And what was wrong with the 3,000- to 4,500-nm business jets then available? The market would be too small to justify the in-vestment needed to build a whole new series of business jets, skeptics said. And what would the size of the market be, anyway? Two hundred airplanes? Eight hundred? No one knew. Dassault Falcon Jet, which for a brief time considered designing a 6,500-nm airplane, dropped out of the running. "We already have an airplane capable of flying 9,000 nautical miles—with just one stop [the Falcon 900EX]," said company officials.

That was then

Six years later, Gulfstream's G-V was certified. Bombardier's Global Express made the grade earlier this year. Now both manufacturers' order books are full. Turns out that there is indeed a market for ultra-long-range business jets, after all.

Being the first out of the starting gate, the G-V has racked up 150 sales to date, and some 75 G-Vs are now in service with corporations and governments worldwide. Gulfstream's Savannah, Georgia,

"Cat's whiskers" warn of a degradation of lift—and show the way out of a microburst.

factory churned out 23 G-Vs in 1998, and the company's acquisition of KC Aviation has helped to boost the aircraft completion rate and shorten the time between manufacture and delivery.

New and improved

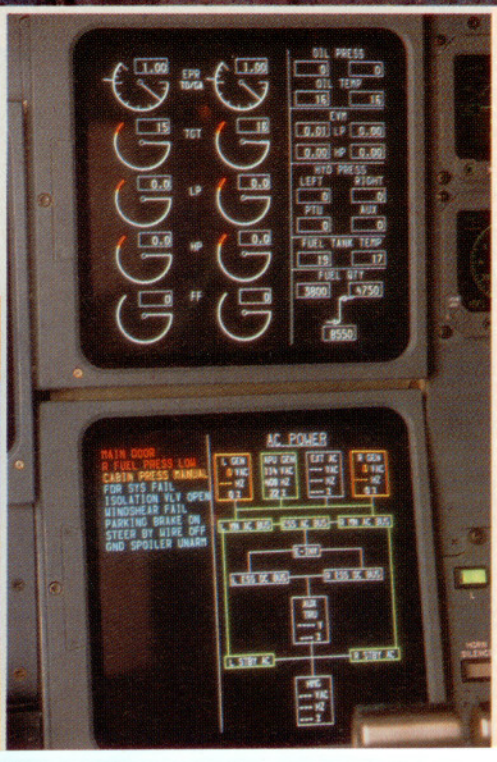
Some believe that the G-V is simply an enlarged, grandfathered version of its predecessor, the G-IVSP (which is still being manufactured in tandem with the G-V, by the way). Not so, says Gulfstream. The G-V is a completely new design that has just a 7-percent parts commonality with the G-IVSP.

"For a 57-percent increase in range over the G-IVSP," a company spokesman said, "we couldn't just add more fuel. The whole airplane had to be redesigned."

The G-V's exceptionally clean wing, the company says, was designed with

The G-V cockpit has the Honeywell SPZ-8500 avionics suite. Displays include engine information and crew alerting system (EICAS) functions and synoptics pages showing the status of each system. Banks at altitude can be made with confidence, while the "cat's whiskers" warn of lift degradation (below).

PHOTOGRAPHY BY MIKE FIZER



the help of computational fluid dynamics and was given a wing cross section that minimizes the problems associated with traditional supercritical aft-loaded designs. This cross section has minimal lower surface reflex, or upwardly curved trailing edge sections. Aft loading creates lift at the aft portions of a wing and causes nose-down pitching moments that can increase drag at high speeds. The drag comes in the form of trim drag, produced by the need for nose-up trim to overcome any nose-down pitching moments. The G-V's slightly reflexed wing undersurfaces minimize these pitching moments.

Thanks to its low wing loading (79.6 lb/sq ft at maximum takeoff weight), minimal drag, and large-radius leading edge, Gulfstream found that the G-V wing needed no slats, vortilons, or vortex generators at the low-speed end of

the airspeed envelope. Consequently, V_{REF}—reference airspeed for use when flying on final approach—came out 12 to 14 knots lower than the V_{REF} used for the G-IVSP. The G-V's V_{REF} runs between 110 and 136 kt, depending on the airplane's weight.

