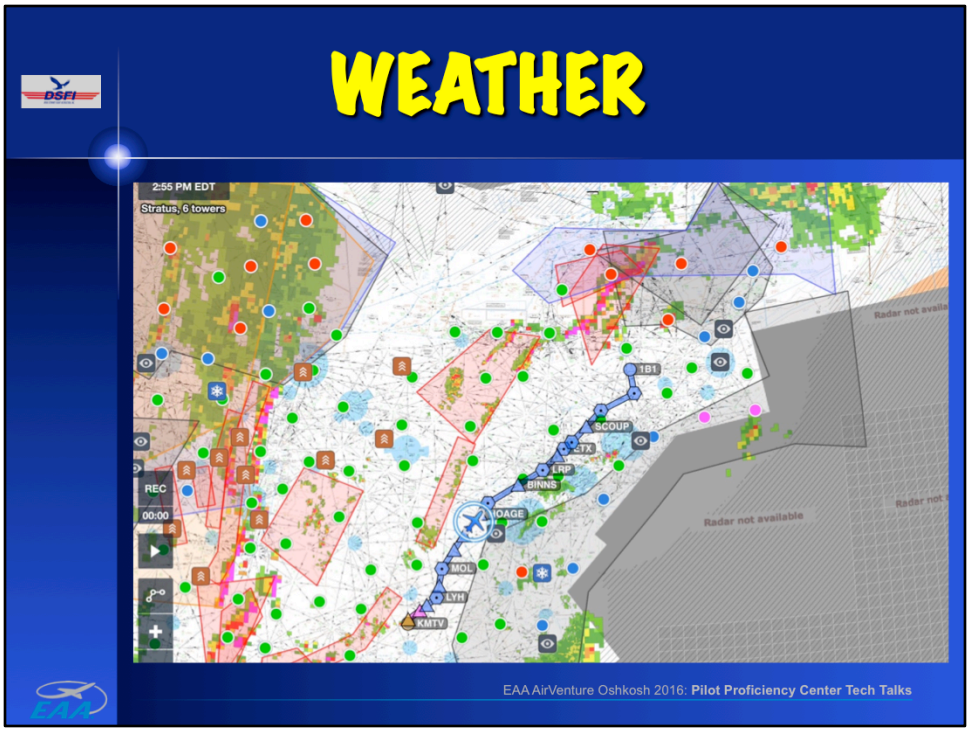
For me, as soon as I have leveled off and completed my cruise checklist, I start checking the weather. If the risk factor is convection, I'm looking to see where the convection is and determine if a strategic change of route is necessary. (Remember – the NEXRAD radar that we get in the cockpit is HISTORY, and NOT to be used for tactical decisions!!) If icing is the risk du jour, I'll be checking the temperature as I climb, cloud tops through datalink as well as PIREPS, not only for the cloud tops but for reports of icing. If ceilings and visibilities will be the challenge I'm constantly keeping an eye on that, always trying to be aware of where I will go in case of an



