Flight Advisor Corner by Hobie Tomlinson

July 2011 **Human Factors, Part VIII**

As we continue our series on "human factors," we now want to take a look at ***"Automation"*** and ***"Risk Management"*** as additional critical components in our accident prevention strategy.

The Old "6-Pack ~ Steam Gauge" Panel vs. the New PFD Panel

Figure 7-2 ~ FAA-H-8083-2

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In General Aviation (GA) an automated aircraft is generally considered one in which an advanced, integrated avionics system is installed. Advanced, integrated avionics systems consist of a **P**rimary **F**light **D**isplay **(PFD)** in front of the pilot and a **M**ulti**f**unction **D**isplay **(MFD)** located in the center instrument panel. In aircraft, which have redundant systems, one PFD is located in front of each pilot, while a single (or dual) MFD(s) is (are) located in the center instrument panel.

The PFD typically incorporates both an **A**ir **D**ata **C**omputer **(ADC)** and **A**ttitude **H**eading **R**eference **S**ystem **(AHRS)** and replaces the typical "6-pack" of instruments (Airspeed Indicator, Attitude Indicator, Altimeter, Turn Coordinator, Heading Indicator, and Vertical Speed Indicator) found on the older, classic "Steam Gauge" panels. Most systems also incorporate Trend Vectors, a Ground Track Cue, with more modern systems also providing Synthetic Vision and a Flight Path Vector Cue: The PFD provides the pilot with the following information:

- **Airspeed** is displayed on a vertical tape located in the top left of the PFD screen. When the airspeed is changing, a magenta trend vector appears, indicating the magnitude of change which will occur in the next few seconds at the present pitch/power combination. When the airspeed is constant, the magenta trend vector will disappear from the screen. Selected airspeeds (i.e. Vr, Vy, etc.) are able to be electronically set, which marks them with labeled pointers (or "bugs").

- **Attitude** is displayed in the top center of the PFD with the following enhancements:
  - **Turn Coordination** is displayed by a small white bar under the bank pointer which will displace to the left or right (just like the ball in a turn coordinator) to indicate any existing yaw or uncoordinated flight
  - **An inverted, magenta "V-Bar" symbol"** appears just above the yellow airplane symbol when the flight director is selected. Flying these two symbols "in-formation" provides flight director guidance cues to the pilot. These are the same cues which the autopilot system uses, but the flight director provides these cues visually to the pilot in the form of an inverted, magenta "V-Bar." Thus by flying the airplane symbol "in-formation" with the inverted, magenta V-bar, the pilot can manually fly the aircraft while still using the computed autopilot flight path cues.
  - **A green "airport" symbol** on the PFD (behind the attitude indicator) displays the actual flight path vector of the aircraft. This is where the aircraft is actually going under the current pitch-power and heading-bank conditions. (When the green "airport" symbol is superimposed on the white horizontal line, the aircraft is actually in level flight; irrespective of its pitch attitude. When the green "airport" symbol is superimposed on the runway, the aircraft is actually tracking toward the runway; irrespective of its heading.)

- **Altitude** is displayed on a vertical tape located in the top right of the PFD screen. The system allows a pre-selected altitude to be set in the window located above

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the altitude tape, which will then provide altitude alerting functions to the pilot. When the altitude is changing, a magenta trend vector appears that shows the amount of altitude change, which will occur in the next few seconds, at the current rate of climb or descent. When the altitude change stops, the trend vector will disappear from the screen. Most systems also allow the "minimums" altitude for an instrument approach to be preset and provide either a visual warning or both a visual and oral warning when that altitude is reached.

- **Vertical Speed** is displayed on a second tape, located just to the right of the altimeter tape. On some systems the vertical speed is only displayed whenever it is greater than 100 fpm, then when the vertical speed is reduced to below 100 fpm, the vertical speed tape disappears from view.

- **Heading** is displayed on a **H**orizontal **S**ituation **I**ndicator (HSI) located under the attitude indicator in the lower center of the PFD. A heading trend vector line appears in the direction of turn whenever the aircraft is turning. This trend vector line indicates the heading that the aircraft will reach in the next few seconds at the current rate of turn. When the heading stabilizes, the heading trend vector line disappears from view.

- **Navigation** data is displayed in the HSI and can be selected to display either GPS computed course data (displayed in magenta on single system and in yellow or white on a dual system) or ILS/VOR course "raw" data (which is always displayed in green). The navigation "data source" is also displayed on the PFD.

- **The HSI** can be selected to display either the traditional full 360 degree compass rose or an abbreviated compass rose showing only the top portion (usually 120 degrees). The HSI also typically displays a magenta-diamond "Ground Track" Cue, which displays the actual ground-track the aircraft is following. Turn the aircraft such that the ground-track cue is superimposed over (on top of) the selected course line and – presto – the aircraft stays on-course.

- **A Wind Vector** arrow is usually displayed on the PFD near the HSI compass rose. This Wind Vector arrow aligns with the wind direction (points toward the direction the wind is blowing to) with the wind velocity (in knots) displayed at the top of the wind vector arrow display.

- **Flight Director/Autopilot** status messages are displayed above the attitude indicator in the top-center portion of the PFD. "Armed" modes of the Flight Director/Autopilot are displayed in white, while "Engaged" modes of the Flight Director/Autopilot are displayed in green. As the Autopilot always flies (follows) the Flight Director "Command Bars," the only difference in annunciation when the autopilot is engaged (vs. just the Flight Director being engaged) is the green "AP" annunciation displayed in the top-center of the PFD.