At the higher end of the envelope, the G-V wing has comparatively low transonic drag. This is the drag generated as a by-product of flying near supersonic speeds—the speeds where the G-V spends most of its time. Gulfstream gives the G-V an M_{MO} (maximum Mach number) of 0.885, a normal cruise speed of Mach 0.85/488 kt, and a long-range cruise speed of Mach 0.80/459 kt.

At its maximum cruise altitude of 51,000 feet, the G-V wing continues to provide enough lift to permit bank angles of 46 degrees—and G-loads of up to 1.43 Gs—before the onset of stall buffeting. For such a high altitude, that's a lot of margin from "coffin corner."

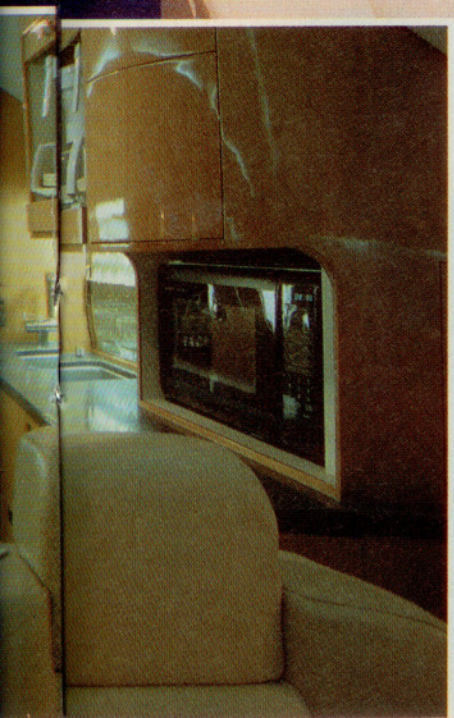
Wing-wise, therefore, the G-V is optimized for both low- and high-speed performance. But the wing is only half the reason for the G-V's improved range and efficiency over the G-IVSP. The 14,750-lbst BMW Rolls-Royce BR710 engines do their part, as well. Full authority digital electronic control (FADEC) and other enhancements that optimize things such as bleed-air extractions, bypass ratios at altitude, and gearbox speed ratios give the big BMWs comparatively low Mach 0.80 fuel burns of some 3,000 pounds per hour in the first hour of flight, then 2,000 pph for the remaining hours. They're Stage-3 quiet, too.

At 10 feet, just think about flaring and raise the nose ever so slightly.

Cruising at FL450 and Mach 0.80, the BR 710s only require between 1,650 and 2,000 lb of thrust per side to do the job. For engines with low-five-digit thrust ratings, that's loafing.

The front office

No amount of blabber about FADEC, Mach numbers, and thrust curves can truly prepare you for your first glimpse of a G-V cockpit. You walk up to this



This 11-seat interior has all the usual luxuries you'd expect in a Gulfstream. External cameras let crew and passengers look at the airplane's exterior on dedicated displays—and can show how the main gear are tracking on a narrow taxiway.

massive room and greet six huge display tubes on the main panel, plus two smaller ones on the glareshield, two more associated with the flight management system (FMS) on the spacious center pedestal, and two more for tuning the communications radios.

After a two-hour familiarization ride in FlightSafety's G-V simulator, it was time for me to strap on the real thing. By then I had an idea of where things were, a feel for the vertical tape and other displays, and the power settings required for various configurations. As for all the ins and outs of the Honeywell SPZ-8500 avionics suite, forget about it. Newcomers to the G-V take a one-week "pre-course" on the ship's avionics suite and FMS before setting foot in the three-week-long FlightSafety International pilot initial training course—and a full week of that training is spent on the avionics alone.