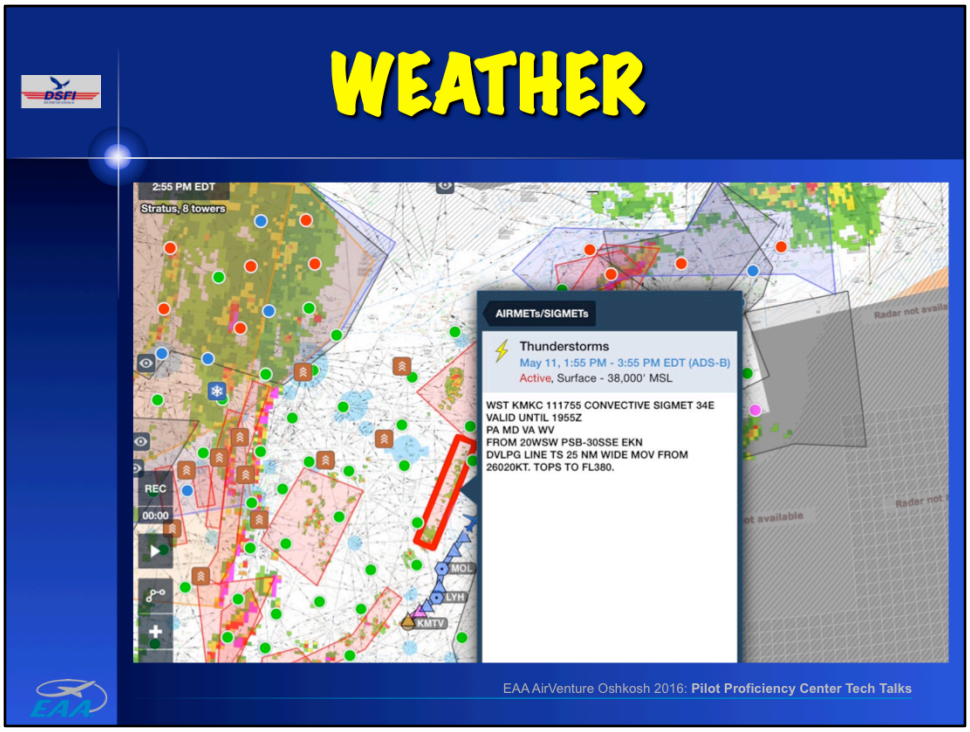
Two hours later we see that a couple of squall lines are forming to the northwest of the route, and that many airports are now reporting VFR conditions. (Remember that VFR per the icons only means ceilings of 3000' and visibilities of 5 miles. It still might be a solid overcast at 3001'.) There is also a PIREP of turbulence not too far east of my destination. (Of course checking that PIREP I might find that it was reported by a 737 at FL240 on descent into Boston and is really of no concern to me.) But we do see that the weather is changing and it will behoove me to not be complacent. Will those squall lines get to my destination before, after, or perhaps at the same time that I do?



This slide is XM weather as depicted in the G1000 weather display. Amongst other things, notice that the colors of the display are not the same as the ADS-B depiction. (We have to be aware that the dBZ representative colors are different between ADS-B, XM Weather, GARMIN radar, and internet radar.) XM weather also displays more products than ADS-B, including storm cells, which we see associated with the squall line. If we were to cursor to those cells we could determine their tops, direction and speed of movement, as well as dBZ reflectivity. For now it looks like they are paralleling my course, and I relax the pucker factor a wee bit.

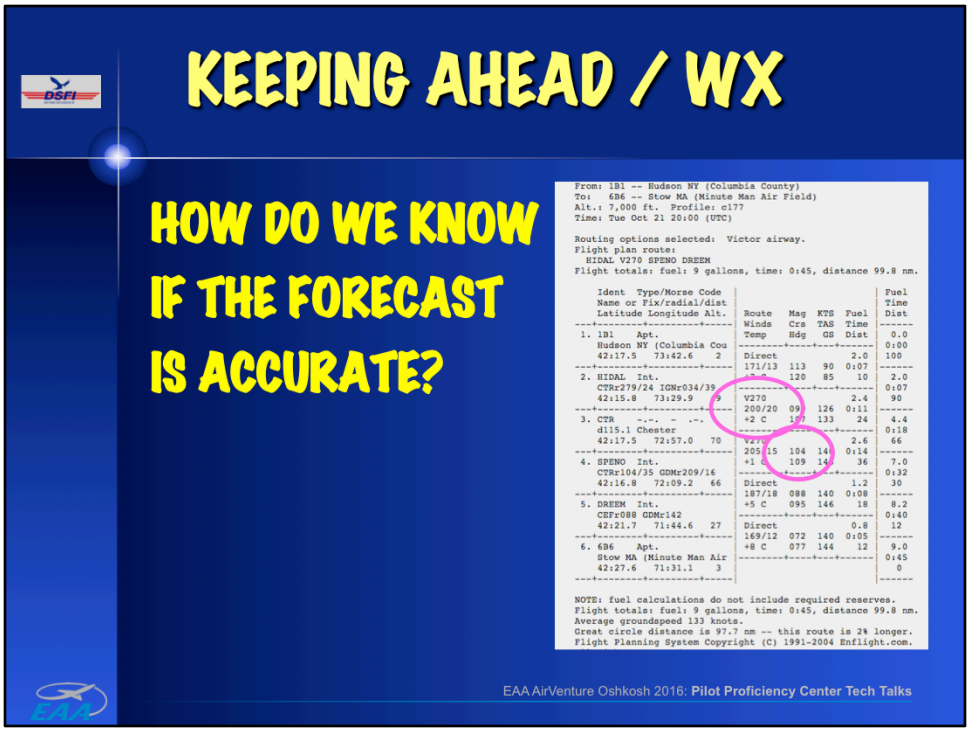


One half hour later we see that it's looking as if the convection will pass just to the north of my destination, but some convective sigmets have been issued, including one just to my west, although for now the nexrad radar isn't showing any convective activity.



