

**A**s very light jets (VLJs) enter flight lines around the world, analysts expect accident rates at levels that — initially — will exceed those of other business aircraft.

Increases in accident rates historically have followed the introduction of new aircraft types. However, for the VLJs, several factors — notably their avionics and automation systems — are expected not only to help mitigate the increases but also to be the impetus for industry-wide safety improvements.

VLJs — defined as turbofan-powered airplanes weighing 10,000 lb (4,360 kg) or less and sometimes called “microjets” or “personal jets” — have begun to trickle into the business jet fleet. The first production certificate for a VLJ was issued Nov. 22, 2006, by the U.S. Federal Aviation Administration (FAA) to Cessna Aircraft for its Citation Mustang; the same day, the first Mustang was delivered to a customer. The only other VLJ manufacturer to deliver an aircraft is Eclipse Aviation, whose first Eclipse 500 was turned over to a customer in January.

Plans for most VLJ models are for twin-engine aircraft with four to six seats, typically capable of being flown at speeds of 300 kt or more and at altitudes up to 41,000 feet. Most are priced from about US\$1 million to nearly \$3 million. Most also are equipped with systems designed to reduce pilot workload and increase safety, including traffic-alert and collision avoidance systems, terrain awareness and warning systems (TAWS), real-time weather data and weather displays, and integrated electronic flight bags.

Many of these aircraft are expected to be flown by professional pilots in unscheduled commercial operations and corporate operations; some will be flown by nonprofessionals, typically pilots with considerable experience in turboprops or piston airplanes with highly integrated cockpits — that is, cockpits in which flight guidance, airplane systems and situational awareness control and display functions are combined into a minimum number of interdependent electronic displays.

**With the first very light jets making their way toward the flight line, analysts foresee a spate of accidents — and features likely to yield safety benefits in the long run.**

BY LINDA WERFELMAN

# ON THE VERGE



Production projections vary widely. One forecast, by the FAA, which the FAA itself characterized as “relatively conservative,” calls for VLJs to enter the active aircraft fleet at a rate of about 400 to 500 aircraft a year, reaching nearly 5,000 by 2017.<sup>1</sup> Other forecasts have predicted 15,000 VLJs by 2020.<sup>2</sup> However, Eclipse Aviation CEO Vern Raburn has said that, despite production delays, he expects that Eclipse alone will deliver about 400 Eclipse 500s in 2007 and nearly 1,000 in 2008.<sup>3</sup> Cessna, which has recorded sales of 250 Mustangs, projects deliveries of about 40 of the aircraft in 2007.<sup>4</sup>

### Unavoidable Accidents

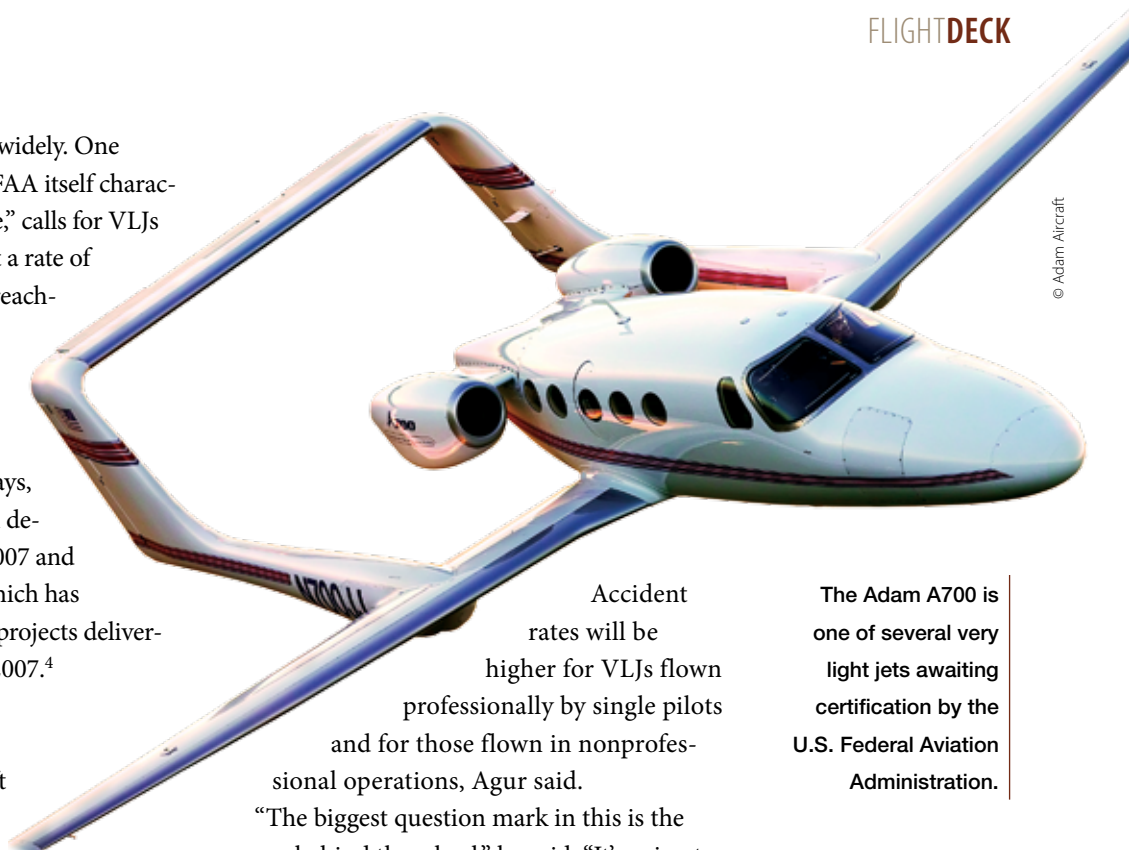
As these new-generation aircraft enter the fleet, accidents will be unavoidable, analysts say.

