Training the VLJ Pilot

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Introduction

The advent of very light jets (VLJs) is one of the most exciting developments in recent aviation history, both because of technology advances and the uses envisioned for these aircraft. However, despite what some marketing executives might have us believe, a VLJ is *not* simply a Cessna 172 on steroids. A VLJ has different systems and capabilities, operates in different flight regimes at significantly higher speeds, and places different demands upon its pilots, who will be highly diverse in previous flying experience. All of these differences must be considered when designing training for pilots flying in all types of VLJ operations: corporate flying, air-taxi service, and personal flying. Aviation magazine articles on VLJs abound, and both the NBAA and the FAA have developed materials applicable for VLJ training – the NBAA through their *Training Guidelines for Single Pilot Operations of Very Light Jets and Technically Advanced Aircraft* [1], and the FAA through their FITS program (FAA-Industry Training Standards for Technically Advanced Aircraft) [2]. However, some important VLJ training issues, such as the training footprint, single pilot resource management, cognitive load, currency, and mentoring programs, have not been covered in much depth and deserve attention because they can have a very real effect on operational safety.

Who are (Potential) VLJ Pilots?

Pilots with diverse types of experience will be seeking to transition to a VLJ and fly it either as a single pilot or as part of a two-pilot crew. As the number of differences grow between a pilot's current aircraft (and type of operations flown) and his or her new VLJ, so too does the amount of new information to be mastered and skills to be learned. (Most VLJ manufacturers will require that all of their customers enter VLJ training with multi-engine and instrument ratings.)

Even pilots currently flying the same types of aircraft will vary substantially in previous experience. Pilots with military or commercial aviation experience will be accustomed to standardized procedures and concepts such as crew resource management (CRM) but many other pilots will be much less experienced with these aspects of operation. Total flight time, actual IFR time, and experience flying in busy and congested airspace will span a wide range. Attitudes with which these pilots approach VLJ flying will also differ. Some will be career pilots and/or fly for the love of aviation. Others may see the VLJ mostly as just a prestigious and convenient way to get around – a means to accomplish some other end. Training all VLJ pilots to similar standards of proficiency, professionalism, and level of safety presents quite a challenge for instructors. Clearly, a "one size fits all" approach will not work.

Approaches to VLJ Training

Some of the most challenging issues for many VLJ pilots are likely to fall in the areas of using standardized procedures, planning, judgment and decision-making, situation awareness, and management of workload, resources, and automation.

A flexible training footprint is needed especially for VLJ pilots who have only personal flying experience, and perhaps also to some degree for most pilots who have not gone through highly structured and rigorous training programs, such as those provided at airlines or in the military. These pilots are typically used to getting training on their own schedules and at their own pace—training customized to their levels of skill and experience. Professional educators refer to such individuals as "adult learners," but what exactly does this mean? Adult learners tend to be fairly self-directed and are capable of critical reflection during the learning process. They learn best when actively engaged in questioning, analyzing, and doing, rather than being lectured to and PowerPointed to death. Many VLJ trainees will have positions of great responsibility and authority in other areas of their lives. Instructors can tap into this experience during training (e.g., emphasizing professionalism), but must be aware that these pilots may be very uncomfortable in situations in which they might appear unskilled or inept. Instructors will need to work with trainees to analyze the expertise and knowledge these pilots already bring to the task, to situate the learning in this context, and to tie the training to previous experience and the motivations of trainees.

This need for flexibility runs counter to the fixed (and sometimes compressed) training schedules many VLJ manufacturers offer as a part of the VLJ purchase price. And because this training will typically be conducted in simulators under FAR 142, which requires a standardized curriculum and schedule, ways must be developed to provide sufficient flexibility to accommodate individual trainee needs while still meeting the FAA-approved standard curriculum. Problems with variability among trainees can be partially ameliorated by carefully assessing trainees' existing experience, skills, and attitudes with a combination of interviews and simulator exercises before starting the formal curriculum. Trainees who have problems with this screening process could be provided customized training up-front to prepare them for the standardized curriculum (or be given the option of having their purchase deposit refunded). Several manufacturers are implementing this type of pre-VLJ training evaluation.

