My Gulfstream G500 Initial

Reinventing **how we train**

JAMES ALBRIGHT/BCA

A Gulfstream GVII-G500 cockpit

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My first impression of the latest Gulfstream's cockpit was that it looked like the work of a luxury automobile maker, rather than that of the business jet builder responsible for most of the flight hours in my logbook. Quite simply, the flight deck of the Gulfstream GVII-G500 is a work of technological artistry.

The space has very few mechanical switches, and glass abounds. The four large display units up front will look familiar to pilots familiar with the G450, G550 or G650. But almost the entire overhead panel is replaced with three large overhead panel touch screens (OHPTSs). There are no flight management system (FMS) or radio control heads. Those and many other conventional interfaces have been replaced by five touch-screen controllers (TSCs). To cap it all, there are two large standby flight displays (SFDs) up high, where the pilot needs them, and these are automatically programmed and have more functionality than the primary instruments of many of the airplanes I grew up flying.

In short, this is a flight deck for the iPhone generation. And while I am somewhat removed from that generation, I am quickly catching up. I discovered that getting up to speed with the latest Gulfstream is a matter of adapting old philosophies with new.

Philosophy One

My company has been operating Gulfstreams since the G-IV and I have been flying them since the G-III. Or is that the G-1159? The disconnect between Gulfstream aircraft names and pilot type ratings has been with us from Day One. The original Grumman "Gulfstream" turboprop carried the type rating G-159. The "Gulfstream II" and later "Gulfstream III" became known as the G-II and G-III, respectively, though both carried a G-1159 type. Since then, many of the aircraft have had what I call hyphen confusion. The G-IV type rating works for the G-IV or GIV, depending on what publication you're reading. (Please not a G4!) The G-V first worked for the G-V aircraft, and later for the G-450 and G-550. All of these aircraft lost their hyphens over the years, but the type ratings retain them: G-159, G-1159, G-IV and G-V. In 2009, the hyphen was officially banished with the G650 and the GVI type rating.

Throughout that evolution, we Gulfstream pilots understood that every Gulfstream was built on the aircraft that preceded it. The company philosophy was clear: If it doesn't work, replace it; if it does work, improve it. And Gulfstream embraced the philosophy of redundancy. The best example of that would be direct current (DC) power production in the G-V series. There are four major DC electrical buses, but there are five transformer rectifier units (TRUs) to produce it. One TRU is constantly powered but delivering power to no bus; it is the "pinch hitter" always ready to step in when called upon. You name the system, in most Gulfstreams redundancy is the prime directive in aircraft design. That's why most Gulfstream pilots will tell you their aircraft are built like tanks.

Two years ago, the CEO of my company asked me for an opinion of the "Gee-Seven." I didn't have one so I arranged a visit to Savannah, Georgia, to find out. The GVII type covers the G500 and G600, two aircraft that are nearly identical except for their size. The G500 is 91 ft., 2 in. long with a wing span of 87 ft., 1 in. The G600 is 96 ft., 1 in. long with a wing span of 95 ft. Gulfstream makes it clear that the GVII is a "clean sheet" airplane and I discovered that to be true in more respects than the obvious. Yes, the fuselage is wider than the G550's and earlier models' but not as wide as that of the G650. Yes, the wing is completely new (and gorgeous).

But the GVII reinvents many concepts that are not only new for Gulfstream but new for any aircraft built by anyone. The fly-by-wire (FBW) sidesticks, for example, are not the sidesticks you will find in a Falcon, Airbus, or even an F-16 fighter. They are better. These active control sidesticks (ACSs) provide

feedback to the pilot by moving in response to control feel, autopilot actions, and even the other pilot's inputs. Since ACSs didn't exist, Gulfstream had to invent them.

What about those touch screens? Fighter pilot friends of mine complain about screens that are too large to press accurately because their hands could not be braced against a nearby object, and that it was too easy to make a mistake with a glancing touch on the wrong part of the screen. Gulfstream wanted a glass with two modes, one for the swiping motion familiar to iPad and iPhone users, as well a surface that required a tactile and definite depression to activate critical switches. The glass didn't exist, so the airframer invented it. And all the touch screens are sized so that the hand can be anchored to one side while the pressing or swiping motion is made. That was two questions answered, but there were many more.