My right-seat mentor and overseer was a Gulfstream test pilot named—I kid you not—Tom Horne. This was getting interesting. He filled out the top of the flight sheet with the two identical names, and after sharing some stories and determining that we probably were not related to each other but possibly might in some way be related to Tom Horn the Indian scout, Horne fired up the auxiliary power unit (APU), the other Horne clicked on two buttons to start the G-V's engines, and it was time to taxi.

A tiller shaped like a half of a control yoke is used for large movements of the nosewheel, and it was fairly easy to negotiate our way to the active at Savannah.

Autothrottles are a novelty for me, let alone an autothrottle takeoff. To do one, you click on one of the autothrottle push buttons located on the aft edge of the thrust levers and wait for the push. The thrust levers automatically come forward until the computed takeoff engine pressure ratio (EPR) values are met, and down the runway you go. The flight management systems (FMSs) figure out the V-speeds and EPRs for the conditions at hand, and the FADEC makes sure no engine limitations are exceeded.

The G-V is a highly automated airplane. Except for takeoffs and landings, most pilots let the SPZ do all the flying. And why not? The autothrottles will maintain the speed, altitude, and climb rate you plug into the glareshield-mounted autopilot controls, and the FMS will fly a preprogrammed procedure or route better than any human could.

Our initial climb is to be flown at 200 kt on an easterly heading, to an altitude

of 1,500 feet. That speed, altitude, and heading were dialed into the autopilot, and after liftoff an invisible hand moves thrust levers back to the precise setting needed for a 200-kt climb.

Out of 1,500 for 15,000 feet, the FLCH (for flight level change, and pronounced "Filch") button on the autopilot glareshield is pressed. This commands either a maximum performance climb or descent—in this case a climb. Up come the autothrottles, and we're in a 5,200-fpm climb at 250 kt. Except for the steering and rotation associated with takeoff, no one has touched the controls.

In 22 minutes and 22 seconds, we're at FL510 and the sky above is a dark, dark blue. Now it's time to flirt with coffin corner. After rolling into a 45-degree bank and holding a 5-degree nose-up pitch attitude, the attitude indicator sprouts a pair of "cat's whiskers"—pitch limit indicators that warn of a 70-percent degradation of lift. This is a warning that you're drifting toward the airplane's stall speed, but there's no buffeting and no stick shaker or stick pusher. This kind of buffet-free maneuvering at this high an altitude is exemplary. I'm thinking that this is pretty bold—yanking and banking so hard at this altitude—but I've got the feeling that the other Horne has done this many, many times before.

"We couldn't just add more fuel. The whole airplane had to be redesigned."

The control display units (CDUs), also glareshield-mounted, can be set to automatically and continuously display the V_{REF} speed for your current weight and configuration. Right now, for our approximately 59,000-pound, clean-configured airplane, it's 143 kt. I kept the nose aimed at the cat's whiskers, and the stick shaker came on at 123 kt, and the pusher kicked in at 110 kt. The aerodyanmic stall, Horne told me, would have come five to eight knots below pusher activation speed.

The Payne Stewart Learjet 35 accident had happened a day before, and the subject of rapid decompression was the topic of the moment at Gulfstream. How would you handle a rapid decompression at FL510 in a G-V? Again, the answer is automation. If the cabin altitude exceeds 8,000 feet, an automatic Emergency Descent Mode (EDM) is invoked. Horne tricked the pressurization system into thinking that

A pre-course and a three-week training course at FlightSafety International prepare first-time G-IV and G-V pilots.

the cabin was climbing by manually dialing up the cabin altitude. At 8,000 feet cabin altitude, EDM automatically rolled the airplane into a steep left bank, dived it at M_{MO} using the autothrottles, then leveled off at 15,000 feet—just as it was supposed to. Without speed brakes, our descent rate was 5,200 fpm. With the boards out, we plunged earthward at 8,600 fpm. While all of this is going on, pilots are freed to don their oxygen masks; the passengers breathe from the drop-down cabin masks.

