The safety side of visualization

The digital visualization revolution unfolding in general aviation is already showing safety dividends. For this trend to continue, the right training and proper mindset will be required. Jan Tegler explains.

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Raymond Wagner, chief pilot for Take Flight Aviation in rural New York, was approaching Orange County Airport with a student pilot at the controls when he noticed the student ignoring the localizer needle on the instrument panel in favor of a nearby display showing a virtual rendering of the world outside his cockpit.

Wagner, of course, would not let matters become dangerous, but the student's total focus on the synthetic vision system, or SVS, was worrisome, because the localizer needle helps a pilot line up with a runway, such as the one they were headed for in their Diamond DA40. Synthetic vision systems provide valuable awareness about terrain, weather and air traffic, but they do not tell a pilot everything he needs to know to land safely. Over reliance on SVS could lead to a missed approach or, in theory, to a deadly accident.

In fact, the tendency of students to fixate on their SVS display is so common that Wagner and fellow instructor Merle Minks turn off the display on initial instrument training flights to force students to use the localizer needle.

Those in the avionics and training industries have firm ideas for how to deal with those risks and ensure that the technology continues to improve safety among general aviation pilots.

The SVS technology, and the weather-piercing enhanced vision systems, or EVS, that are starting to join them on some aircraft, received a boost from FAA a little over a decade ago. The agency began sponsoring research on the technology at MITRE Corp.'s Aviation Integration Demonstration and Experimentation for Aeronautics Laboratory. The main goal was to see how the technology could support the agency's equivalent visual operations initiative, the aim being

Approaching a runway, a pilot would see what's on the left with the naked eye; on the right is what the pilot would see on the head-up display on the combined vision system made by Collins Aerospace.

Collins Aerospace

to safely narrow the separation among aircraft during instrument-only flying so it is equivalent to the separation when visibility is good.

FAA has only partially achieved equivalent visual operations, but as it turns out, SVS and EVS are doing more than empowering air traffic controllers to safely pack aircraft closer together in the sky. "There's a greater good," says Brian Ast, who leads human factors engineering from Garmin's company headquarters in Kansas.

Reducing terrain accidents

One benefit in general aviation has been a reduction in cases of CFIT, or controlled flight into terrain, when a pilot does not realize his aircraft's dangerous course until the last moment, if ever. Particularly vulnerable to CFIT are pilots who are rated to fly only in good visibility under visual flight rules as opposed to those rated to fly in poor visibility under instrument-flight rules. "Let's say a VFR pilot inadvertently flies into clouds. The pilot can use an SVS to safely turn around and fly out of the clouds. And maybe he decides to make a 180-degree turn to the right instead of the left because with the SVS you can see a representation of mountainous terrain or an obstacle over there," says Ast.

Jens Hennig of the General Aviation Manufacturers Association in Washington D.C., says the history of SVS is starting to prove the benefit. "If you look at when installed avionics and tablets with flight information like SVS first started to become available in general aviation around 2006, you'll see that this is when we finally started seeing certain fatal accident categories such as CFIT start declining."

Specifically, the rate of fatal general aviation accidents per 100,000 flight hours fell to 0.05 in 2016, down from 0.12 in 2008, according to an analysis released by the General Aviation Joint Steering Committee, an industry-government group founded in 1997 under FAA's Safer Skies Initiative.

"That's a decline of CFIT accidents by more than half in eight years, a good decrease," says Hennig.

Advocates of SVS are anxious to learn from the National Transportation Safety Board whether the technology was aboard the Sikorsky S-76B helicopter that crashed near Calabassas, California, in January, killing Kobe Bryant and eight others.

"You wonder if they had better terrain awareness in that aircraft, would that have been helpful?" says author and pilot Tom Haines of the Aircraft Owners and Pilots Association.

If Bryant's pilot did not have SVS aboard it would not be surprising. Synthetic vision is not yet widely installed in helicopters, although it is common in business jets, turboprops and fixed-wing general aviation aircraft and is coming soon to commercial airliners.

Airline pilots rely on EVS

As for EVS, airline pilots are the primary users of the technology. Video cameras on a plane's nose or wing are tuned to detect invisible thermal radiation and project scenes of terrain and obstacles in green shading on a glass panel known as a combiner positioned in front of the windscreen. In some versions, millimeter-wave radars integrated with the cameras pierce fog, smog and clouds. Trained to fly on instruments, professional pilots rely especially on EVS with its head-up display to help them take off, land and navigate in all kinds of weather conditions, day or night.

Pilots with proper training and FAA authorization can land Gulfstream business jets equipped with the company's enhanced vision flight system "with sole reference to the EVS image versus natural vision," says Jeff Hausmann, Gulfstream Aerospace Corp.'s director of advanced flight decks.

Even when a pilot can't see a runway with his eyes, he can look through an EVS to see an image of the runway with the flight symbology overlaid on it. This view can guide the pilot almost to touchdown. The final touchdown and the subsequent rollout or slowing would most likely be performed by the pilot with his or her own eyes, because FAA regulations for EVS require 305 meters of runway visual range — the distance over which a pilot can see markings delineating the runway.

Collins Aerospace's marketing manager for head-up vision systems, Grant Blythe, says airlines are choosing EVS for new jets they're adding to their fleets. The company's EVS is available for Boeing's 737 NG and MAX models. Blythe adds that the company is seeing particular interest for its EVS among Asian airlines.