I started with a list of 20 doubts about this new technology, and one-by-one members of the Gulfstream design team convinced me that they got it right. So, they designed a good airplane, but was it worth upgrading from what we already had? Our Gulfstream G450's most frequent overseas destination is France. The G500 would get us there 45 min. faster while using less fuel. So, where do I sign?

I returned home and told my CEO that not only was the G500 the right airplane for our company, but that no other airplane being built today could compare to it in terms of safety and capability. While all other new aircraft on the market today are evolutionary in design, this one was revolutionary. We placed our order and take delivery later this year.

Now I had to worry about training three pilots to fly it and a mechanic to maintain it. I will write in the future about the purchase and delivery processes. But I just finished G500 initial pilot training and want to give a current assessment about the program designed by FlightSafety International in Savannah. As I write this the first 20 G500s have been delivered to rave reviews. Gulfstream can build them, but could FlightSafety teach pilots to fly them? I enrolled in Class No. 10 to find out.

Back to School

I have a theory about all aircraft initial courses that holds the amount of instruction expands or contracts to the time allocated while the subject matter tracks whatever is trendy at the time. Twenty years ago, I thought my Bombardier Challenger 604 initial spent too much time on systems while ignoring the FMS. "You will learn that in the field," I was told. A few years later, my G-V initial seemed to emphasize systems over stick and rudder. In the G450/G550, the FMS took center stage at the expense of the other systems. In all three cases, we had 24 days to learn, not a day more. I showed up to G500 initial thinking FlightSafety would need to strike just the right balance for me to walk away with a type rating. (I don't learn as quickly as I used to.)

Learning a new airplane has always been one my favorite things to do, and I have been doing it for a long while. I was in U.S. Air Force pilot training exactly 40 years ago and after completing Cessna T-37 instruction, moved on to the Northrop T-38, the supersonic jet the Air Force called the Talon, but which we pilots called "The White Rocket." In the years that followed, I went back to "initial" training many times and have come to expect a certain pattern to repeat.

First, you sit down in class to learn the aircraft's limitations and systems. While the former was an exercise in rote memorization, the latter was useful for those of us with mechanical minds. You don't really need to fly an airplane to learn how the air-conditioning system works. You can teach me what I need to know about an engine with a chalkboard and a few slides. Once that is done, you hit the simulators if you have them, the flight line if you don't. There was always a distinct break between the classroom and the cockpit.

This old school mentality also meant you didn't actually need pilots to teach ground school, and if you used real pilots, they didn't have to be the best. One of my Challenger 604 instructors was a retired military pilot who had never flown any aircraft that didn't have "Navy" painted on the side. My first G-V instructor had never flown any Gulfstream other than the simulator. Once you graduated from ground school you were strapped into a cockpit and started flying. Depending on the airplane, the emphasis would be on stick and rudder skills, instrument flying or programming all the electronic gizmos. But you never got all three.

Reading ahead in our course material, I realized that learning the GVII was going to require a new type of teaching. The airplane is, in a word, holistic. Everything is related to everything else. You cannot talk about the air-conditioning system, for example, without also considering cockpit avionics. The auxiliary power unit (APU), for another example, has a relationship with the inertial reference units (IRUs). I looked in vain for a flight management system (FMS), communications suite, or even a way to turn all those glass screens on or off. It became clear that the instructor was going to have his hands full with me. I was starting to wonder if 63 years of age was too old for this dog to learn new tricks.

Fortunately, FlightSafety was in on the ground floor with Gulfstream when the GVII was little more than crayon drawings on a large blank sheet of paper. When I first started seeing FlightSafety instructors wearing black golf shirts with "G500 Initial Cadre" on the sleeve I thought it was simply a collection of senior instructors lucky enough to win the favor of the center manager for the first class. I later found out that these were members of the "Design Build Team." Not only would they help design the aircraft but also the simulators and the course designed to teach it all. I quickly discovered that these initial cadre members were the best FlightSafety had to offer, and it showed.

Day One in school was with retired U.S. Coast Guard Pilot Ken Norris at

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FlightSafety G500 instructor Ken Norris in class

the helm. At his side, every day in the classroom, was another accomplished instructor, Daniel Gomez. Yes, two instructors for one class. Norris was able to weave seamlessly from one subject to the next because Gomez had everything teed up perfectly as it was needed. This is crucial because every subject in this airplane is related to every other subject.

