FLYING LESSONS for January 3, 2019

by **Thomas P. Turner**, Mastery Flight Training, Inc.
National Flight Instructor Hall of Fame inductee

FLYING LESSONS uses recent mishap reports to consider what *might* have contributed to accidents, so you can make better decisions if you face similar circumstances. In almost all cases design characteristics of a specific airplane have little direct bearing on the possible causes of aircraft accidents—but knowing how your airplane's systems respond can make the difference as a scenario unfolds. So apply these *FLYING LESSONS* to the specific airplane you fly. Verify all technical information before applying it to your aircraft or operation, with manufacturers' data and recommendations taking precedence. **You are pilot in command and are ultimately responsible for the decisions you make.**

FLYING LESSONS is an independent product of MASTERY FLIGHT TRAINING, INC. www.mastery-flight-training.com

Pursue ***Mastery of Flight***

This week's LESSONS:

Let's kick off 2019 with some reader Debrief mail.

Questions? Ideas? Opinions? Send them to mastery.flight.training@cox.net

Debrief: Readers write about recent *FLYING LESSONS:*

Many of you wrote about last week's *LESSONS* concerning total electrical failure and scenario planning. Frequent Debriefer and prolific CFII/MEI Dave Dewhirst writes:

> Great article. Those thoughts are exactly what we should be teaching. The best opportunities are during airplane specific transition or during a biennial Flight Review. **Take each system one at a time and determine how many ways that system can fail.** It might not be electronic. A cable can break on a fuel selector. One of the problems is that most flight instructors have never given any thought to how to create these kinds of training routines.
>
> I am a firm believer in redundant systems, not just redundant instruments. On legacy airplanes, any avionics technician who recommends deleting the vacuum system should be shot. These old airplanes still represent 50% of the fleet. They do not have left and right busses, triple-fed buss, buss tie, or an essentials buss. The airplane has one buss and the technician has hooked everything to the single source of power, calling it an upgrade. A battery-operated flight instrument with a 30-minute life is not much of a backup. Keeping the vacuum system to drive a set of flight instruments allows the pilot to fly to the limit of his fuel. Further, he does not need to select any emergency system, it is always ON. The real head-shaker is the technician who has to keep the vacuum system to operate the boots and then deletes the vacuum instruments. That is just nuts.

Thanks, Dave. First, to address your last point, I agree: if an airplane's pneumatic system must be retained to operate its deice boots system, there's no reason not to use that same system to power at least backup flight instruments. Commenting further…

For most of aviation's history we have flown IFR in airplanes that are extremely minimally equipped by today's standard. Even as recently as when I began teaching in high-performance aircraft in the early 1990s, it was extremely uncommon to have any secondary ("backup") instrumentation at all; standby instrument air systems for air-driven attitude gyros had only just begun to become standard equipment in new-production airplanes, and emergency electrical generation was a rarely installed option that had significant limitations. This when the vast majority of the fleet was a generation behind in emergency instrumentation and electrical redundancy, because the vast majority of the "hard IFR" general aviation fleet at that time had been built before 1982.

Cirrus Design products and the rise of owner-flown turboprops (and now, "pure" turbine) has made the percentage of legacy airplanes in the "hard IFR" fleet smaller. These new airplanes, and older airplanes that have been greatly updated, often do have redundancies we didn't even see at the beginning of my high-performance aircraft career. The trend over the last several years was to go all-electric primarily to avoid the perceived greatest threat, that of instrument air (vacuum or pressure pump) failure.

I believe it was Sporty's Pilot Shop that commissioned (from, I believe, Mid-Continent Instruments) the first comparatively low-cost, battery-powered backup attitude indicators. Somewhere along the way someone successfully lobbied for permitting use of these and similar devices as a replacement for the IFR-required turn coordinator/turn and bank, as long as a slip/skid indicator was retained in some fashion. This helped popularize the backup attitude indicator as a feature in many legacy IFR airplanes. Glass cockpit designs then seized on these electric horizons as the required backup for electric Primary Flight Display (PFD) installations, and the pneumatically-driven gyroscopic attitude indicator began to become a thing of the past. The ***greatest perceived mechanical threat**** to controlled flight in Instrument Meteorological Conditons (IMC), vacuum or pressure pump failure, was eliminated in these aircraft.