"In Beijing or Dehli there's ever-present smog," Blythe says. "It causes a lot of problems for airplanes there, and the EVS technology is magical for seeing through that and solving their issues."

Collins also is supplying SVS and EVS as part of a tailored avionics package for the Lockheed Martin X-59 experimental supersonic plane that is the focus of NASA's Low Boom Flight Demonstration program aimed at quieting supersonic aircraft. Designed without cockpit windows to help minimize noise-producing shockwaves at supersonic speed, the X-59's lack of natural forward vision means pilots will be totally reliant on SVS and EVS. Collins' EVS will be displayed on a screen in its instrument panel rather than a head-up display or HUD in the X-59.

Blythe says the systems will enable X-59 pilots to land in "nearly all conditions."

Training GA pilots

For general aviation pilots, practice and self-discipline may be the key to staying on the right side of the risk-benefit equation, industry officials say.

▲ **An illustration of the** completed X-59 Quiet SuperSonic Technology aircraft landing on a runway. Because the experimental supersonic plane was designed without cockpit windows to help minimize noise-producing shockwaves at supersonic speed, pilots will rely on synthetic and enhanced vision systems displayed on a screen in its instrument panel.

Lockheed Martin

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— Ric Peri, Aircraft Electronics Association

Flight instructors will play a large role and right now many "have a lot of homework to do" to gain enough knowledge to teach student and experienced pilots about the capabilities of vision systems and avionics, says John Niehaus a certified flight instructor, Learjet charter pilot and director of program development for the National Association of Flight Instructors. "You almost need to create an additional course to fully understand the capabilities."

Niehaus notes that synthetic vision systems are part of avionics packages on many of the planes in which instructors teach. Two- and four-passenger private planes including Diamond Aircraft's DA 40 and Cessna's classic 172 can be purchased from the factory with the technology.

Ric Peri, the Aircraft Electronics Association's expert on government and industry affairs, says the avionics industry is aware that there may be a need for more training.

"The new and novel is always a mind-grab," Peri says. "It's almost overwhelming when you look at a display and see through clouds, but as you learn it and become accustomed to it, you use it more and more effectively."

Peri reasons that there is "a balance to strike" in adopting vision systems. "Do I need one if I'm a pilot flying a Cessna 182 around the patch? Probably not, but if I'm going cross country or flying in congested airspace it really helps."

When a pilot does decide to install SVS or buy an aircraft with the technology on it, he must be judicious about how much reliance he places on it. "They can suck you right in," says Haines. "I've been mesmerized and see it all the time in other pilots who are continuing to focus on the displays even on nice days when you can see well outside."

Haines suspects that the flight training he received decades ago in aircraft equipped only with analog instruments reminds him to look outside of his aircraft more often than younger pilots might. He understands the temptations when he flies his modern Beech A36 Bonanza.

"I've got synthetic vision with a flight path marker," says Haines. "When you're flying an IFR approach, it's almost like cheating. You basically put the green flight path marker on the end of the runway and fly to it. You've got to pay attention to altitude but it is very helpful to those of us who fly for transportation and have the need to get places."

According to Niehaus, for VFR and instrument-rated pilots there's a fine line between teaching them to take advantage of the benefits of vision systems and having them become overconfident because of what they have.

"A good instructor will say that just because you see the terrain or a thunderstorm on your screen doesn't mean you have all the information you need. Look outside, make sure you understand what's in front of you."

Blythe says that vision systems "are so intuitive for the way the brain processes images" that they

▲ **The Symmetry Flight** Deck in the Gulfstream G700 has dual head-up displays.

Gulfstream

can return pilots' situational awareness with a glance if they get disoriented. The downside is that they "are so compelling" that pilots may rely on them too much.

Niehaus says students and experienced pilots transitioning into cockpits with SVS or EVS, which is becoming available for general aviation planes too, tend to "look at the fun new toys instead of looking outside." He adds that he has seen pilots "staring at the blobs of bad weather on an SVS display when in reality they're flying right into what they're trying to avoid because they're not looking outside."

"Proper training is very important," says Roger Dykmann, who directs sales for BendixKing, an avionics maker for general aviation aircraft based in Albuquerque, New Mexico. "We encourage pilots to evaluate their panel requirements for their style of flying, make educated decisions about how to equip their aircraft and then properly train for that equipment."

So far, aircraft and avionics manufacturers haven't incorporated cues in vision systems to remind general aviation pilots to keep their eyes out of the cockpit when possible. For now, says Ast, instilling the importance of visual engagement whenever possible should be done in training by "your flight instructor, safety pilot or whoever it may be trying to keep you safe."

But Ast thinks cues and "those types of improvements will come" as the cost of the avionics go down. "That's where the industry needs to be headed now," he concludes.

For airline pilots, Collins Aerospace has developed a laptop-based virtual reality trainer to help them get comfortable with looking through EVS head-up displays to perform approaches, landings and takeoffs before they go through instruction on airlines' full-motion simulators where training time is expensive and limited. The trainer's software can also render high fidelity SVS images and could be adapted as an SVS training tool.

"Having the ability to practice procedures, to transition from a synthetic vision or enhanced vision image to natural vision is a real advantage," Blythe says.

Hennig of the manufacturers group says synthetic vision systems and someday maybe even enhanced vision systems are on their way to becoming a standard component of general aviation avionics and that pilots will adapt to them as they have to new technology throughout aviation history.

"There's data to show there's always someone who uses technology incorrectly, but I also have data where you see the drop off of accidents if they use it properly," he says. ★