As a longtime Gulfstream pilot, I saw similarities in some of the systems but much of what I knew was not relevant. "Forget about your first love," Norris cautioned, asking us to abandon

previously held knowledge that no longer applied. We were a class of 24 students. Very few of us had any FBW experience. About half had never flown a Gulfstream of any type. Four spoke English as a second language. But none of us had ever flown anything like the GVII.

The topics for each hour of the first day seemed to be picked at random. We never finished a topic having fully grasped the subject; I was always left wanting more. "This is going to make sense," Norris assured us. "You have to get through the complexity to find the simplicity." It was as if he was saying, "Patience, grasshopper." But with things like this, I rarely have patience. I want it now! Before we even scratched the surface of the systems, we were programming our first flight plan.

Each desk included a working mockup of the cockpit on a large monitor that allowed students to view and manipulate every cockpit control. To our right we had a cursor control device (CCD) to manipulate the forward cockpit displays. (These CCDs will be familiar to G450, G550 and G650 pilots.) Just on top of the CCD we had a touch-screen controller (TSC). To our left was an active control sidestick (ACS). In short, we had everything we needed to fly.

"Nobody go flying yet!" Norris warned. "Right now, you need to get familiar with the TSC. We'll go flying tomorrow." Flying on Day Two? This was happening fast. On Day One we had barely scratched the surface of several systems while learning a heavy dose of cockpit avionics. This was not how this is usually done! Norris ended the day by posing a series of questions for what he calls the "Exit Ticket." Each student got several chances to cover the territory gained from the day. I felt fortunate to answer my questions correctly even as I had to admit I got some of the other students' questions wrong.

Our study materials included a client's guide complete with homework and an interactive cockpit called iFlightDECK designed for our iPads. (If you don't have an iPad, FlightSafety will give you one.) The iFlightDECK includes a textbook of sorts; I found it wanting when compared to most eBooks but it does contain a wealth of knowledge. The cockpit displays in iFlightDECK are very helpful for practicing with the avionics.

Just as the previous day ended with Exit Tickets, the next morning began with "Bell Ringers" designed to ensure each student had a grasp of the ground covered and was doing the previous day's homework. By the end of the first week, we had learned to accomplish everything needed to program an instrument flight plan, start engines, take off, shoot an instrument approach, land and shut down. Our systems knowledge was on the rise. Somehow, despite my doubts about the teaching method, we were learning.

As a lifelong student of the learning process, I was gaining knowledge of the airplane even as I attempted to learn about this new method of instruction. We could no longer parse the airplane system by system; rather, we had to somehow learn it all at once. After the first week I figured out why: The Gulfstream philosophy had gained a new tenet.

Philosophy Two

The GVII retains the Gulfstream redundancy philosophy but adds another: automaticity. If you can relieve the crew of routine tasks, you free the pilots for more important duties. This has been true of all Gulfstreams to a lesser extent. Take the task of programming an airplane's pressurization system, for example. G-IV and earlier pilots had to program their pressurization systems with the cruise altitude, climb and descent rates, landing field elevation and altimeter settings. This is simply entering information that exists somewhere else in the cockpit but is not obtainable by the pressurization system. Mistakes meant a failure to pressurize, depressurize, or worse. G-V and later pilots were relieved of this task because the FMS — which already knew the cruise altitude, field elevation and altimeter setting — would program the pressurization system automatically.

This ongoing quest for automaticity was extended to other systems but was limited by physical switches. The computers didn't have the ability to press, turn or toggle the many physical switches needed to operate the airplane.

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A conventional "hard" circuit breaker

All that has changed in the GVII, and to understand why, consider the humble circuit breaker.

A typical mechanical circuit breaker is nothing more than an on/off switch with a temperature-sensitive strip or disc of metal that is bent into one shape and has the property of popping its shape at a certain level of current, thereby throwing the spring-loaded switch off and breaking the circuit. It is not very useful as a switch, since repeated actuations will eventually weaken the metal disc, the spring and other internal components. Each circuit breaker takes up valuable panel real estate, and with the wires needed to connect from power sources to components, having a mechanical circuit breaker is a physical burden on the airplane. It also requires a human being to pull or push it, as well as find it in the first place. Finally, the hardware version of a circuit breaker isn't very accurate. The break point of the metal disc is subject to changes in the ambient temperature, age and repeated use. Even when brand new, a physical circuit breaker has a wider tolerance than many of today's sensitive electronics should have to endure.