See:
www.sportys.com
www.mcico.com

*I say *perceived mechanical* threat, because the *real* greatest threat to continued controlled flight in IMC, mechanical or otherwise, is pilot performance as affected by human factors.

I wrote often in those early days of "glass cockpit" installations that general aviation had taken a big step backward in redundancy. I was referring primarily to tying almost all PFD indications to a single Attitude/Heading Reference System (AHRS) which, if it went awry, would take out both primary and any reversionary flight modes. The electric backups cover what I believe is *the greatest perceived mechanical threat* to AHRS-driven flight, anything that disturbs AHRS function.

Many *FLYING LESSONS* readers know that about two years ago I was tasked with planning and managing the update of an early 1980s airplane to "modern" standard (at least what we call modern today; check back in a couple of years). This included consideration of whether to replace the instrument air pressure system, which powered the attitude indicator and in turn had its own emergency backup pressure pump, with an all-electric system. It was not an easy decision, and in fact several pilots and mechanics cautioned me to retain the air-driven system with the backup attitude indicator.

Ultimately I chose to go all-electric, again, to reflect current standards. We included a full-time standby alternator system that automatically assumes the load in the event the primary alternator fails, and has the capacity to power systems virtually the same. As it turned out the airplane has *two* electric backup attitude indicators, each with its own emergency battery—and one of those is good for four hours of flight. That made me more comfortable with replacing the bulky primary and backup pneumatic pumps, which also eliminated the usual 400- to 500-hour Time in Service replacements of those pumps.

I think it was a good trade-off. It also formed the genesis of my thoughts on what in airplanes so equipped is *now* the greatest perceived mechanical threat to controlled flight in IMC: electrical fires and failures—in the case of my employer's airplane, my action in response to an electrical fire, to shut off the entire electrical system, is the greatest mechanical threat to control in IMC.

I return to an insightful statement from Dave:

> …most flight instructors have never given any thought to how to create these kinds of training routines.

That's a real problem regardless of the equipment on board a particular airplane. But it becomes increasingly critical as that airplane's complexity increases. The problem is the presentation of realistic failure *scenarios*—not just tasks, like accomplishing the Electrical Fire or Overheat checklist, if your airplane even has such a procedure in its manual (not all do), but the entire chain of decisions from first indication of an emergency until the airplane is safely on the ground. Reader and Cirrus training expert Mike Radomsky addresses this:

> Thank you for another very interesting and informative issue of *FLYING LESSONS.* This one is near-and-dear to me, not only because I spend so much time providing Emergency Procedures Training in a full motion simulator, but also because I have experienced a total loss of power - in a Cirrus, with dual-almost-everything. I was the proximate cause of the outage - I switched everything off after thick smoke poured into the cockpit.
>
> You are on the money. I'll add these comments:
>
> In general, **HAVING *stuff does not equal being able to* USE *the stuff***. This applies to this situation (backup AHRS like Stratus, handheld radio), as well as other situations like survival (do you really know how to use that firestarter kit?).
>
> Some specific issues include being able to actually use backup equipment. If your backup radio is not one you use routinely, do you remember how to set frequencies? How to connect the headset? Where that external antenna jack is? For backup AHRS - have you ever practiced flying with a tablet as your sole attitude reference? Where would you put it? There is a huge difference in dealing with issues that seem minor while sitting in a chair at zero knots and 1G, compared with accomplishing even well-rehearsed tasks while trying to control an airplane without an autopilot, in turbulence, in the dark, with scared passengers, etc.

Flying a modern IFR-capable airplane requires a lot of study and practice. I'm still trying to refine my own procedures (I probably always will) to ensure I'm ready in the unlikely event of an electrical emergency.