Checking the SIGMET I see that there is a developing line of TSRA moving from the west at 20 knots. I should be able to outrun this squall line, but to be safe I check the "flight category" of the airports along my route and see that if there is the need for a precautionary landing, all the airports are reporting VFR.

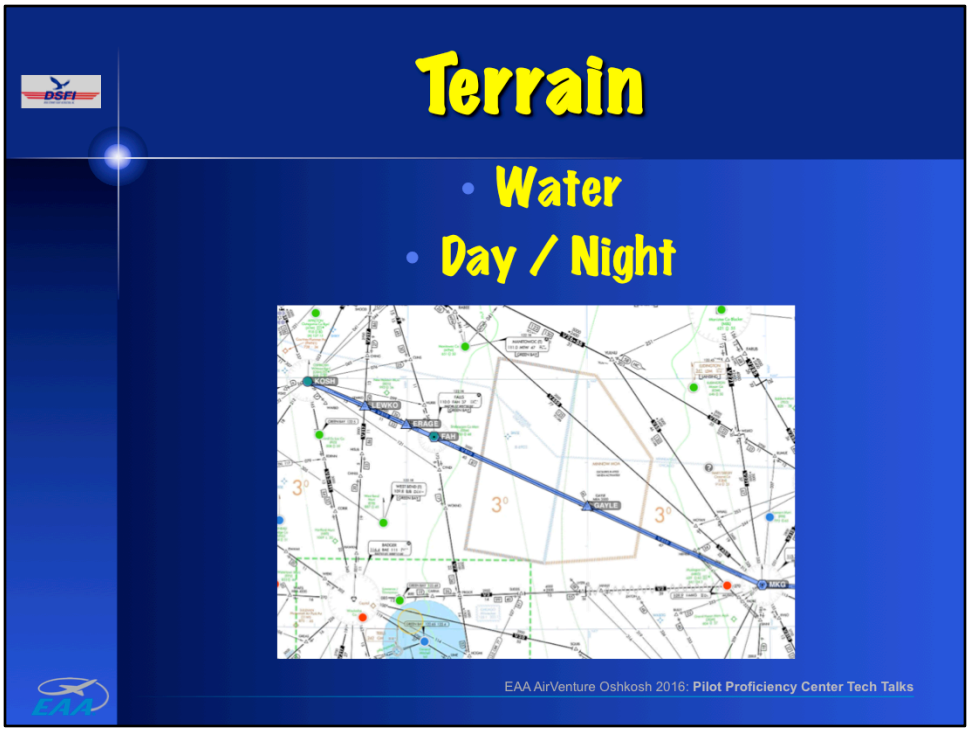
In an earlier era I would not have had all this information which allows me to continually assess the changing weather and modify my "escape" plans as necessary.