A "virtual" circuit breaker is essentially a transistor that can make or break two wires based on the status of a third. It can be an electrical component or part of a circuit etching in a microchip. These virtual circuit breakers have been in use for many years in an attempt to reduce weight, increase the accuracy of circuit protection, and to free up panel real estate. But they have another virtue that not all aircraft use to full advantage: They make for very efficient switches. For an example, let us consider the very mundane task of starting an APU prior to engine start.

In the last few Gulfstreams I have flown, the routine to get the APU on line is the same: Turn on a master switch so as to complete a computerized built in test (BIT); do a fire test; turn on a fuel boost pump; turn on the airplane's navigation lights; and then press a start button. Why can't that be automated? On most airplanes the fuel pump and navigation lights switches are physical switches. In the GVII they are controlled by virtual circuit breakers called solid-state power controllers (SSPCs). Hitting the APU start button allows it to activate the fuel pump, turn on the navigation lights, start the APU, turn on most cockpit displays, open the system's bleed air, and place the IRUs into navigation mode.

This automaticity philosophy means that repetitive tasks that do not require a pilot's active decision-making are handled automatically. Pilots are given control of the components if they want it, but for the most part it just takes care of itself. The learning challenge is coming to grips with having everything "just happen" while learning how to take control if you need it. Pilot-to-airplane interfaces are handled by three overhead panel touch screens (OHPTSs) and five touch-screen controllers (TSCs) spread throughout the cockpit. The result is a cleaner look while further increasing redundancy. Any one OHPTS can do the work of all three and the TSCs are swappable.

Getting in Touch With the Airplane

After a week of classroom and learning from our desks, it was time to get hands-on with a flight training device (FTD) that has synthetic displays of the entire cockpit, providing a chance to fly from takeoff to landing and to explore normal and abnormal procedures. The FTD is so good that the FAA allows pilots to log time at the controls. While we students yearned for actual time in the full-motion simulator, our instructors kept letting us know that this was a building block approach. We would get there.

Days in the FTD were mixed with more days in the classroom, each feeding off the other. Learning the finer points of each aircraft system became easier as our confidence with the OHPTSs and TSCs grew. I felt I knew most of the systems well enough to pass a check-ride oral, just a week and a half into the program. The one exception was the flight control system.

As noted, and like many of my classmates, I had no experience in FBW technology and thought that subject would take up most of the instruction. It did not. The active control sidesticks are designed to mimic conventional controls where that is best, and to improve upon the stick and rudder found on the airplanes I had flown with a stick, cables and pulleys. I have about 1,000 hr. flying with a stick, but not a sidestick. I thought perhaps this would be a problem; it wasn't. Consider your left arm on an ergonomically designed armrest, trying to move a stick in four directions. Pulling back is easier than pushing forward. Moving the stick inboard is easier than outboard. The active sidestick takes all this into consideration. Even my classmates with no stick time at all adapted very quickly.

Each flight control surface has multiple sources of hydraulics and electrons driven by multiple actuators and computers. Should all of that fail, every surface except one pair of spoilers also has an electric backup hydraulic actuator that doesn't need airplane hydraulics or the usual assortment of computers.

A typical business jet accelerates so quickly during takeoff that time is compressed inside any pilot's ability to read a stack of CAS messages. I recently timed a fairly heavy GVII takeoff and found the "80 kt." call took place 15 sec. after brake release and V1 was just 7 sec. later. If your answer is "I'll abort for any red or amber CAS" you should carefully look at the possible messages your airplane can throw at you.

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FlightSafety G500 flight training device

From a pilot's perspective, this airplane flies like an airplane.

By the time we showed up for our first simulator session, we already had a firm grasp on the cockpit screens, the systems and how to fly the airplane under normal conditions. We lightly delved into abnormal procedures and had already heard several times Norris' final cliché: "This is a fly-by-CAS airplane."

Philosophy Three

We pilots are paid the big bucks because of our superhuman abilities to make lightning-quick decisions under high stress. Yes, not many mortals can be shooting down a runway at over 100 mph, seconds before the ominously named "decision speed" and hear a triple chime; scan a list of red, amber and cyan crew alerting system (CAS) messages; and decide to abort or continue a takeoff. Yes, that's what we do. But that has become a lie because our jets have become so fast.

