

# Beyond the Buttons:

## Mastering Our Marvelous Flying Machines

story and illustrations by Susan Parson

Once upon a time, every office had a simple, practical machine called a typewriter. It took a little time to learn the basics of the QWERTY keyboard, but mastery of the machine was still a straightforward mechanical matter. Then along came progress in the form of computer-based "word processing." The computerized word processor could do much more than the humble typewriter....but it took longer to learn, and document creation was no longer a simple matter of typing in Pica or Elite. Instead, we had to learn to manage information, make the automation obey our wishes, and cope with the unintended consequence of seeing easier changes (anybody still remember White-Out?) lead to more changes. Nay-sayers abounded, but resistance to computerized word processing was ultimately futile. We have all been assimilated.

So what does office technology have to do with aviation? More than you might think, because a similar technological transition is occurring in the general aviation world. The simple six-pack of round gauge instrumentation is rapidly losing ground to the sleek and shiny new world of glass cockpit avionics that "boot" rather than "start." As with word processing programs, it takes longer to learn to fly these planes. However, their systems can do a lot more for the pilot. In fact, for pilots schooled in the traditions of stick-and-rudder for the basics and needle/ball/airspeed for instrument flying, it may still feel a bit like "cheating" to relinquish so much of the traditional piloting workload to a computer. What these pilots may not recognize is that accepting help on mundane tasks, such as keeping the wings level, gives them more time to spend

on important decision-making tasks, like evaluating weather and considering alternatives. Those who invest the time and money to truly master glass cockpit aircraft will find that they have a lighter workload.

What does it take to be pilot-in-command of a glass cockpit aircraft? Just as the advent of word processing technology taught us that the mechanical mastery of the QWERTY keyboard was necessary but not sufficient, the rapid rise of glass cockpit avionics is showing us that pilot skills for both normal and emergency operations must include not just mechanical manipulation of stick and rudder, but also the mental mastery of three key flight management skills: information management, automation management, and risk management. Let's take a look.

### Information Management

One of the axioms of aviation training is that the volume of information presented is akin to drinking from a fire hose. Pilots making their first acquaintance with glass cockpit avionics can fervently relate: the primary flight display (PFD) and multi-function display (MFD) screens are chock-a-block with information, colors, menus, and sub-menus. There is so much to see that a new glass cockpit pilot can easily be drenched in data, but still thirsty for useful knowledge (e.g., how to find a specific piece of information).

The foundation of glass cockpit information management is to understand the system at a conceptual level. In the Garmin G1000™, for example, information is organized in "chapters" and "pages" that are identified in text at the top and by symbols at the lower right of each "page."

Also, the pages in the "waypoint" and "nearest" chapters are presented alphabetically, so you will find the "airports" page before you get to "user waypoints" or "VORs." Remembering how your system is organized can help you manage the sheer volume of available information. It is also far more effective (and far less frustrating) than attempting to memorize mechanical manipulation of the knobs. Simulation software and books on the specific system you are learning can be of great value in this effort.

The next critical information management skill is to recognize that reading is fundamental. Understandably enough, pilots new to glass cockpit avionics often become fixated on the "knobology," to the point of believing they must memorize each and every sequence of button pushes, pulls, and turns. Not so. Though human beings are notorious for our reluctance to read the directions, a far better strategy for accessing and managing the information available in glass cockpit computers is to stop, look, and read. Both the Garmin G1000™ and the Avidyne™ displays have clearly labeled buttons, knobs, and "softkey" menus. Reading before you push, pull, or twist can often save you some trouble.

Once you are actually behind the display screens on a glass cockpit aircraft, your goal is to meter, manage, and prioritize the information flow to accomplish specific tasks. Whether you are an instructor or a pilot transitioning to glass cockpit avionics, you might find it helpful to direct the fire hose flow of information into a few conceptual "drinking glasses" like these:

**Personal preference.** You might remember "have it your way" as an old





fast food advertising jingle, but the concept definitely applies to setting up the displays in a glass cockpit aircraft before you fly. Just as you can configure your personal computer display to suit your individual preferences and styles, you can set up many aspects of the glass cockpit PFD and MFD screens in the way that works best for you. An obvious example is map orientation. Most systems offer options that generally include "north up," "track up," "DTK" (desired track up), and "heading up." Being a "heading up" fan myself—saves me from turning my charts upside down—map orientation is one of the first things I check.