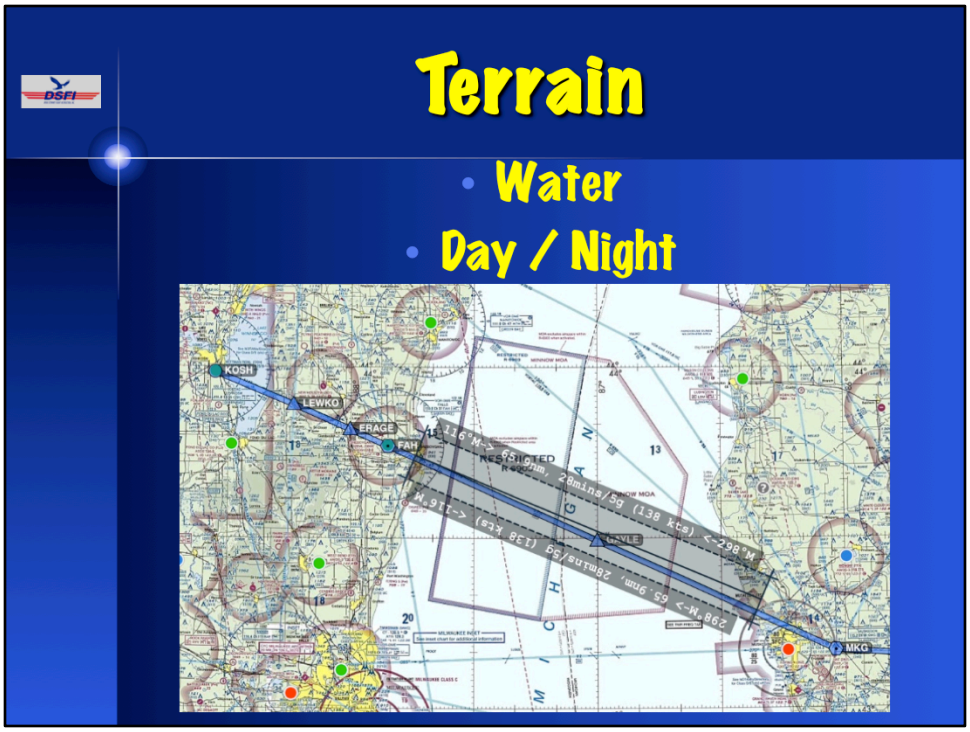
One of the important tools that I use to create SA of the accuracy of the forecasting is my flight log. The flight log provides me with what to expect vis-à-vis heading, ground speed, and temperature. These three things are determined by the expected winds aloft, which are forecasted, NOT guaranteed. The winds aloft forecast is based upon the predicted movement of fronts, and pressure zones. If these pressure zones don't move as expected then the overall forecast will not be correct.

So if I find that in order to accurately track a given course requires a heading other than what was planned, if the ground speed is different from what was expected, and / or the temperature is other that that which was forecast, we can probably assume that the overall forecast is wrong. This might mean that the TSRA that was not supposed to get to your destination until two hours after your planned arrival gets there at the same time that you do.

Thus if my planned heading, groundspeed, or temperatures are other than what I had planned I know that it is important for me NOT to be complacent, expecting the WX to be just as forecast, but to pay attention, perhaps even realizing the need to plan an alternate even though none had been required by regulation. However if we DON'T know what to expect for headings, groundspeeds and temps, how will we know if the forecast is holding true or not? Just askin'….



SA regarding the terrain over which we fly begins well before the flight begins. With the advent of tablet apps such as foreflight, once a route has been selected it is easy to toggle between enroute charts and sectionals to check the terrain. The following slides show “the r-e-s-t of the stowrey”.I am not saying that I would, or would not fly some of the routes in the slides. What I am saying is that every pilot has to determine the risk t imposed by the terrain upon the flight. In some cases the risk might be acceptably mitigated, and in some it might not. That becomes an individual decision. But to fly a route without giving any consideration to the underlying terrain is foolhardy. I will admit to flying over Lake Michigan enroute to and from Oshkosh, however I mitigate the risk to an acceptable level for myself by flying no lower than 8000’ MSL and carrying personal flotation devices.



This is a lot of cold water to overfly, and I've never seen any boats much farther than 10 miles offshore. Does that pose a risk you are willing to take?

