Flight Advisor Corner by Hobie Tomlinson

August 2011 **Human Factors, Part IX**

This month we will continue with ***Automation*** by looking at some of the **Automation Skills and Procedures** necessary for automation's proper use.

Advanced Avionics offer multiple levels of automation from strictly manual flight to highly automated flight. While aviation organizations label automation levels slightly differently, some using three levels of automation while others use four levels of automation. Typically, I categorize them into the four following levels of automation:

- **Raw Data** is when the aircraft is being flown manually without the use of either the autopilot or the flight director. With the more modern systems, the "Ground Track" Queue and "Flight Path Vector" Queue still display and can be used much like a flight director to maintain the desired ground track or flight path. In the raw data mode the aircraft is typically being navigated either by visual reference to the ground or by ground-based navigation signals (i.e. VOR, LOC, or ILS), hence the term "Raw Data." Ground-based navigation signals are typically displayed in Green on the Electronic Flight Displays, thus the term "Green Needles."

- **Basic Automation** is when the aircraft either is being flown manually by using the Flight Director commands or is being flown on the autopilot by using the pitch or roll modes of the autopilot to direct the aircraft's flight path.

- **Intermediate Automation** is when the aircraft is being flown on the autopilot while using specific autopilot modes (i.e. Heading, Vertical Speed, Flight Level Change, Altitude Hold, etc.) to control the flight path.

- **Advanced Automation** is when the aircraft is being flown on the autopilot while inputting all flight path requirements through the Flight Management System (FMS). When using advanced automation, the autopilot is usually engaged in the NAV (navigation) and VNAV (vertical navigation) or ALT (altitude hold) modes. Very advanced systems with auto-throttles will also control the aircraft's speed via FMS commands or the "Speed Set" knob on the autopilot mode control panel.

While No Single Level of automation is appropriate for all flight situations, it is important to know how to manage the course deviation indicator (CDI), navigation source, and the autopilot in order to avoid potentially dangerous distractions. It is also important to understand the peculiarities of the particular automated system you are currently using to ensure that you know what to expect, how to monitor it for proper operation, and to have the ability to promptly take the appropriate corrective action should the system not preform as expected.

Raw Data Flying ~ Piper J3 Cub

Wikipedia Image

<u>At the Most Basic Level</u>, this means knowing at all times what autopilot modes are engaged (Green Autopilot Mode displayed in the top of Primary Flight Display – PFD), and what autopilot modes are armed to engage (White Autopilot Mode displayed in the top of PFD). It is important to verify that the armed (white) functions (i.e. NAV, ALT, etc.) engage (turn green) at the appropriate time. Automation management is a very good place to practice verbalization of autopilot modes, both when they are selected (armed - white) and when they engage (turn green). This is especially true when arming the system to make a change in course or altitude, and it is a good habit to cultivate, even when flying single pilot

<u>Proper Automation Management</u> also requires a thorough understanding of how the autopilot interacts with the other aircraft systems. For example, with some autopilots, changing the navigation source on the Electronic Horizontal Situation Indicator (e-HSI) from GPS to LOC or VOR while the autopilot is engaged may cause the autopilot's NAV mode to disengage. In this case the autopilot lateral mode defaults to "Roll" mode and has to be reselected back to NAV. (In the Roll mode the autopilot will simply maintain a "wings level" condition unless the turn controller is moved out of the neutral detent to turn the aircraft.) This issue does not occur on a more modern autopilot system when "auto-transferring" from GPS navigation to LOC navigation. Another example of autopilot mode default is when the altitude selector is changed during the autopilot's altitude capture process. This will cause the Altitude mode to default to the Pitch mode. (In the pitch mode the autopilot simply maintains the existing pitch attitude, unless the autopilot pitch wheel is moved out of the neutral detent to change the pitch of the aircraft.) Lastly, changing the primary source information for the autopilot (i.e. Attitude input) will typically disconnect the autopilot.

<u>Enhanced Situational Awareness</u> typically occurs with automated systems, which can offer increased safety. Although aircraft flight manuals (AFM) explicitly prohibit using the multifunction displays of topography, terrain awareness, traffic, and weather data-link as primary data sources, the information displayed still provides unprecedented situational awareness information. The downside of all this information is that without a well-planned information management strategy, it is easy to allow yourself to drift into the complacent role of passenger-in-command!

In-Flight Risk can be increased by failing to monitor automated systems. When you fail to monitor the automated systems and/or fail to check the results of the selected inputs to the automated systems, you can easily become detached from the aircraft's operation.