“You can look at a number of new-generation aircraft, compared to those same aircraft in later years, and accident rates start out relatively high,” said Robert Matthews, senior aviation safety analyst at the FAA Office of Accident Investigation. “Then you have kind of a learning curve, and after that, the accident rate comes down. The learning curve gets shorter with every generation of aircraft. ... The real point is that, after the ever-shorter learning curve passes, the accident rate for a new generation of aircraft reaches a stable state that is well below [the accident rates] of preceding generations.”

The shortening of the learning curve is a result of the knowledge accumulated by pilots and operators during the introductory phases of earlier aircraft generations, Matthews said.

Eventually, he and other analysts said, the accident rates for VLJs will differ little from accident rates for other business aircraft.

“Professionally flown VLJs will have an accident rate that’s comparable to the business jet fleet,” said Peter v. Agur Jr., president of The VanAllen Group, a business aviation consulting group, and a member of the FSF Corporate Advisory Committee.



Accident rates will be higher for VLJs flown professionally by single pilots and for those flown in nonprofessional operations, Agur said.

“The biggest question mark in this is the person behind the wheel,” he said. “It’s going to take a substantial mind-set change for some of them to realize that they can’t fly a VLJ like they would fly a Cirrus or a Bonanza.”

Training should help to accomplish that mind-set change, he said, referring to the partnerships that have developed between manufacturers and training vendors — often with encouragement from insurance companies — to craft training programs specific to each type of VLJ. Some of these training programs will rely, in part, on “mentor pilots” with experience in the aircraft to accompany the new VLJ pilots during their initial time in the cockpit.

The U.S. National Business Aviation Association (NBAA) has recommended a rigorous training process for single pilots of VLJs to address the areas of greatest risk, including many that touch on insufficient skills for use of a flight management system, autoflight equipment or another elements of the avionics and/or automation system. Among the areas emphasized for single pilots is single pilot resource management (SRM), the single-pilot version of crew resource management. SRM training discusses “the process of managing resources available to the single pilot, [including]

The Adam A700 is one of several very light jets awaiting certification by the U.S. Federal Aviation Administration.

Representatives of Avidyne say simplification of cockpit instrumentation was a primary consideration for designers of the Entegra.

the pilot’s resource of preflight planning, personal knowledge, materials and personnel on board the aircraft, and additional resources beyond the cockpit,” NBAA says.<sup>5</sup>

**Safety Influences**

In the long run, some of the VLJs’ own attributes may have the greatest influence on safety — not just for VLJ pilots and operators but also for other elements of the aviation industry.

“Some of it is pretty obvious — flying at high altitudes will keep these airplanes above much of the weather and high above terrain,” Matthews said, noting that altitude should provide some protection against en route weather-related problems and controlled flight into terrain. In addition, their higher power-to-weight ratios will give pilots an ability to at least maintain a safe altitude after an engine failure, he said.

Perhaps the most influential safety factor, however, may prove to be the advanced avionics and automation systems installed in VLJ cockpits.

“There is no question that these systems will constitute the greatest in-flight resource” for VLJ pilots — especially single pilots, said Capt. Richard J. Walsh, vice president of flight operations and business continuity for Cardinal Health and former director of operations and training for United Airlines.<sup>6</sup>

Agur said that the highly sophisticated avionics installed in VLJs will “improve the quality of information, and the simplicity of the automation of the system will be beneficial” in safe operations of the aircraft.