Scenario-Based Training

Over the years, the airline industry has developed the concept of scenario-based training (SBT), which goes beyond the technical aspects of systems knowledge and aircraft-handling skills, to help pilots learn and practice the higher-level skills necessary to *manage* a flight. SBT is also a cornerstone of the FAA FITS program. In the classroom, instructors lead discussions of how to plan flights and anticipate and respond to threats to safety. VLJ simulator training can draw upon the airlines' Line-Oriented Flight Training (LOFT), in which pilots fly complete flights, starting with flight planning, and respond to diverse challenges that are encountered in both normal and non-normal situations during flight. These simulations allow trainees to practice decision-making and managing workload, resources, and automation in realistic conditions.

SRM is not CRM

Crew Resource Management (CRM) is an essential part of airline training and operations, providing techniques for crews to manage all available resources when dealing with in-flight challenges. Following a series of air-taxi accidents, the NTSB called on the air-taxi industry to provide CRM training for part 135 pilots, and this will clearly be important for VLJ two-pilot operations. But what about VLJs operated by single pilots? The FITS program includes the concept of CRM for single pilot operations - - Single Pilot Resource Management (SRM) - - but little has been written about specific techniques for putting SRM into practice.

SRM is usually discussed in the industry in one of two ways. The first is to define CRM and then state that SRM is the same as CRM, but with only one pilot. Sometimes great pains are taken to identify all others with whom the single pilot may interact (i.e., ATC, fuelers, maintenance personnel, passengers) as the single pilot's "crew." Occasionally some mention is made of what is lost when there is no co-pilot but how this loss changes the concept of resource management is usually not discussed.

The second approach is to list all the resources that a single pilot will have at his or her disposal, perhaps provide a few examples about how these resources might be used (e.g., have a passenger be in charge of folding/handling charts), and then counsel that it is the pilot's job to "manage" the resources. Other than the few examples given, *how* this management should be accomplished is never really described.

Although CRM is a broad concept that covers many topics, the core theme has always been *crew* communication and coordination. Many of the other aspects of CRM, such as planning, decision making, workload management, and situation awareness, flow from this core theme. Although ATC, fuelers, and (non-pilot rated) passengers can be important resources for a single pilot, they do not and cannot play the same kind of role that a second pilot in the cockpit plays. They cannot fly the aircraft, handle most co-pilot duties, provide back-up and double-checking, or raise questions and make suggestions the way that a second pilot on board the aircraft does.

So, though some may consider it blasphemy, we hold that SRM is qualitatively different from CRM. In SRM, the emphasis must be on flight planning, decision making, and especially on workload management. Workload management includes managing task demands, using resources effectively, and maintaining situation awareness. It is easy to get overloaded and lose situation awareness when flying as a single pilot and will be even more so in a VLJ, given how much more quickly events will transpire at higher speeds. Pilots who are even just a little rusty on the avionics may quickly find themselves behind the aircraft and in over their heads. In training single pilot workload management, reducing workload by performing tasks early whenever possible should be emphasized—for example, programming the flight plan on the ground and preparing for arrival before starting descent. In flight, pilots can reduce workload by strategically shedding lower-priority tasks and using the autopilot effectively. During the busy arrival period, pilots may also "buy time" by reducing speed, asking for delaying vectors or even requesting holding, though it is not clear how happy controllers will be if these requests from VLJ pilots are frequent and bog down the flow of traffic.

From airline operations we have learned that it is crucial not to get sucked into tending the automation during busy periods such as approach—rather, pilots can go to lower levels of automation that require less pilot input, such as flying through the mode control panel, and in some cases it is even better to revert to flying manually. However, single pilot operations may require somewhat different approaches to automation management than crew operations, and research is needed to develop appropriate guidance for the former.

The total volume of workload is not the only issue in cockpit task management; pilots must frequently juggle several tasks concurrently by switching attention back and forth [3]. Concurrent task demands are especially high in single pilot operations, but many pilots—like drivers attempting to drive while talking on a cell phone—underestimate how drastically "multi-tasking" increases vulnerability to error. Inadvertent errors of omission, such as failing to complete an interrupted checklist or dropping the instrument scan are common manifestations. SRM training should provide pilots with explicit techniques for managing concurrent task demands—for example, creating conspicuous cues, such as placing an empty coffee cup on the gear handle, as a reminder to resume an interrupted task.