This type of automation complacency/dependency led to the iconic 1999 American Airlines accident in the Colombia, South American Andes. In this accident, the crew accepted a last minute change to their expected approach at the destination airport. In their rush to reprogram the B757's automation, they missed the fact that they had directed the aircraft to proceed toward an incorrect waypoint. This caused the aircraft to deviate from the intended flight path while the crew was expediting their descent into the destination airport. This deviation caused the aircraft to fly into an area of much higher terrain – which when combined with the expedited descent – caused the aircraft to experience a CFIT (Controlled Flight Into Terrain) event resulting in the loss of all onboard.

Even though the pilots were equipped with the proper charts and had all the tools necessary to manage and monitor their flight, they allowed themselves to become rushed and defaulted into allowing the automation to fly and manage itself. The pilots had created their own hazard by failing to properly manage and monitor the autoflight system.

What is notable about this accident is that the pilots self-induced their own hazard though their inattention and distraction. When they failed to evaluate the turn made by the aircraft – after the incorrect waypoint was entered – they maximized their risk, instead of minimizing it. An avoidable accident became a large tragedy through a simple pilot error caused by rushing, complacency, and distraction.

A Good Process for maintaining situational awareness and proper information management includes practices that help ensure that awareness is enhanced – not diminished – by the use of automation. Two basic procedures for insuring that situational awareness is maintained are to *always double-check all system entries* and to *make verbal callouts of all autoflight mode changes* – even when flying single pilot. At the very minimum, ensure the navigation presentation always makes sense. Was the correct destination/waypoint entered into the navigation system? Callouts (verbalization) of all autoflight mode changes – even for single pilot operations – are an excellent way to maintain situational awareness and manage information.

Other Ways to maintain situational awareness are as follows:

- **Preform a Verification Check** of all programming while still at the ramp and *before starting to taxi* the aircraft. *Distracted taxing leads to runway incursions!*

- **Check the Flight Routing** before departure to ensure that all programmed routing matches the planned – or actually cleared – routing. Print a paper copy of your planned flight routing and use this copy to verify what has actually been programmed in the autoflight system. If they do not match, double check the autoflight entry, do not automatically assume the FMS computer data is correct.

- **Verify** all entered waypoints

- **Make Use** of all onboard navigation equipment. (I.e. backup GPS data with VOR information and vice versa.)

- **Match** the use of automated systems with an equivalent level of pilot proficiency. ***Do not allow*** *confidence in automated systems to lull you into exceeding your personal – or the aircraft's – limitations!*

- **Plan Realistic Routings.** Although very long, direct routings are possible; inserting intermediate waypoints will dramatically improve situational awareness while enroute.

- **Always Verify** all autoflight computer data entries. Incorrect keystrokes made during high workload periods may go undetected and introduce navigational errors unless the data is continually verified.

Autopilot Systems can greatly reduce pilot workload – especially during single pilot operations. The result is to free pilot attention for other flight deck duties, to improve situational awareness, and to reduce risk of a controlled flight into terrain (CFIT) accident. The real safety challenge comes in maintaining operational safety should the autopilot become inoperative. Proper risk management would dictate that any single pilot flights undertaken with an inoperative autopilot be limited to DAY-VFR. Should the autopilot fail inflight – during single pilot IFR-IMC operation – proper risk mitigation would be diverting to avoid Low-IFR approaches and high density traffic areas. If an IFR – or high traffic density – flight needs to be made with an inoperative autopilot, a good risk mitigation strategy would be to arrange for a second pilot to accompany you on the flight, which would keep the pilot workload within acceptable boundaries.

Familiarity with all onboard equipment is critical in optimizing safety and efficiency. Unfamiliarity with autoflight systems will add to pilot workload which may contribute to a loss of situational awareness. This level of proficiency is critical enough to be looked upon as a requirement. Unfamiliarity should be considered a hazard with high risk potential. Self-discipline is the key to success.

Respect for Onboard Systems is also critical to success. A proper understanding of the systems is essential to obtaining the benefits which the system can offer. Understanding the onboard systems leads to a respect which is achieved through cockpit discipline and mastery of the installed systems. It is also very important to be able to adequately fly the aircraft without being completely dependent on the automation, PFD and/or MFD.

Reinforcement of Onboard Systems occurs as competency improves with understanding and practice. While computer-based software and incremental training provides initial knowledge, actual in-flight practice is required to gain experience. This reinforcement yields dividends in both automation use and workload reduction.

Moving Beyond Rote Workmanship is the key to effective automation use. Whenever a pilot has to analyze which key to push next – or always uses the same keystroke sequence – he may be trapped in a rote process. Mechanical processes indicate a shallow understanding of the system. Being able to operate the system with competency and comprehension provides great time benefits when situations become more diverse and pilot tasks increase.

Understanding the System is important because automated aircraft require the same monitoring attention as analog aircraft. Pilots need to be able to fly the aircraft to the standards of the PTS. This allows for smoother flights and allows more time to attend the system, rather than managing multiple tasks. It is important to read and understand the installed system manuals as well as adhering to all AFM/POH procedures and limitations.