This isn't just a problem with the speed of our jets, it is also the very nature of the CAS as typically designed. You normally have red (that's the really bad stuff), amber (that's bad but not too bad), cyan (sometimes bad, sometimes good) and white (informational) CAS messages. These messages stack onto our displays in the order they occur, the first ones on the bottom. The only further delineation is by severity: red on top, followed by amber, cyan and white.

With the GVII, CAS messages can be grouped underneath one another by consequence. A causal CAS, such as an engine failure, will be an "umbrella" to others that are "consequential alerts." A right-engine failure, for example, has several consequences:

R Eng Fail (U)
>R Hyd System Fail (U)
>L-R Outboard Brake Fail
>Spoiler Panel Fail (U)

Note that the consequential alerts can also be umbrella messages themselves. You can quickly discern what the causes

are and what are just consequences to those causes. The alerting system further protects the pilot from distraction by filtering these messages in varying levels: low-speed takeoff, high-speed takeoff and landing. There is little a pilot can do about an engine fire at V_1, for example. That message would be filtered starting at V_1-5 until 400 ft. above the runway or 30 sec. after takeoff.

The combination of the more intelligently stacked CAS messages and smarter filtering greatly reduces the burdens on pilot decision-making during critical phases of flight. The V1 conundrum is now reduced to: "Double or triple chime before V_1: Abort, otherwise continue the takeoff."

The Simulator

The first time I strapped into the pilot's seat of a GVII full flight simulator I felt instantly at home. The seat is comfortable, the sidestick armrest adjustable to the point there is no undue arm or wrist strain, and every touch screen and display is just where you want them. Beyond that, I was taken aback by the clarity of the simulator's visuals. The outside scenery is presented on curved mirrors that give the pilot unparalleled visibility forward and aft.

Our sim instructor was Brian Greene, another founding member of the Gulfstream/FlightSafety design build team. Just as it was with our classroom sessions, Greene seemed to discard the original simulator instructor's playbook. Starting with our first session we were encouraged to "see what she can do" and get comfortable with stick and rudder with a real stick. We had further "see what she can do" demonstrations in follow-on sessions to really understand the flight envelope protection designed into the airplane.

Unlike some initial flight courses, this one did not tailor the simulator sessions to teach for the check ride; there was no "check-ride profile" practice. Each session built on the previous lesson and we slowly, but surely, learned what we needed to know. The simulators are brand new and are, as they should be, in excellent condition. Greene never hesitated to put the world on "freeze" so he could point out whatever we had missed. Between my simulator partner and me, we had a collective 80 years of flight experience and nearly 30 of those in Gulfstreams. But as Norris reminded us often, this airplane is different and we had to forget our "first loves."

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FlightSafety G500 flight simulator

I have rarely experienced an aircraft initial course in which the simulator so effectively translated theory into practice. During one of our unusual attitude recovery exercises, my simulator partner put the airplane into a steep dive and by the time I was told to open my eyes and recover, we were well beyond VMO. I applied the correct nose-low recovery procedure only to find the nose well above the horizon and I had to execute a nose-high recovery. In a fit of embarrassment, I gave the novice pilot's complaint: "Why is it doing that?" Norris answered with his own question: "When does the high-speed protection mode of the flight control computer kick in?" Of course, the airplane was designed to protect us in that very situation.

It seemed hardly a day went by without Greene providing us an epiphany of one sort or another. In any other airplane I would have to wonder what I was doing: I am far too experienced to be learning at such a level. It is as if I was saying to myself, "I'm better than this!" But this is a new airplane in many ways and after 22 days it would seem I learned enough. This was type rating No. 9 for me.

I sent FlightSafety International a five-page critique that was 90% praise with a little room left over begging for a better textbook than provided by iFlightDECK. The instructors are the best. Likewise, the classroom, the FTD and the simulator were the best I had ever experienced. I think any other training provider can learn from this program.

As we ready to take delivery, the training has increased my excitement at the prospect of flying with those touch screens, the magical sidestick and everything else on this airplane designed to make my life as a pilot easier. I had to shovel my way through a lot of complexity, to be sure. Now I truly appreciate the simplicity all of that effort gets me. These are philosophies I can learn to love. **BCA**

The author's new aircraft on its second flight