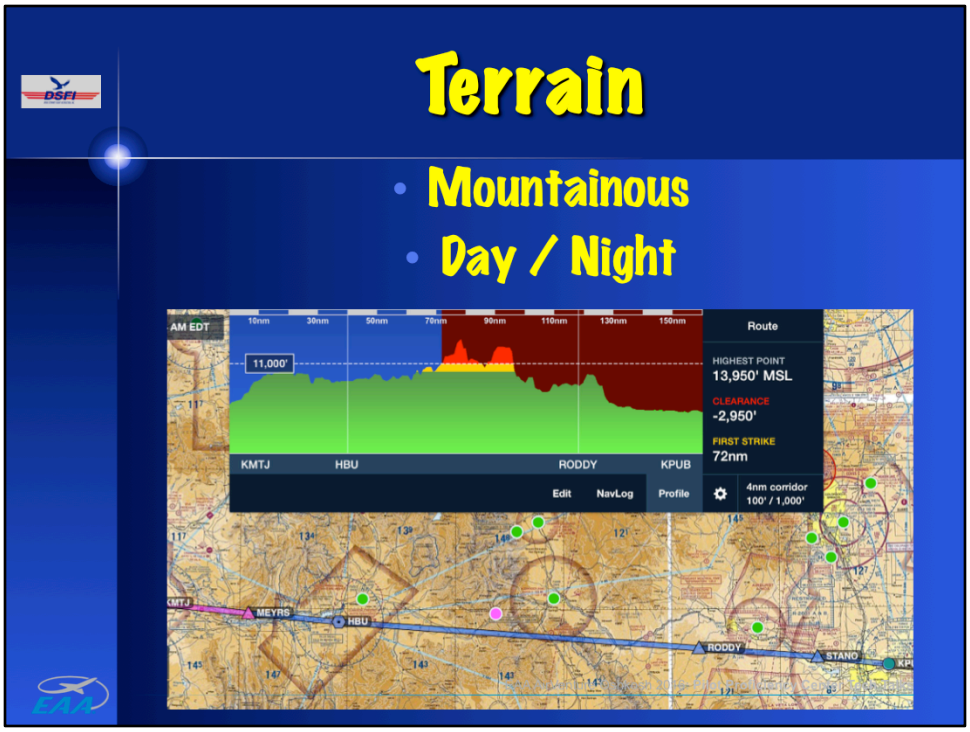
Terrain

- Desert
- Day / Night

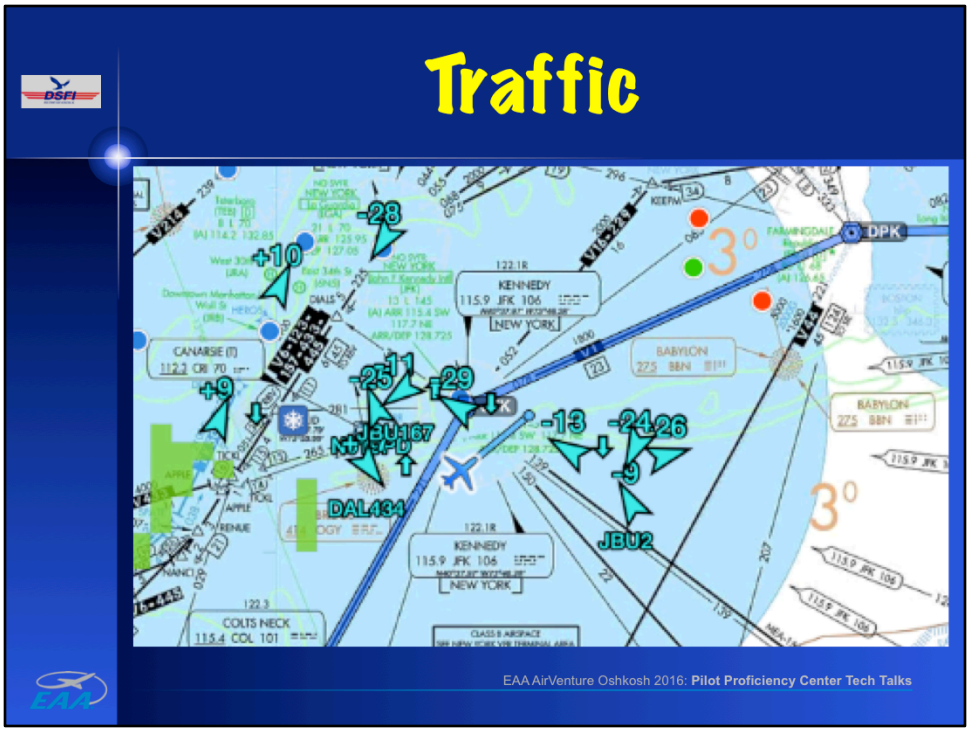
The desert doesn't often have LIFR, but even in CAVU conditions choices for off airport landings are not all that great. Whereas I might accept the IFR routing during daylight hours, at night I want to fly IFR as in **I F**ollow **R**oads

Terrain

- Mountainous
- Day / Night



MEAs and OROCAs should protect us from CFIT, but do you consider the possibility that in icing conditions a descent to escape the ice might not be possible?



I think we all are aware that when in VMC conditions “see and avoid” becomes our responsibility. But we also need to be keenly aware that ATC can reduce separation minimums once a pilot has stated “traffic in sight”. Do you consider this if you lose the traffic you at one time had “in sight”.