Automation Management skills do not negate the need to know how to fly the aircraft. Maneuver training still remains an important component of flight training in aircraft with automated systems because over 55 percent of all GA accidents still happen during the relatively unautomated takeoff and landing phases.

Advanced avionics systems tend to embolden pilots who can develop an unwarranted overreliance in the automated systems in their aircraft and begin to believe that this "technology fix" provides the "magic bullet" which will compensate for their piloting shortcomings. The biggest safety deficiency in GA, high performance aircraft – used for cross-country flying – still remains poor Aviation Decision Making (ADM). A recent NTSB study on the relative safety of "glass cockpit" aircraft determined that poor ADM seems to afflict pilots of technically advanced aircraft (TAA – i.e. glass cockpit) at a higher rate than the GA rate as a whole. The review of TAA accidents cited in this study showed that the majority were not caused by something directly related to the aircraft, but by the pilots lack of experience combined with a chain of poor aviation decisions. A consistent theme – for both VFR and IFR rated pilots – is continued VFR flight into IMC conditions.

Pilot skills for normal and emergency operations rely not only on proficient mechanical manipulation of the "stick and rudder" controls, but also on mental mastery of the Electronic Flight Display (EFD). The three key flight management skills required to fly TAA aircraft safely are *information management*, *automation management*, and *risk management*.

Information Management seems an overwhelming task to the new pilot transitioning to a TAA. The PFD (primary flight display), MFD (multifunction display) and GPS navigator screens seem to offer unlimited information presented in colorful menus and submenus. It is helpful to remember that these systems are similar to computers in that they store some folders on the desktop and some within a hierarchy system.

The primary information management skill for flying highly automated systems is to ***understand the system at a conceptual level***. Remembering how the system is organized helps manage the available information. The rote learning of "knob-and-dial" procedures is inadequate for safe operation of these aircraft. Learning how advanced avionics systems work leads to better memory of their procedures and allows the solving of problems which have not been encountered before. Due to the limits of understanding, it is probably impossible to understand all the behaviors of a complex avionics system. Knowing that surprises are to be expected and being willing to continually learn new things about the system is far more effective than attempting to memorize the mechanical manipulation of knobs and push-buttons.

The second critical information management skill is to sense what is going on. Pilots new to automated systems tend to become fixated on the knobs and push-buttons and try to memorize every data input sequence. A far superior technique for accessing and managing the information available is to just stop, look, and read the information presented. Actually reading the presented information before pushing, pulling or twisting the knobs and buttons can usually save much time and trouble.

The third required information management skill is the ability to actually manage and prioritize the information flow in order to accomplish a specific task. An important aspect of this task is corralling the information. This can be accomplished by tactics such as configuring the PFD and MFD screens according to your personal preferences. This would include such items as configuring for "track up" (my preference) or "north up," displaying a full compass rose, or just an "arc" view (top 120 degrees of the compass rose), and using either a single queue (v-bar) or a double queue (cross pointers) flight director.

It is important to manage the information flow for each specific operation. Pilots need to have the ability to prioritize the information for a timely display of the information required by the task at hand. Some specific examples of managing the information display for a specific operation are as follows:

- **Programming map scale** setting for enroute operations versus terminal area operations. (One of the failures which led to the infamous "destination overfly" event by an airline crew was the loss of situational awareness because the MFD moving map display was left at an inappropriately large scale setting.)
- **Using Terrain Display** on the MFD during night or IMC flight in mountainous terrain.
- **Using Nearest Airport Display** on the MFD during night or IMC flight over inhospitable terrain.
- **Programming Weather Data-link** to display weather echoes and METAR status flags on the MD.
- **Programming Traffic Information** to display on the PFD (or MFD).
- **Programming the MFD** to display Situational Awareness items such as airports, VORs, geopolitical boundaries, TFRs, airspace boundaries, available fuel range, etc.

- **Maintaining an Appropriate Balance** between eliminating excess MFD "clutter" and displaying the information which is relative to the flight segment.

- **Keeping the MFD Range** appropriate to the phase of fight (i.e. Terminal, Enroute or Approach).

This looks like a good place to break for this month. Next month we will pick up with ***Risk Managemen****t* and then take one last look ***Aviation Decision Making*** (ADM).

The thought for this month is as follows: **"If all else fails, immortality can always be assured by spectacular error!" `** ***John Kenneth Galbraith, Economist.*** So, until next month, be sure to **Think Right to FliRte.**

Advanced Automation Flying ~ G1000 Equipped DA-42

Wikipedia Image DA-42 Twin Starr (N49494) based @ KBFI (Seattle, WA) - Photo by Matthew Piat

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