Mike also caught me in an error, writing:

> Finally, this:
>
> > You wrote "**Everything is gone** except the backups: a yellow light is flashing rapidly on your standby attitude indicator, advising you to push a button to transfer it to battery power (it will transfer automatically if you delay or forget)."
>
> The automatic transfer of power is different than backup devices I've flown with. I'm used to the opposite - the light flashes to give you an opportunity to transfer power by pressing a button; if you don't, after a minute (typically), the device powers down, to take care of the condition where you simply switched off the Master after shutting down.

That's right—although some early "peanut gauge" automatic backup switching was automatic, the standard now is to require the pilot's active input to *keep* an electric backup running in the event it loses primary power from the airplane's electrical system. This is so batteries don't run out when the pilot shuts down and walks away from the airplane. In some early systems the pilot has to push a button to shut down the backup. Now the much better system is the system will power down (usually after about 30 seconds) if the pilot does nothing. That way the battery is not depleted if the pilot forgets. Thanks for making that clear, Mike.

Retired Cessna jet trainer and saleman (and pilot who first let me fly with an Angle of Attack indicator, in his tricked-out Cessna 182) Charles Lloyd observes:

> The electrical challenge goes beyond an EFIS [Electronic Flight Information System] equipped aircraft. This is a very interesting and challenging subject. ***Even aircraft equipped with steam gages can stand to have a careful analysis*** made to improve flight safety.
>
> Until recently I flew a steam gage 1966 Cessna 182J equipped with a Garmin 430W, 530W and S-Tec Model 50 (Electric Turn and Bank). My first analysis was to examine the dry vacuum pump and install a standby electric dry vacuum pump. Dry vacuum pumps are notoriously unreliable. More reliable wet vacuum pumps have an undeserved reputation for spraying oil on the aircraft's belly. Accessories Inc. here in Wichita stated that wet pumps have a bum rap. There is a bronze oil metering bearing at the rear of the pump that wears [in] as early as 750 hours and permits too much oil to lubricate the pump and thus the dirty belly syndrome. I flew with a wet vacuum pump with an oil separator installed on the aircraft for more than 750 hours and the belly was relatively clean when I sold it. Plus, I had a more reliable pump the operate the vacuum instruments.
>
> Later Midcontinent Instruments developed an electric powered ADI with a 30-minute standby battery and I moved the vacuum powered ADI to the right panel. Lots of redundancy there.
>
> Finally, I installed a Ram Air Turbine 25 amp alternator and bus voltage indicator. The STC recommend[s] attaching the standby alternator to the avionics buss. With an alternator failure the procedure was to turn off the alternator and use the battery to provide a pad for the wimpy alternator. An analysis and inflight test showed that I could operate the 430W and autopilot indefinitely with the standby alternator. Every other electrical item except the 430W GPS and the transponder were turned off. On the first operational flights I found that I had to be careful about long transmissions with the battery in the off position as this would overload the buss. However, with the battery acting as a buffer the transmissions did not overload the system.
>
> There are standby alternators that attach the rear of the engine. However, the Continental engine is mounted so close to the firewall that there is no room for this type installation on a Continental-powered 182.
>
> **You need to analyze your specific aircraft and then create specific procedures to handle electrical and vacuum failure situations**.

Thanks, Charles, for applying your professional experience to help those of us who must make such analyses ourselves.

Reader and *FLYING LESSONS* supporter David Kenny, who for many years was chief statistician for the AOPA Air Safety Institute and a great aid to my work, reminds us:

> Your example of an in-flight electrical fire, perhaps in IMC at night, is a perfect example of why ***it's necessary to drill physical skills on the task-based level before they can be usefully incorporated into scenarios.*** Merely flying partial panel with no other complications can tax the capabilities of a pilot who hasn't practiced it often or recently. Until you can do it comfortably enough to have some processing power left over, it's hopeless to try to attempt partial-panel flight in the dark while simultaneously running through checklists and trying to figure out where to go with your navigational equipment inop.