Mark Sandeen, vice president of sales and marketing for Avidyne — whose Entegra integrated avionics system will be in the cockpits of the Adam 700 and Spectrum VLJs — said that simplification of cockpit instrumentation and automation was a primary consideration for Entegra designers.

“A simpler flight deck is a safer flight deck,” he said.

The Entegra system will present standard flight instrumentation — attitude director indicator, horizontal situation indicator, altimeter, airspeed indicator and vertical speed indicator, as well as a moving map and weather, terrain and traffic information — simultaneously on high-resolution, flat-panel, liquid crystal displays and coupled with the autopilot.

“Having all of this information displayed at one time on one page ... is probably one of the biggest changes in 10 years,” Sandeen said.

Among the Entegra’s features is an integrated air data computer that provides a continuously



© Avidyne



© Cessna Aircraft Company

updated on-screen display of wind speed and direction, “taking the guesswork out of finding the right altitude to optimize ... flight time,” the company says.

In addition, six-second trend indicators for airspeed, altitude and heading — typically installed on air transport jets — can help reduce pilot workload associated with changing or maintaining airspeeds or altitudes, the company says.

Garmin’s G1000 integrated avionics suite is being installed in the Cessna Citation Mustang. In the Mustang, the avionics suite includes two 10-in (25-cm) primary flight displays and one 15-in (38-cm) multi-function display (MFD) — to present primary flight, navigation and communication information, as well as information on terrain, traffic, weather, engine instrumentation and crew-alerting system data. The all-glass avionics suite is designed to “simplify operation, enhance situational awareness and increase flight safety,” Garmin said.<sup>7</sup>

The integrated GFC 700 automatic flight control system includes roll, pitch and yaw control, and automatic pitch trim and Mach trim control, using data available to the G1000 to maintain airspeed references, Garmin said.

The Mustang was the first aircraft with an integrated flight deck to receive wide area augmentation system (WAAS) certification, enabling pilots to use global positioning system (GPS) information for precision instrument approaches. The primary benefit of WAAS navigation is that it provides pilots with highly accurate information about their aircraft’s latitude, longitude and altitude. A 2003 Flight Safety Foundation study concluded that use of WAAS-based instrument approaches could prevent 141 accidents and 250 fatalities over a 20-year period.<sup>8</sup>

Among other features on the G1000 is the Garmin SafeTaxi program, which helps pilots navigate at unfamiliar airports by providing a graphical representation of airport runways,

The Cessna Citation Mustang was the first very light jet to receive production certification from the U.S. Federal Aviation Administration.



© Eclipse Aviation

Eclipse Aviation calls the Avio NG avionics system on its Eclipse 500 a “virtual copilot.”

taxiways and hangars, along with the position of the aircraft on the ground. The program will include information on more than 700 U.S. airports; information on other U.S. airports and international airports will be added in the future.

The G1000 also includes ChartView, an electronic version of Jeppesen approach charts and airport diagrams that can be viewed on the MFD, thereby reducing the amount of paper in the cockpit, and FliteCharts, an electronic version of the U.S. National Aeronautical Charting Office (NACO) *U.S. Terminal Procedures Publication*, which includes departure procedures, standard terminal arrival routes, approach charts and airport diagrams.<sup>9</sup> About 17,500 approach plates for 2,916 airports are included.

Garmin’s G1000 with many of the same features, and a new name — the Prodigy flight deck — will be installed in the eight-seat Embraer Phenom 100, expected to enter service in 2008.

### ‘Virtual Copilot’

Eclipse Aviation characterizes its Avio NG avionics system as a “virtual copilot” designed

to reduce pilot workload in the Eclipse 500 by “simplifying tasks, generating useful information, managing systems and assisting with troubleshooting.”<sup>10</sup> The Avio NG will be produced with Innovative Solutions and Support, Honeywell, Chelton Flight Systems, Garmin International and PS Engineering — a partnership that was announced after Eclipse and Avidyne ended their working relationship in February.

The system, which uses integral, redundant computer systems to apply integration technology throughout the aircraft, “goes to work as soon as power is applied to the Eclipse 500 jet, bringing all aircraft systems to life and confirming normal operation,” the company says. “Avio NG prompts electronic checklists and walks the pilot through FMS entry, and calculates weight and balance, and performance.”<sup>11</sup>

During approach, the system “helps simplify this critical stage by maintaining approach speed with autothrottle, slowly bringing cabin pressure down and automatically keeping fuel balanced between the tanks,” the company says. Later, Avio NG verifies that the landing gear is down and locked and that flaps are set.

