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Collegiate Flight Education Using the Cockpit Evolutionary Model

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The art of teaching students to fly safely has continued to evolve for over a century. The training community has had to adapt their teaching techniques and methodologies to keep up with changes in aircraft powerplant, airframe, and avionics installed on the aircraft and simulators used for training. The last 20 years have brought about a blistering pace of innovations, especially in the area of avionics and the use of Electronic Flight Bags (EFB). Flight training professionals have had to keep up without a corresponding pace of training technique revolution to serve that growth. This article will discuss the "cockpit evolutionary" training methodology used by [submitter university] and details the process of changing the training platform designs of the past to one that will most benefit students as they transition to professional pilot employment.

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Traditionally, training aircraft utilized a standard round dial, analog cockpit design. Students received their primary training in small two or four place trainers and would not see any glass cockpit displays until they transitioned to a jet either in corporate or the transport industries. The training community assumed that the hiring organizations would provide the transition training, and the hiring organizations gladly assumed this role because they wanted students trained to their Standard Operating Procedures (SOP). The challenge was that the learning curve was steep for students as they moved into the large aircraft cockpit. Students received little primary training consideration for their ultimate future flying platforms. The "Law of Primacy" suggests that a person will revert to the way they were initially trained if no other experience in their training would overshadow or drive their behavior while under performance stress.

Figure 1. Analog Cockpit Instrumentation

The general aviation industry has gradually phased out the production of analog instrument training aircraft as the attractiveness and dependability of the Garmin and Avidyne cockpits in general aviation, and Rockwell and Honeywell glass cockpit designs in larger aircraft continue to grow. Today, it is impossible to find an aircraft with an analog cockpit without going to the used aircraft market. This has caused many trainers produced in the 1980s through early 2000s to be continually sold and resold, driving their resale prices to well over their retail price when manufactured.

When the FAA released regulatory guidance in 2003 about what constituted a Technically Advanced Aircraft (TAA), it finally set a standard that the airframe and avionics manufacturers could integrate aircraft design around (TAA Safety Study Team, 2003). 14 CFR 61.1 (Aeronautics and Space, 2021) defines a Technically Advanced Aircraft as one which has an "electronically advanced avionics system". So, the TAA aircraft must have an electronic, glass Primary Flight Display (PFD), a Multifunction Display (MFD) and a two-axis (minimum) autopilot. Not mentioned in the regs, but equally important is a Flight Management System (FMS), which integrates all the pieces together. The computer integrates all the pieces of the system together and does self-checking should any component sense data that is out of tolerance or needs pilot intervention.

The Flight Management System on a jet is usually a centrally mounted keyboard or touch screen, which allows the crew to input flight plans and other data into the system, which ultimately can be flown through a coupled autopilot. Each segment of the flight is input into the FMS, and the autopilot simply follows the plan. If an error exists in the plan, then the FMS would not accept the inputs, thus double checking the first officer whose primary task is to keep the flight programmed to the ATC clearance. This model is how modern TAA training aircraft operate, except it is much easier to hand fly a TAA aircraft than it is to hand fly a jet. This TAA Training experience does not translate well back to an analog instrumented aircraft since each instrument is independent of the others and requires the pilot to truly understand instrument readings and to determine if an instrument or system has malfunctioned.