The descent was arrested at FL280, the altitude where V_{MO} meets M_{MO}, and where we saw a Mach 0.85 number, a cruise indicated airspeed of 340 kt, a true airspeed of 506 kt, and a fuel burn of around 2,000 pph per engine. With our "meager" 10,000-pound fuel load (the G-V's maximum fuel capacity is 41,300 pounds, or approximately 6,164 gallons), we'd never realize the airplane's optimum range for that speed, but this exercise was to demonstrate the airplane's ability to fly at dash speeds on shorter legs, when high passenger loads and tankering of fuel may be the order of the day.

Low speed maneuvering

In preparation for the landings to come, Horne had me make some quick, 45-degree banks from one direction to another. The control forces are what you might expect from such a large airplane, and I had to throw the foot-wide yoke with gusto to make the roll reversals.

In slow flight, the cat's whiskers again came into play. Our V_{REF} for the upcoming landings came up as 118 kt on the CDU, so we slowed and then threw out the landing gear and full flaps. Speed bled off as power was reduced while maintaining altitude. The cat's whiskers popped into view, and Horne suggested a few roll reversals at 45 degrees of bank, with the airplane symbol tucked firmly into the notch in the whiskers. There was no stall buffeting. At 55 degrees of bank the same maneuver was repeated, but this time the shaker came on at about 122 kt—which was our approximate V_{REF} for our landing weight. The point being that at approach speeds you still could bank vigorously without fear of a stall—as long as you stayed with the cat's whiskers.

The cat's whiskers also can serve as a valuable wind shear, microburst, and terrain-avoidance escape tool. With full power (go ahead and slam the thrust levers forward all the way; the FADEC won't allow any engine redline excursions) and the pitch symbol up in the whiskers, you may reach stick-shaker, but you'll be climbing as safely as possible in such emergency situations.

Landings

I wish I could say that there was some super-special trick to landing the G-V, but there isn't. Fly V_{REF} plus five or 10 kt (depending on surface wind conditions) during the first portion of the final aproach course, then slow to V_{REF} as the wheels close on the runway. The Enhanced Ground Proximity Warning System (EGPWS—a standard feature) will count down your altitude above ground level as you settle.

"Forty feet...30 feet...20 feet," goes the automated voice. At the 20-foot callout Horne says to begin arresting the descent. At 10 feet, just think about flaring and raise the nose ever so slightly. My problem was a common one, I was told: letting the nosewheel settle too quickly to the runway after the main gear touchdown.

After an ILS and a visual approach, I was given a V_1 cut on the following takeoff. It wasn't too hairy. Maintain full power, stomp on the good engine's rudder, and keep the airplane symbol up into the command bars—that's all you need to do to climb away at what looked to us like 900 fpm.

The short-field landing was the most exciting. A very firm touchdown and aggressive braking gave us a 2,000-foot landing distance on Savannah's Runway 9—not bad at all for an airplane weighing some 57,000 pounds and touching down at 110 kt.

"The poor passengers!" Horne

PAUL BOWEN

said to Horne. "Ah, it's OK, we feel it more than they do because we're so far forward," he said. Maybe, maybe not.

I have it on good word that, in fact, two of our four passengers had slept through our entire flight routine. That included the stalls, the banks, and the emergency descent. But that short-field landing was a wake-up call.

Back there

With a 50-foot-long, seven-foot-four-inch-wide cabin, the G-V can be fitted out to suit any taste. The one we flew had luxurious leather seats; a couch; and, of course, a complete galley and aft lavatory. For an airplane designed to leap oceans *and* continents in a single bound, this is the kind of interior that you'd need to comfortably fly for 10 or more hours.

As Gulfstream interiors go, ours actually was rather conservative. When it comes to interior completion, anything goes, and the customer rules. That's why the price of a completed Gulfstream (or any other large business jet) can be all over the map. The base price of a green (uncompleted except for the cockpit) G-V is currently around $32 million, but an interior with gold fixtures, wide-screen entertainment centers, and a bedroom or two can bolt another $8 million or more to the ultimate price.