## Accident Avoidance

In a 2006 analysis of VLJ safety benefits and risks, Matthews said that their advanced avionics and real-time weather displays and flight monitoring — combined with other factors such as pilot training and increased engine reliability — would have helped avoid half of all fatal accidents that occurred in the past 10 years among airplanes operating under U.S. Federal Aviation Regulations Part 135, *Commuter and On-Demand Operations*.<sup>12</sup>

“With first-class avionics, with TAWS and terrain displays, it would be a whole lot easier for these aircraft to avoid flying into terrain,” Matthews said.

Agur said that the avionics and automation features being incorporated into VLJs eventually will lead to improvements in larger aircraft, including airliners.

“The development of integrated avionics technologies will be driven by the need for automation in single-pilot operations in VLJs, but it will affect the equipment in cockpits across the board,” Agur said. “These developments designed for VLJs will stimulate advances system-wide, driving safety improvements for the entire industry.

“In the long run, what’s coming for VLJs now will be tremendously beneficial to the rest of the industry.” ●

### Notes

1. U.S. Federal Aviation Administration (FAA). *FAA Aerospace Forecast, Fiscal Years 2006–2017*.
2. Baxter, Mary Pat. “So What’s All This About VLJs?” *FAA Aviation News*. July–August 2006.
3. Trautvetter, Chad. *A Better Brain for the Eclipse 500*. <[www.avweb.com/avwebflash/news/Better\\_Brain\\_Eclipse\\_500](http://www.avweb.com/avwebflash/news/Better_Brain_Eclipse_500)>.
4. Cessna Aircraft Co. *Cessna Delivers First Citation Mustang, Gains FAA Production Certificate*, Nov. 22, 2006. *Cessna Citation Mustang Wins Full FAA Certification*, Sept. 8, 2006. <[www.cessna.com/news/archives.chtml?year=2006](http://www.cessna.com/news/archives.chtml?year=2006)>.
5. U.S. National Business Aviation Association (NBAA). *NBAA Training Guidelines: Single Pilot Operations of Very Light Jets and Technically Advanced Aircraft*. January 2005.
6. Walsh, Richard J. “Risk Management for Very Light Jets.” In *Aviation Safety — Contemporary Challenges: Proceedings of the 50th Annual Corporate Aviation Safety Seminar*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2005.
7. Garmin. *Cessna Selects Garmin’s Integrated Avionics System for Citation Mustang*. March 31, 2003. <[www.garmin.com/pressroom/corporate/033103.html](http://www.garmin.com/pressroom/corporate/033103.html)>. *Garmin G1000 Enhancements Provide New Capabilities and Added Safety*. <[www.garmin.com/pressroom/aviation/101706.html](http://www.garmin.com/pressroom/aviation/101706.html)>.
8. Dodd, Robert; Jobanek, Jan M.; Li, Guohua; Barnett, Arnold. “Safety Benefits of the Wide Area Augmentation System During Instrument Approaches.” *Flight Safety Digest* Volume 22 (May–June 2003): 22–46.
9. This U.S. National Aeronautical Charting Office (NACO) information is more commonly associated with a NACO sister agency, the National Ocean Service (NOS).
10. Eclipse Aviation. *Eclipse Aviation Partners With World-Class Suppliers to Deliver Next-Generation Avio Total Aircraft Integration System*. March 5, 2007.
11. Eclipse Aviation. *The Next Generation of Avio Total Aircraft Integration*. <[www.eclipseaviation.com/eclipse\\_500/avio](http://www.eclipseaviation.com/eclipse_500/avio)>.
12. Matthews, Robert. “Corporate Aviation Safety: The Year in Review.” In *Aviation Safety — Supporting the Corporate Mission: Proceedings of the 51st Annual Corporate Aviation Safety Seminar*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.

### Further Reading From FSF Publications

- Werfelman, Linda. “Sidestepping the Airway.” *AeroSafety World* Volume 2 (March 2007): 40–45.
- FSF Editorial Staff. “Here Come the Very Light Jets.” *Flight Safety Digest* Volume 24 (July 2005).
- FSF Editorial Staff. “Increased Reliance on Automation May Weaken Pilots’ Skills for Managing System Failures.” *Human Factors & Aviation Medicine* Volume 52 (March–April 2005).
- FSF Editorial Staff. “RVSM Heightens Need for Precision in Altitude Measurement.” *Flight Safety Digest* Volume 23 (November 2004).
- FSF Editorial Staff. “Global Implementation of RVSM Nears Completion.” *Flight Safety Digest* Volume 23 (October 2004).

**“The development of integrated avionics technologies will be driven by the need for automation in single-pilot operations in VLJs.”**