David wrote this in response to *FLYING* LESSONS for November 15, 2018, which because it goes to Dave's and Charles' points I'll repeat:

> **I'm something** of an old-school type where the current philosophy of Scenario-Based Training (SBT) is concerned. I wholeheartedly agree that instructors should incorporate realistic scenarios into training. Where I differ from the modern mainstream is that I think we need to hone task-based skills first, and then add scenarios to make it real.
>
> **Concert pianists** don't go on stage to play a concerto without spending innumerable hours practicing scales and chords. Only when those movements happen almost without thinking do they progress to playing actual melodies and harmonies. They learn the basics, then apply that learning to advance situations. And the good ones keep practicing the basics throughout their entire career.
>
> **Similarly,** pilots need to do the same thing: **master the basics, *then* apply them to specific situations**. Done well, the pilot can then correlate what he/she has learned and practiced to an unusual situation that presents itself in flight. Every decade or so we find regulators unveiling the latest "back to basics" program, even on the air carrier level...because the basics are *that* important.
>
> **Any decent flight instructor** has *always* used Scenario-Based Training...when it became appropriate to do so. Practice the basics, then apply them in scenarios. I think we're making good strides doing that in flight instruction.

> **Where I *don't*** see it happening much, however, is in scenario-based abnormal and emergency procedures training. We're sort of stuck in the task-training level there, especially if we train exclusive in actual aircraft. We need to continue to practice and improve on our emergency skills preparedness. But I think we also need to begin taking it to the next level here as well—by thinking about, visualizing and discussing **Scenario-Based Survival**.

See http://www.mastery-flight-training.com/20181115-flying-lessons.pdf

Reader Roger Roberts wraps it up this week:

> Great article and in laying out a real-life scenario of what it would be like during an electrical failure. It might be helpful to pilots to post the typical costs of putting in an alternate buss and a backup alternator as well as an external antenna in legacy aircraft. I know that would help me.

Given the very wide range of airplanes makes and models and the worldwide distribution among *FLYING LESSONS* readers, the price range would be tremendous. For information applicable to your airplane you might post a query the Type Club that supports your airplane type.

You're right, we don't often teach emergencies as the beginning of a string of checklists in general aviation, but instead treat them as individual, isolated events we either solve or do not solve. To reiterate my earlier comment, **we need to practice emergencies as a chain of decisions and actions that begins at the first sign of trouble and is not concluded until the airplane is on the ground and all occupants have safely exited or been evacuated.** Thanks, Roger.

Questions? Comments? Suggestions? Let us know, at mastery.flight.training@cox.net

---

"Thank you for your tireless pursuit of GA safety. I'm certain that you have made a difference."

- Retiring NTSB Member and *FLYING LESSONS* reader Dr. Earl Weener

Readers, please help cover the costs of providing *FLYING LESSONS* through the secure PayPal donations button at www.mastery-flight-training.com. Or send a check to **Mastery Flight Training, Inc.** 247 Tiffany Street, Rose Hill, Kansas USA 67133. Thank you, generous supporters.

Aviation Mastery February 9-10, Orlando, Florida

Gary Reeves of Pilotsafety.org is hosting a two-day Aviation Mastery program in Orlando, Florida February 9-10. Keynote speakers and breakout sessions will address ways to master the flight environment with emphasis on single-pilot operations, tips on use of iPads and specifically ForeFlight Mobile software, and AOPA's popular Rusty Pilot seminar. The full schedule is here; Tickets are on sale with discounts for enrollment before February 1st.

The name is similar, but Mastery Flight Training *is not associated with this program. I know Gary Reeves, however, and expect this will be a great event.*

See:
www.pilotsafety.org
https://aviationmastery.org
https://aviationmastery.org/schedule
https://www.eventbrite.com/e/aviation-mastery-with-jason-schappertmzeroacom-gary-reevespilotsafetyorg-tickets-52027382301#tickets

Share safer skies. Forward *FLYING LESSONS* to a friend

Pursue *Mastery of Flight.*

Thomas P. Turner, M.S. Aviation Safety
Flight Instructor Hall of Fame 2015 Inductee
2010 National FAA Safety Team Representative of the Year
2008 FAA Central Region CFI of the Year
Three-time Master CFI