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- **The Yaw Damper** is an independent, single-channel autopilot which is only connected to the aircraft rudder. Its sole function is to react to and prevent aircraft yaw. Its primary purpose is to counteract adverse aileron yaw and to improve the aircraft's longitudinal stability in turbulence. Because all aircraft autopilot systems (with the exception of sophisticated "Auto-Land" Systems) are two-axis systems (utilizing ailerons and elevator to control the aircraft flight-path), the yaw-damper function provides a smoother ride by eliminating aileron induced, adverse yaw. When the Yaw Damper is engaged by itself, a green "YD" annunciation is provided in the top-center of the PFD. Because autopilot engagement always engages the Yaw Damper, the green "YD" annunciation is replaced by a green "AP" annunciation whenever the autopilot is engaged.

- **The Air Data Computer** (ADC) constantly monitors the existing pressure altitude and temperature. It computes True Airspeed (TAS) and Static Air Temperature (SAT), which is the actual free air temperature. Ram Air Temperature (RAT) or Total Air Temperature (TAT) is the actual air temperature sensed by the aircraft and is the temperature which is displayed on an uncompensated air temperature gauge. The ADC computes the SAT by adjusting (subtracting) the compression heating effect generated by the aircraft from the sensed RAT (or TAT). The SAT and RAT (or TAT) temperatures values are then displayed to the pilot on either the PFD or MFD. The ADC also converts the analog pressure data from the Pitot tubes and static ports to digital information which can be displayed on the PFD.

- **Attitude Heading Reference System** (AHRS) uses small electronic sensors to feed acceleration data to a computer chip which then computes attitude and heading information for the PFD. This system must be allowed to "align" to the center of the earth (while the aircraft remain stationary) before being useable. Because this system is totally electric, the nemesis of the "steam gauge" panel (a vacuum pump failure) is now a non-event. Most automated aircraft have a second alternator/generator for this reason.

- **Synthetic Vision** displays a three dimensional view of the current terrain outside the aircraft in the PFD (rather than a "flat" earth background). This display will turn terrain that is too close to the aircraft's altitude yellow and then red, as the terrain begins to exceed the aircrafts existing altitude. Most systems also provide an audio warning when red terrain is displayed at close range. This system generates a terrain display from a terrain database chip, which requires periodic updating to remain current. This **T**errain **A**lerting and **W**arning **S**ystem (TAWS) is a very important safety system in preventing **C**ontrolled **F**light **I**nto **T**errain (CFIT) accidents.

The MFD typically incorporates an instrument-certified **G**lobal **P**ositioning **S**ystem **(GPS)** which provides navigation data by displaying the aircraft's programmed flight plan ground track. (Outside of United States airspace, GPS systems are known as GNSS – **G**lobal **N**avigation **S**atellite **S**ystems.) The programmed flight plan ground track is

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displayed on the MFD in white (at various, selectable ranges) and includes all waypoints on the programmed route. The active waypoint (the waypoint to which the aircraft is proceeding) and its associated ground track to that waypoint is displayed in magenta. (GPS systems always fly a great circle route to a waypoint; however, unlike VOR navigation, GPS systems never navigate away from a waypoint.) The newest aircraft's MFDs also incorporate **C**rew **A**lerting **S**ystems **(CAS)** to textually display any associated Red Warning messages, Yellow Caution messages and White Status messages to the pilot(s). Other MFD functions are to display engine instruments and aircraft system status (i.e. fuel, electrical, hydraulic, flaps and gear position, etc.) In addition, the MFD will display textual flight plan progress data, geological features, airspace boundary information, traffic information, terrain graphics, uplinked XM weather graphics, instrument approach charts, as well as providing XM radio programs.

Collins PFD & MFD ~ F/O Panel ~ during CL604 North Atlantic Crossing

Figure 2 ~ Hobie Tomlinson Image

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Contrary to Popular Belief, flying aircraft equipped with the new **E**lectronic **F**light **D**isplays **(EFDs) –** i.e. PFDs & MFDs – requires the same attention as flying aircraft equipped with the older analog instruments and conventional avionics suites.

The standard rules for using EFDs are as follows:

- **Always be able to manually fly the aircraft** to the standards of the appropriate Practical Test Standards (PTS). Although this may seem to be an insignificant item, acquiring and maintaining the necessary stick-and-rudder skills to manually fly the aircraft to the industry accepted standard provides pilots with necessary confidence in their abilities, makes their airmanship smoother, and frees up their mental processing ability to attend to the required automated systems tasks. Without these necessary skills, pilots find themselves needing the majority of their cognitive ability just to control the aircraft.

- **Read and understand** the installed electronic flight system's manuals to include the use of the autopilot and other onboard electronic management tools.

- **Adhere** to the AFM/POH procedures.

It is important for pilots to maintain their flight skills. Pilots need to retain their ability to maneuver the aircraft manually within the industry accepted standards which are set forth in the appropriate FAA PTS. Maintaining your flight skills requires that the automation be occasionally disengaged to enable you to manually fly the aircraft. This regular practice of your stick-and-rudder skills will go a long way toward your ability to maintain an acceptable level of pilot proficiency. Even the major airlines have recognized the need to allow their crews to manually practice flying instrument approaches in good weather, while still using the autopilot to fly approaches in poor weather. The strategic use of the autopilot to reduce the crew's workload in poor weather allows the crews adequate time for the improved flight progress monitoring that poor weather requires, while still providing them a means to maintain their flight proficiency by manually flying the approaches during the good weather days.

This seems like a good breaking point for this month. Next month we will continue with ***Automation*** by looking at some of the **Automation Skills and Procedures** necessary for automations proper use.

The thought for this month is as follows: In a letter written to his father ***Wilber Wright*** made the following statement: ***"In flying I have learned that carelessness and overconfidence are usually far more dangerous than deliberately accepted risks."***

So until next month, be sure to **Think Right to FliRite!**

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