Weight is another consideration. The G-V has a 6,700-lb standard allowance for interior completion. The average completion weight, however, is 7,100 pounds, and some have weighed in at 8,000 pounds or more. So if you go with the marble flooring and multiple workstations and add a shower to the bathroom, then the extra weight will cut into your payload. The G-V's maximum payload with full fuel is 1,600 pounds, which Gulfstream translates into eight passengers plus baggage. As long as you don't bust the 6,700-lb interior allowance, you can top off the tanks, load those eight aboard, and fly 6,500 nm, Gulfstream says.

For all its grandeur, the G-V's competitor—Bombardier's Global Express—seems equally imposing. That airplane will be fodder for another story, hopefully also by Tom Horne. This one, of course, not that one—although I suspect that Gulfstream's Tom Horne would dearly love to probe the competition's envelope. □

Links to additional information about Gulfstream may be found on AOPA Online (www.aopa.org/pilot/links.shtml). E-mail the author at tom.horne@aopa.org

Gulfstream G-V
Average completed price: $39.5 million

Specifications

Powerplants	BMW Rolls-Royce BR710A1-10, 14,750 lbst each
Recommended TBO	7,000 hr
Length	96 ft 5 in
Height	25 ft 10 in
Wingspan	93 ft 6 in
Wing area	1,136.5 sq ft
Wing loading	79.6 lb/sq ft
Power loading	3.07 lb/lb thrust
Seats	Up to 19
Cabin length	50 ft 1 in
Cabin width	7 ft 4 in
Cabin height	6 ft 2 in
Basic operating weight (includes four crew)	48,000 lb
Maximum ramp weight	90,900 lb
Maximum gross takeoff weight	90,500 lb
Maximum payload	6,500 lb
Payload w/full fuel	1,600 lb
Maximum landing weight	75,300 lb
Maximum zero fuel weight	54,500 lb
Fuel capacity, std	6,164 gal (41,300 lb)
Baggage compartment capacity	2,500 lb, 226 cu ft

Performance

Takeoff distance, balanced field length	6,469 ft
Maximum demonstrated crosswind component	28 kt
Rate of climb, sea level	3,880 fpm
Single-engine ROC, sea level	1,280 fpm
Cruise speed/range/fuel consumption w/NBAA IFR reserves, 8 pax, 4 crew	
@ Maximum range cruise	Mach 0.80 /459 KTAS, 6,500 nm 2,600 pph
@ Normal cruise	Mach 0.85/488 KTAS, 5,700 nm, 3,070 pph
Maximum operating altitude	51,000 ft
Landing distance @ 75,300 lb	3,424 ft

Limiting and Recommended Airspeeds

V_{MCG} (min control w/one engine inoperative, ground)	103 KIAS
V_{MCA} (min control w/one engine inoperative, air)	112 KIAS
V_{YSE} (best single-engine rate of climb)	170 KIAS
V_A (design maneuvering)	206 KIAS
V_{FE} (max flap extended)	250, 20-220, 39-170 KIAS
V_{LE} (max gear extended)	250 KIAS
V_{LO} (max gear operating)	
Extend	225 KIAS
Retract	250 KIAS
V_{MO} (max structural cruising)	340 KIAS
M_{MO}	Mach 0.885
V_1 (takeoff decision speed)	140 KIAS
V_2 (takeoff safety speed)	146 KIAS
V_{REF} (landing reference speed)	136 KIAS
V_{S1} (stall, clean)	125 KIAS
V_{SO} (stall, in landing configuration)	108 KIAS

For more information, contact Gulfstream Aerospace Corporation, Post Office Box 2206, Savannah, GA 31402-2206; telephone 912/965-5555; fax 912/965-3084; Internet: www.gulfstream.com
All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, sea level, gross weight conditions unless otherwise noted.