The effectiveness of simulation training could be increased by developing sets of scenarios that present task management challenges at different levels of difficulty for each phase of flight. Encountering these challenges, trainees could practice prioritizing tasks, strategically shedding lower-priority tasks, buying time, and selecting a level of automation that will help reduce workload. Many accidents could have been prevented if the pilots had focused only on those tasks that were absolutely essential. Instructors might develop practical "rules of thumb" for using specific resources as a function of workload and phase of flight and train these rules, starting with ground instruction. Workload often builds up so insidiously that pilots may not recognize that they are getting task saturated, so it is especially important to provide techniques to help them recognize and respond to overload before it gets out of hand.

Ground school CRM training often includes a discussion and analysis of relevant incidents and accidents. This activity can be an invaluable component of CRM or SRM training but to connect to VLJ trainees' experience, the examples used should come from the types of flying already familiar to the trainees, and then expanded to VLJ flying and operations.

Cognition in the Cockpit.

Manufacturers are working to design VLJs that are as easy to use as possible and feasible for single pilot operations through use of advanced and integrated avionics, autoflight, and automated aircraft systems (e.g., FADEC). In fact, many tasks, such as engine operation and fuel management, will be far easier for pilots in VLJs than in the aircraft they currently fly. However, some of this advanced technology can be both a blessing and a curse. There is no doubt that flying VLJs (and other technically advanced aircraft) will be a highly cognitive endeavor. Not only are the usual cognitive skills still required, such as remembering ATC clearances and making appropriate decisions, but now pilots must also monitor mode annunciations and flight management systems, understand aircraft performance differences under different automation modes, and remember how to locate and use various resources on a multi-function display. (One popular GA glass cockpit requires nine separate steps just to change the backlighting on the primary flight display.)

Properly used, advanced automation can indeed make pilots' tasks more manageable, but the cognitive demands of operating the automation can get pilots into trouble quickly if they do not stay current and proficient in its use, if they are simply taught which buttons to push rather than being provided a conceptual map of how the automation works, if they do not adjust the level and type of automation used to the situation at hand, or if they succumb to "automation complacency" (unwittingly assuming that everything the automation is doing must be correct and essentially relinquishing management of the flight to the automation).

A recent study conducted at NASA Ames Research Center examined the types of problems that all types of potential VLJ pilots are having in the aircraft they currently fly, as evidenced by incidents and accidents that occurred during a 12-month period [4]. These problems have implications for training VLJ pilots and point to issues not previously identified in discussions of VLJ operations.

In this analysis of 388 Aviation Safety Reporting System (ASRS) incident and NTSB accident reports, one rather surprising finding was that almost two-thirds of the events involved some type of difficulty with cognition in the cockpit: confusion, poor decision making, distraction, prospective memory problems (i.e., forgetting to perform an intended action at a later time), and habit capture, among others. (Habit capture refers to performing an habitual action when a different action was intended, such as leveling off at the altitude called for in a frequently-flown departure procedure when ATC has already cleared you to a higher altitude).

Cognitive performance difficulties in aviation can have serious safety consequences. Flight path deviations (e.g., busting altitude) were frequently associated with problems with cognition and/or using advanced aircraft avionics. For example, flight path deviations occurred in 67.4% of the 46 events in which the pilot was distracted and in 80.5% of the 41 events in which the pilot had difficulty using the avionics.

A more thorough understanding of the roots of these cognitive problems is necessary in order to devise proper interventions, and this will require empirical research. Was a loss of situation awareness due to mismanaged workload, complacency, distraction, or inadequate proficiency/currency? Did confusion using avionics arise from the pilot's lack of thorough understanding of the system, non-intuitive or cumbersome system design, automatic mode changes, some combination of each, or something else entirely? Training and frequent practice with advanced avionics systems will ameliorate some of these problems, but human-centered design of automation and interfaces is also crucial.