FAA and Aircraft Owner and Pilots Association (AOPA) data suggest that there are 220,000 aircraft currently registered in the United States as of 2020, and 90% of these represent general aviation (Aircraft Owners and Pilots Association, 2019). It is hard to get an accurate estimate of how many of those aircraft are considered Technically Advanced Aircraft (TAA), but we can, for the purposes of discussion, assume that at least 70% of the aircraft registered today do not meet the TAA definition. It stands to reason that a pilot trained from day one in a TAA glass cockpit aircraft might never encounter an analog instrumented aircraft if they are hired directly into corporate or airline operations. Experienced training professionals would probably agree that the mental process of interpreting critical flight parameters on an analog instrument takes training and practice and considering the law of primacy, that students may not ever have received instruction on that platform. In the worst possible flight scenario, a pilot is flying solid IMC, at night, over a great expanse of water and encounters an electrical failure in an unfamiliar aircraft. In a TAA aircraft, everything is routine until the electrical power is interrupted. We train them how to load-shed power consumption and how to make critical decisions before the panel goes dark. Take the same pilot in an analog cockpit who was never formally trained in that cockpit (The FAA has never mandated any transitional training either way), and analog instrumentation may be downright confusing and disorienting if they never had training in it. It stands to reason that since there are so many aircraft still flying with traditional analog cockpit instrumentation, it is quite possible that a pilot could end up in this scenario with little to back them up except pure instinct.

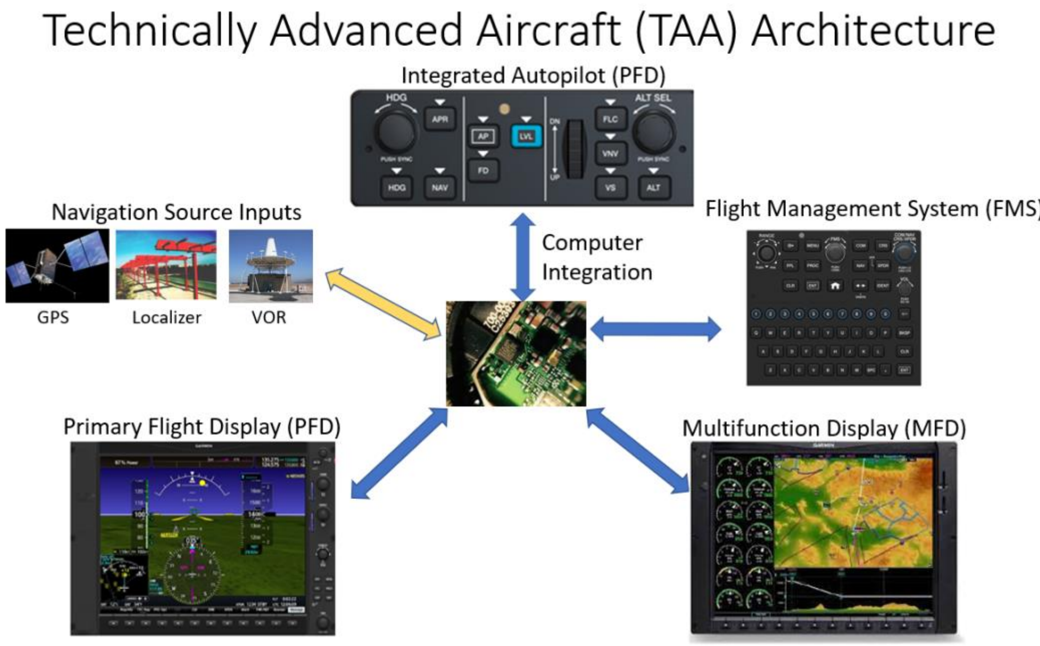

Figure 2. Technically Advanced Aircraft architecture

In the July 2007 FAA News magazine, I authored an article entitled "No Going Back," which discussed this concept in detail (Gaffney, 2006). A student who is trained in analog first and then transitions to TAA has at least a mental primacy to revert back to analog instrumentation in a pinch even if they have not flown such an aircraft in a while. The training community, aided by OEM trained instructor pilots, determined ways to transition analog pilots from analog to TAA since the electronic displays were designed to mimic the analog instrumentation while supplementing the pilot with the need-to-know information. This transition worked as long as the pilots were trained to understand the menu topology of the system and to use the correct "buttonology" to configure the screen and its functions. This takes a combination of ground training, practice in a simulated environment, and eventually training in an actual aircraft. Training providers quickly determined that training a pilot to fly a TAA aircraft without the prerequisite ground instruction only led to improper system interpretation and operation. We still find pilots who try to program GPS navigators with the **D->** (Direct to) button rather than the **FPL** Flight Plan Button. This is a quick recipe to fly through restricted airspace or through an obstacle by accident and inhibits the system from offering the pilot critical and timely information regarding their flight path and instrument procedures and frequencies associated with the waypoints along that flight path.