To a large extent, you can also have it your way in terms of how much (or how little) information you display. I don't like clutter on my desk, but I do like a lot of information on the PFD. In Garmin G1000™ equipped aircraft, for example, I always configure the PFD to show the inset map with the "topo" and "traffic" overlays, the Nav1 and Nav2 bearing pointers (tuned, of course, to useful frequencies), and the flight plan inset. I also make sure that the "V-speed" bugs for the airspeed tape are selected on. On the MFD side, I check and, as needed, adjust the fields on the waypoint status bar to suit my needs for the specific flight.

**Specific operation.** The "just in time" delivery system has become commonplace in the manufacturing world, and glass cockpit avionics put this concept to work for the general aviation PIC and flight manager. You now have the ability to prioritize information for "just in time" display of just exactly the information needed for any given flight operation. In Avidyne™ equipped aircraft, for example, system start begins by prompting you to set the appropriate fuel level. A good information management practice is to put the comprehensive engine systems status page (rather than the moving map) on the Avidyne™ MFD for taxi, takeoff, and initial climb, because engine status information has much greater utility and value to you during these critical phases of flight. A



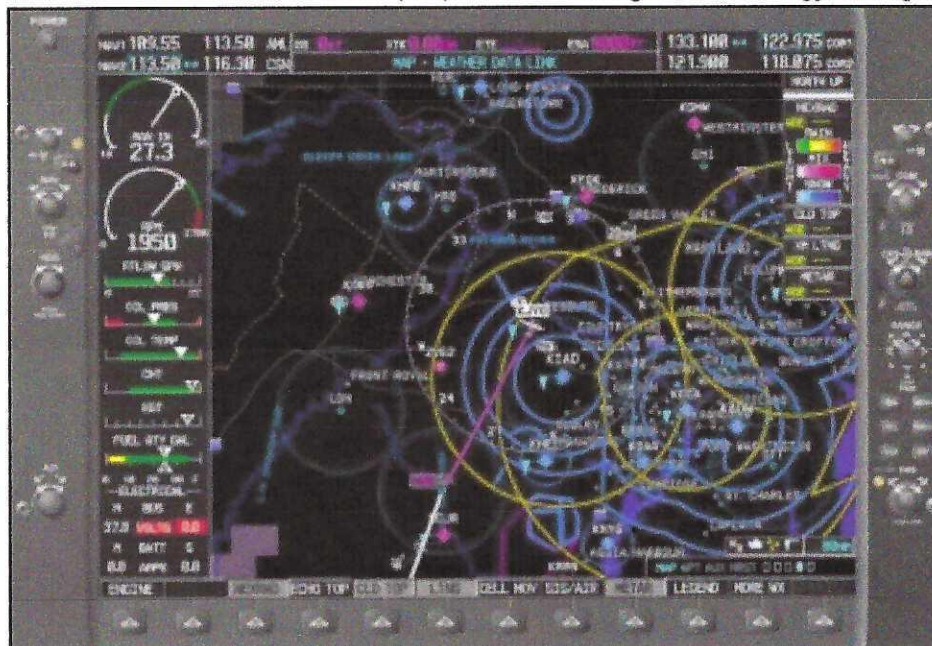
few other examples of managing information display for a specific operation include:

- Map scale settings for en route versus terminal area operation.
- OBS mode to set up a "random" (non-published) holding pattern in GPS.
- Terrain awareness page on the MFD for a night or IMC flight in or near the mountains.
- Nearest airports inset on the PFD at night or over inhospitable terrain.
- Course deviation indicator (CDI)

sensitivity for en route, terminal, approach.

- Weather datalink set to show echoes and METAR status "flags."

**Situational awareness.** Aircraft flight manuals explicitly prohibit using the moving map, topography, terrain awareness, traffic, and weather datalink displays as the primary data source, but these tools nonetheless give the pilot unprecedented information for enhanced situational awareness. Without a disciplined information management strategy, though,





these tools can also make it easy for an unwary pilot to slide into the complacent role of passenger-in-command. For example, a pilot, whose navigational information management strategy consists solely of following the magenta line on the moving map, can easily fly into geographic or regulatory disaster, if the straight-line GPS course goes through high terrain or prohibited airspace, or if the moving map display fails (yes, it can happen.) Remember also that GPS is a supplemental system.