Also be aware that there are only two replies to ATC calling traffic. They are either “traffic in sight” on “negative traffic”. I so often hear pilots saying “looking” but consider this… ATC certainly hopes you are “looking”, otherwise they wouldn’t bother calling the traffic. Have you ever heard a pilot respond with “not looking”? DUH! What they want to know is whether you SEE the traffic, or not. “Looking” doesn’t help ATC! Either: “TRAFFIC IN SIGHT” or “NEGATIVE TRAFFIC”.

It is rare, (although not impossible) for an airplane system to fail without giving some kind of warning. Thus it is critically important that you include a scan of engine and fuel gauges as part of your scan. With the advent of electronic engine monitors it is now possible to monitor many different parameters in one or two gauges. (This is the panel of my C177RG.) For example my EDM 700 engine monitor provides: EGTs; CHTs; Oil Pressure and Oil Temperature; Voltage; Rate of CHT cooling; and Temperature spread between individual CHTs. My FS450 provides fuel information, including: fuel burn in GPH; fuel remaining, fuel used; fuel required to the next fix; fuel remaining at the next fix; how much time remaining until empty (at current rate of fuel burn), and MPG (miles per gallon). I am keenly aware that the fuel monitor is a "garbage in – garbage out" type of instrument and thus it is critical for me to ensure that the data entered into the monitor is accurate. These two instruments, the EDM700 and FS450 are an important part of my "scan"!

With the G1000, or Avidyne Integra, system monitoring is taken to an even higher level and many different parameters can be monitored and managed.

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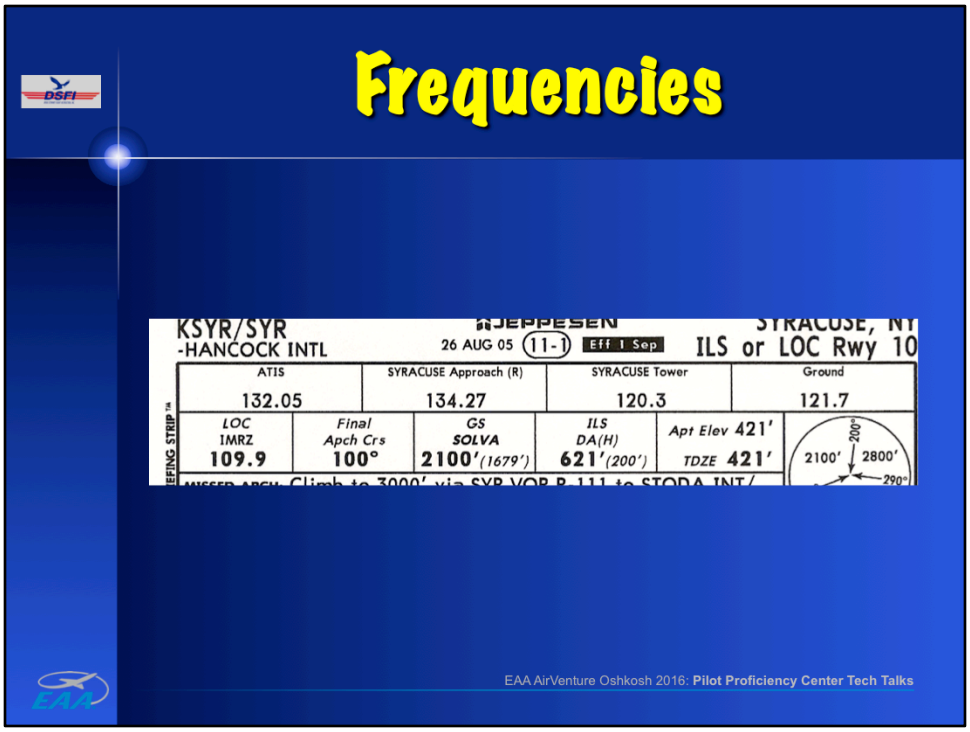
There are many ways to manage the radios. If you have a system that works… terrific.I won't necessarily tell you to change it. FWIW, here is how I set up my radios, along with the reason why. (If I don't provide the reasons for why I do things, then how are you to decide if it will work for you?)

For me, Comm #1 is for ATC. What I mean by this is that I will use Comm #1 to contact: Tower; Departure; Center; Approach; and the Unicom CTAF. That's all! I use Comm #2 for all other frequencies: ATIS /AWOS/ASOS; Clearance Delivery; Ground Control; FSS; and Unicom (for non-CTAF calls).