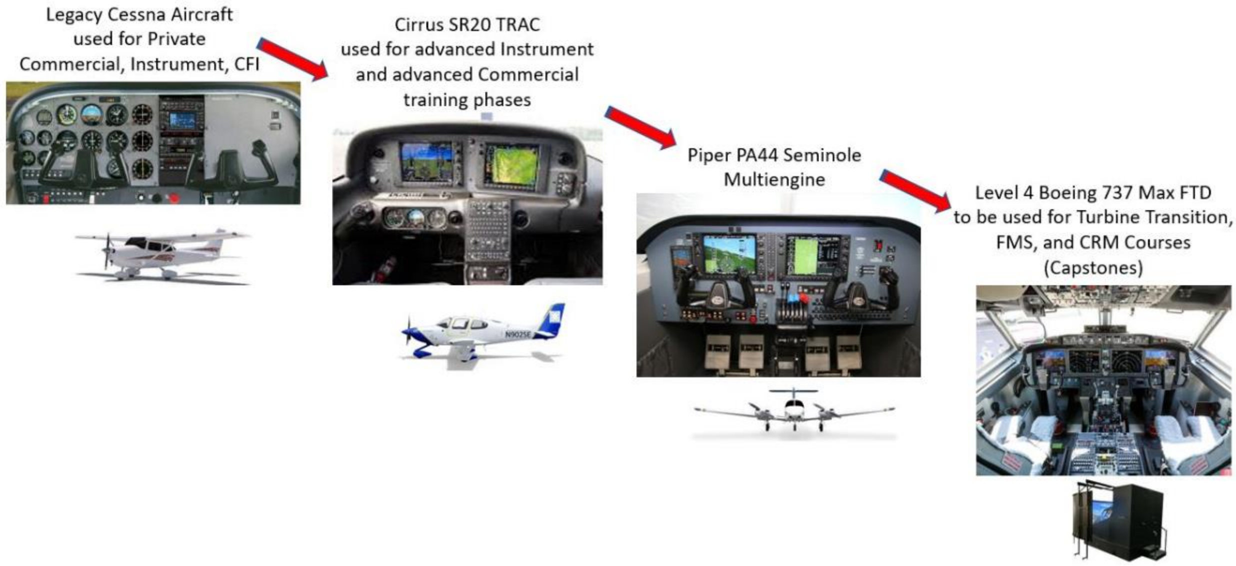

Figure 3. Cockpit Evolutionary Model

No major General Aviation manufacturer is currently producing an aircraft with analog instrumentation and, with the eventual disappearance of analog instrumented aircraft from training fleets through obsolescence. It is imperative that we consider our training strategy to ensure pilots get some type of training in the analog environment even though in their eventual professional career, they may never experience one. [The submitter university] has developed its training syllabi to follow this evolutionary cockpit model. We provide initial training using analog instrumented Cessna aircraft. We teach the instrument rating in analog aircraft and then move the students through ground school courses, classroom training, and Garmin Perspective Plus Kiosk training before moving them into the Cirrus SR20. We then use a scenario-based training syllabus to transition the student to advanced TAA cockpit operations. After the Commercial Instrument Multiengine certification is completed, the students move to the multiengine training phase, where they will use a TAA PA44 Piper Seminole. Then they move to the transport aircraft portion of the curriculum where we utilize classroom, CBT, and eventually a fully tactile 737 MAX AATD where we hone their CRM and flight management skills using crew-based Line Oriented Flight Training (LOFT) scenarios to emulate operations in a large transport aircraft environment. After conferring with our airline development partners Southwest, Delta, and Envoy, we believe we are going to produce the safest and most effectively trained graduates using this model even though the airline will retrain the graduate to use their SOPs and checklists. In self-assessment for our accreditation reaffirmation with our accrediting agency, Aviation Accreditation Board International (AABI), we also believe this strategy is sound and produces graduates to meet or exceed published Student Learning Outcomes.