Your strategy for situational awareness information management should have several components:

- Always double-check the system. At a minimum, ask yourself whether the presentation makes sense. I once programmed a moving map navigator to take me to Augusta, Maine (KAUG) when I wanted to go to Augusta, Georgia (KAGS)—big difference. Because I was so enthralled with the fantastic capabilities of my new gizmo, I'm ashamed to say that it took me awhile to catch the mistake. Lesson learned. If your aircraft is equipped with weather datalink, you must remember that you are looking at recent weather, not real-time radar returns, and take note of the weather data "age" legend on the MFD. It sounds easy and obvious on the ground, but pictures are surprisingly and powerfully persuasive.
- Use callouts. One of the information management techniques I now teach for situational awareness in glass cockpit aircraft is callouts – even for single pilot operations. Specifically, I ask pilots to read the appropriate displays (e.g., PFD, MFD, autopilot status annunciator) out loud after making any change in course or alti-

tude. Callouts for what is expected next (e.g., next fix, next altitude) are useful as well. This practice helps you make the most of your situational awareness gadgetry, while keeping you firmly in the role of pilot in command. It's also a great way to catch your programming mistakes before they catch you.

## Automation Management

Glass cockpit aircraft are highly automated. While most include some kind of automatic flight control system, otherwise known as the autopilot, "George" is not the only piece of automation you need to manage in order to avoid the potentially dangerous distractions of "automation surprise." For example:

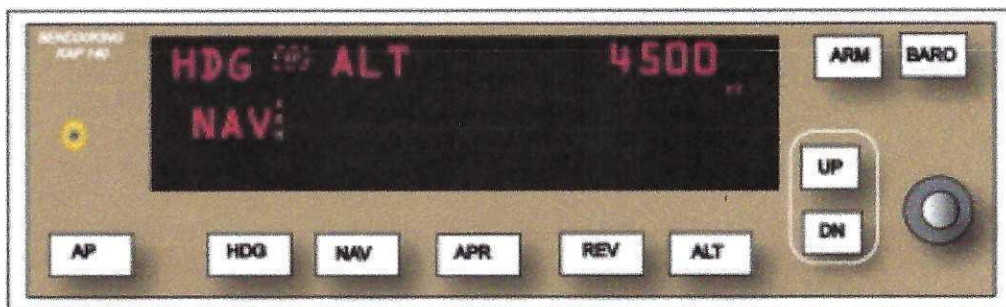
**CDI sensitivity.** By default, the course deviation indicator (CDI) needle is set to scale its sensitivity automatically for the appropriate flight operation. During the en route phase (more than 30 nm from the destination airport), the G1000™ electronic Horizontal Situation Indicator (e-HSI) provides an "ENR" annunciation to tell you that a full-scale CDI deflection puts you at least five nm from the desired course. Within 30 nm of the departure or destination airport, CDI sensitivity switches automatically to "TERM" mode, in which a full-scale CDI deflection indicates at least one nm from the desired course. Within two nm of the final approach fix, CDI sensitivity scales to "APR" mode, in which a full-scale CDI deflection indicates at least 0.3 nm from the desired course. If, however, the pilot who flew

before you decided to disengage the automatic CDI scaling feature, would you know how to recognize the change? (Hint: If you see a numerical value on the e-HSI instead of one of the three notations for ENR, TERM, or APR, your system is not using the default settings.)

*Reverse is also true*

**Navigation source.** In the Garmin G1000™, loading an ILS or LOC instrument approach procedure while navigating by GPS causes the system (by default) to automatically locate, identify, and install the LOC course in the Nav1 frequency box, and slew the Nav1 OBS to the final approach course. Also by default, the system is configured to automatically switch the active navigation source from GPS to Nav1 on an ILS or LOC approach. While these features can certainly ease your workload at a busy time, it is extremely important that you know what to expect, monitor for proper operation, and promptly take appropriate action if the system doesn't perform as you expected.