The reasons: The main reason I set my radios up this way is so that I can monitor the AWOS (if flying in to a non-towered airport) while still transmitting and receiving on the CTAF. It will also allow me to check the ATIS if it changes after I have contacted either the final approach controller or tower. I have witnessed pilots who use both Comm #1 and Comm #2 for ATC get thoroughly confused, and forget which radio is the "active" radio, or even lose a frequency when switching from one radio to the other (as opposed to merely swapping between standby and active frequencies in one radio.)

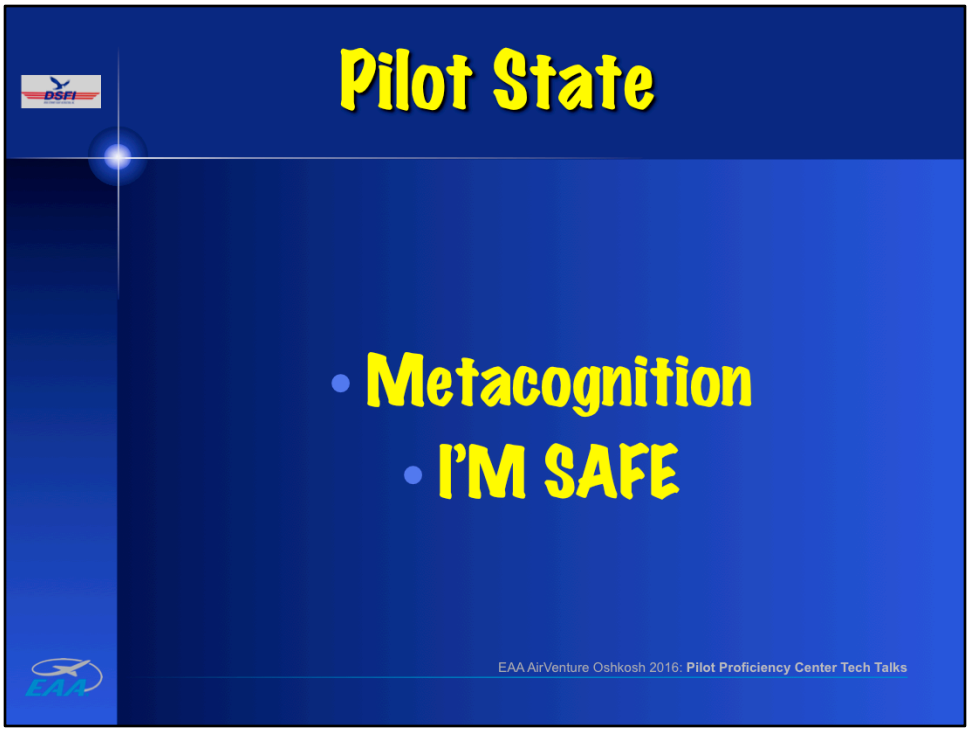


There are many resources from which we can stay ahead on our frequencies, regardless of whether they might be on paper on an approach plate, an airport information plate, the AFD, enroute charts, etc., or electronic through our GPS or tablet app. As stated earlier, if we know where we are, then part of knowing “what’s next” includes frequencies. Have you loaded the next frequency into the standby? More on this in a couple more slides…

The audio panel is the management “headquarters” for all the radios. If you own your own airplane you probably know your audio panel and it’s proper operation. But if you are a renter pilot it’s quite possible that you might find an audio panel in an airplane with which you are not familiar. Whereas the operating principles of these devices is similar, their actual operation is not. If you find an unfamiliar audio panel in a rental airplane get a few minutes of dual instruction in it’s use, rather than blasting off, thinking you’ll figure it out “on the fly”. It could save your life!

More critical than the management of the avionics and audio panel, is the requisite knowledge to manage the autopilot. Even for owner pilots mismanagement of the autopilot can get a pilot in serious trouble, not only with the FAA (as in an altitude bust… "but I set the altitude in the altitude pre-select…") but perhaps with an unrecoverable loss of control. (Autopilots set for a rate climb have flown an airplane right into a power on stall…) I think it should be obvious that a pilot should be intimately familiar with the autopilot before flying in IMC. But that is not the focus of this presentation.