The speed with which events will transpire in a VLJ will increase the cognitive demands on the pilot. In the NASA study, 281 of the 388 aircraft involved were advanced single-engine piston or light twin aircraft [4]. Although a few aircraft capable of fast speeds were represented in this number (e.g., Piper Malibu, 234 KTAS), none of the singles or light twins in the study was capable of VLJ-type speeds (generally between 340-500 KTAS). Consider how much more demanding it is to sort out any confusion, assess a problem or potential risk, make alternative decisions, and generally stay ahead of an aircraft that travels three to four times faster than what you are used to. With training and experience, VLJ pilots will certainly learn to operate at these speeds—the question is how much will be required for pilots who have not previously flown at these speeds, particularly in single pilot operations?

How Current is Current?

Insurance carriers will likely mandate yearly recurrent training for VLJ pilots, but maintaining currency between training sessions may be an issue for pilots who do not fly VLJs for a living. Presently, currency requirements include three take-offs and landings to a full stop prior to carrying passengers and shooting six instrument approaches every six months. These minimum requirements may not allow pilots of advanced aircraft to remain proficient in aircraft handling and operating procedures and in using advanced avionics. "JEB" Burnside recently wrote in *Aviation Safety* that "…the learning curve for some of the [avionics] equipment can be steep. Many pilots confess to still learning all the things their Garmin 430/530 can do after several years' use. And most panel-mounted avionics cannot hold a candle to the FMS-like equipment planned for VLJs." (pg. 18, [5]). Pilots who do not use this equipment on a regular basis can quickly become rusty and, in the stress of flight operations, have difficulty remembering how to perform critical functions.

Problems with lack of currency go beyond the use of advanced avionics, however. In our NASA study we found that fewer hours of recent experience was significantly associated with a disproportionate number of incidents and accidents [4]. Twenty-five percent of the 388 pilots had flown 24 or fewer hours within the previous 90 days, yet these lower-currency pilots were involved in over a third of all the NTSB accidents analyzed. This lower 25% group were also involved in half of the low-fuel arrival or fuel starvation/exhaustion events and involved in over half of the fatal accidents in which recent experience could be determined. Half of the 388 pilots had logged fewer than 63 hours in the previous 90 days, and this half were involved in 70% of the CFIT accidents recorded.

We are not suggesting that new currency regulations should be instituted, but we believe that guidelines and strategies for maintaining proficiency in VLJs and other technically advanced aircraft are needed for pilots who will not be flying these aircraft frequently. These strategies can be customized to the experience and flying patterns of the individual pilot. Flight training devices (FTDs) used at home can be very helpful with practicing procedures and using avionics systems. These devices are even more helpful when used with software that allows pilots to practice flight planning and decision-making in realistic weather scenarios. Periodic flights with an instructor or a mentor pilot (discussed next) are, of course, another strategy less-frequent flyers may find beneficial.

Mentor Pilots

Some, though not all, VLJ manufacturers are developing mentor programs in which highly experienced pilots will fly with newly-minted VLJ pilots who do not have extensive experience in jet operations. Participation in a mentoring program may even be required for these less experienced pilots to obtain insurance. Additionally, following the completion of training in a level C or D flight simulator or flight training device, some VLJ pilots will be required to obtain 15 or 25 additional hours of supervised operating experience (SOE) in order to exercise pilot in command privileges without limitations (see FAR 61.63(e))—it is conceivable that this SOE could be completed through a mentoring program. Even for many pilots not required to complete SOE following training, mentoring could provide an invaluable bridge from initial training to the challenges of actual flight operations in diverse conditions. However, the VLJ industry will need to address several crucial questions in designing these mentoring programs. For example: Should mentoring conducted as a part of SOE differ from mentoring when no SOE is required? When SOE is not required, will the mentor be an instructor and provide instruction or just be a safety pilot? If not an instructor, would the mentor take command of the aircraft if the VLJ pilot got into a dangerous situation? Will the mentor be required to certify when the VLJ pilot is ready to fly solo in non-SOE situations, and if so, to whom would this information be given? Will the mentor even be required to have a type rating in the aircraft? These and other issues involving mentoring programs and the use of mentor pilots remain to be worked out.

Conclusion

The VLJ industry is opening up exciting new realms for personal flying and for corporate and air-taxi operations. Safety in any realm of aviation is of course crucial, and training requires special attention when new types of aircraft are developed. Understanding the cognitive demands of VLJ operations, especially involving single pilots, and developing training focused on workload and automation management that is tailored to the experience of individual VLJ pilots should help make the transition to the era of the VLJ as smooth and safe as possible.

References

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