**Autopilot.** At the most basic level, managing the autopilot means knowing at all times which modes are engaged, and which modes are armed to engage. You need to verify that functions you have armed (e.g., nav tracking or altitude capture) do engage at the appropriate time. Automation management is another good place to practice the verbal callout technique, especially after commanding (or arming) the system to make a change in course or altitude. When teaching in these aircraft, I now require pilots to read the display out loud, even (or perhaps especially!) for single pilot opera-





tions. In the Bendix/King KAP 140 illustration on page 12, for example, the callout might be as follows:

*Heading mode is ENGAGED, and aircraft is following the heading bug on the e-HSI to intercept the desired course. Altitude hold mode is ENGAGED to maintain pre-selected altitude of 4,500 MSL. Navigation mode is ARMED to capture the desired course upon intercept.*

In glass cockpit aircraft, proper automation management also requires a thorough understanding of how the autopilot interacts with the other systems. With some autopilots, for example, changing the navigation source on the e-HSI from GPS to LOC or VOR while the autopilot is engaged in NAV (course tracking mode) will cause the autopilot's NAV mode to disengage. The autopilot's lateral control will default to ROL (wing level) until the pilot takes action to reengage the NAV mode to track the desired navigation source.

Let's look at an example. After the pilot activates an ILS or LOC instrument approach procedure, the G1000™ system defaults are set to switch the navigation source automatically from GPS to the Nav1 localizer frequency as the plane approaches the localizer. You could be in for a potentially dangerous "automation surprise" if you have one of the autopilot's navigational tracking modes (NAV, APR, or REV) engaged when the system automatically switches the navigation source, especially if you fail to notice that the system is no longer tracking the desired course. To ensure that you remain ahead of the airplane and fully in charge of your glass cockpit systems, you need to understand, anticipate, and manage such functions (e.g., by first manually switching the navigation source and then engaging the autopilot's APR mode). **Correct source first**

**THEN APP  
Risk Management**

The last, but by no means the

least, of the three flight management skills needed for mastery of the glass cockpit aircraft is risk management. There is no question that the enhanced situational awareness and automation capabilities offered by a glass cockpit airplane can vastly expand its safety and utility, especially for personal transportation use. At the same time, there is some risk that lighter workloads could lead to the cliché of "fat-dumb-and-happy" complacency. Just remember that any glass cockpit pilot tempted to relax into a passenger-in-command role is likely to find some very sharp corners in all this cutting edge technology. As with any piece of glass, you must always handle it with care.

It is especially important to recognize that there are limits to what the systems in any light general aviation aircraft can do. To help pilots remember this point, some Avidyne™ equipped aircraft now offer a risk management checklist page that the pilot must acknowledge before continuing to program the system. Whether or not your aircraft is so equipped, just remember that being pilot-in-command always requires sound aeronautical decision-making (ADM), and that it sometimes means saying "no" to a flight you really want to take. Here's a recent personal example, using the PAVE risk identification checklist:

**Pilot(s):** On a recent winter evening, I planned a night cross-country flight with a fellow G1000™ instructor. Both of us are night current, instrument current, and fully proficient in use of the G1000™ systems.

**Aircraft:** The aircraft was a G1000™ equipped, single engine airplane with the full weather datalink package installed.

**enVironment:** Weather at the proposed time of

departure was still VFR, but visibly deteriorating to marginal VFR and forecast to be IFR approximately two hours after completion of the trip, which was along a well-known route to a familiar airport. Temperatures aloft for the proposed altitude (which would put us in the clouds) were just above freezing. The intended route of flight included short segments over mountainous terrain.

**External pressures:** We really, really, really wanted to fly!

After watching the ceiling and visibility decline noticeably during the preflight inspection, we quickly lost faith in the forecast. Despite the proficiency of the pilots and the capability of the aircraft systems, the two of us reluctantly concluded that the risk posed by a night flight over mountains in instrument meteorological conditions (IMC) with possible icing was well beyond the limitations of a light single-engine airplane—and we lived to fly another day.

## Beyond the Buttons

Even the most reluctant converts will probably agree now that the convenience of computerized word processing made it well worth the effort to learn new skills. Similarly, pilots, who invest the time needed to master information, automation, and risk management challenges of the glass cockpit aircraft, will benefit immensely from the enhanced potential for safety and aircraft utility. Prepare to be assimilated!



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