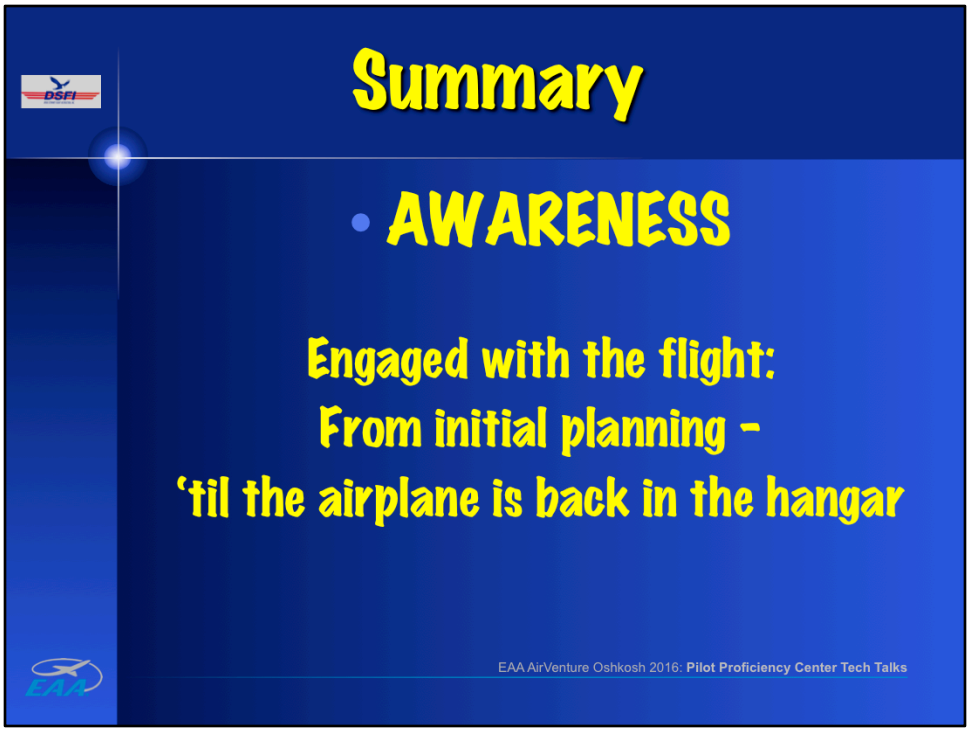
Regarding SA and autopilot use, the autopilot annunciator is your friend. Every time you push a button on the AP controller do you check the annunciator to ensure that it is annunciating what you thought you had commanded your autopilot to do? Failure to do so might lead to a pilot deviation and a trip to the local FSDO, or worse, a Flight in to CFIT. Particularly when you are setting your autopilot to capture an approach course or an altitude. Checking the AP annunciator could save your butt in more ways than one.



The last piece of equipment which we must keep tabs on is perhaps the most important piece, and that's us… the pilot! I suspect every pilot is familiar with the "I'M SAFE acronym: "Illness; Medication; Stress; Alcohol; Fatigue (also Food and Water); and External Pressures (not to mention internal pressures as well… hydration management is a double edged sword) so I won't go into that.

But the term metacognition might be new to you. What it means is: being aware of and understanding one's own thought processes. When we are flying we not only have to monitor our physiological state (I'M SAFE does that…) but just as importantly we have to monitor our mental state. It is very easy to lapse into thinking about anything but the flight not that long after completing one's cruise checklist, especially if the autopilot was coupled up prior to going through the checklist. We are all so susceptible to thinking about things like: the interview you are flying to conduct; the award you just won; the argument you had with a boss, spouse, or child; etc.; etc. What becomes critical is that as soon as you realize / recognize that you haven't been involved with the flight for the last 10 minutes that you get right back to; assessing "where am I? – what's next?"; how's the engine doing?; how much fuel do I have left?; etc.; etc.

In the utopian society described in Aldous Huxley's book "Island" there are parrots inhabiting the island that have been trained to constantly say: "Be here now!… Pay



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In the utopian society described in Aldous Huxley's book "Island" there are parrots inhabiting the island that have been trained to constantly say: "Be here now!… Pay Attention!, Be here now… Pay Attention!". As pilots I think we need a metaphoric parrot sitting on our shoulder reminding us to stay engaged with the flight from start to finish (at least I know I could use one.)**. This is perhaps the biggest key to maintaining situational awareness. We have to stay engaged with the flight, the weather, the terrain, traffic, frequencies, the aircraft and avionics systems, and our**

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