While this stepped process of training is not revolutionary, the process of migrating a legacy flight training program to a technology-driven evolving cockpit training paradigm in the span of a few short years is. What makes this process special is that we are shifting the focus of our AABI accredited program from a "tried and true" 14 CFR 141 based program into an integrated cockpit model where we use technology building blocks to develop our students' aeronautical decision-making skills to prepare them for a technology-based career field.

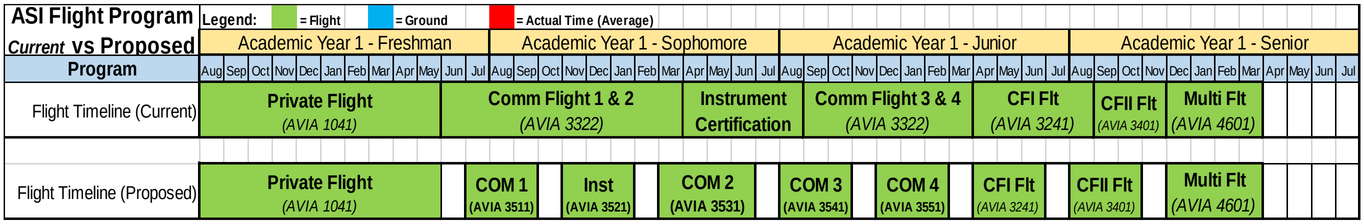

Figure 4. Traditional 14 CFR 61/141 Training Flow

To prevent training disruptions, we are keeping our FAA 141 syllabus intact with the exception of migrating the complex-high performance phase of the Commercial syllabus from maintenance-intensive Cessna 182RG to the Cirrus SR20 TRAC aircraft and incorporating the necessary technology training using Frasca RTD and Garmin Perspective Plus training Kiosk ground training devices. While this Commercial stage still accomplishes the high-performance endorsement with the 215 HP IO-390 Cirrus SR20, the Complex endorsement is deferred to the Multiengine phase of the program.

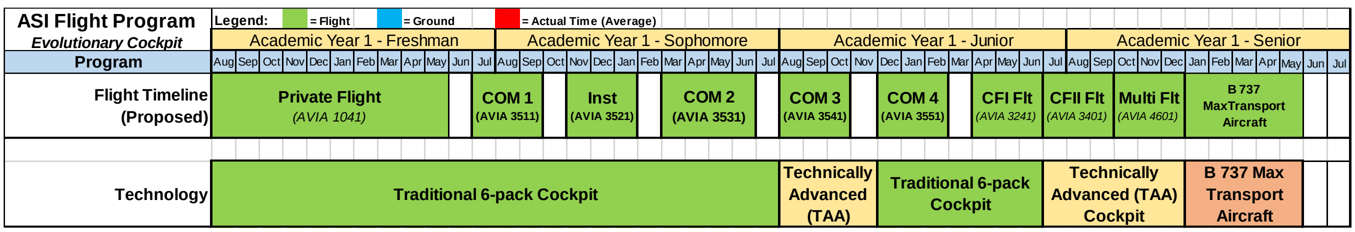

Figure 5. Cockpit Evolutionary Model Training Flow

While these fundamental changes give our students the technology boost they need to move from the analog 6-pack Cessna to the Garmin Perspective Plus Cirrus and the Garmin equipped Piper Seminole, it still does not completely prepare them for the transport category aircraft cockpit. We were seeking a way to bridge the gap, so our students were not only prepared for interviews with regionals and our pipeline partners, but they would also be competitive with the "best of the best" students coming from other heavy-weight university programs. Southeastern has moved forward with the installation of a Boeing 737 MAX AATD training device that will be used in three junior and senior year courses, including the program Capstone course. This device will be in place by January 2022. We will provide each student with 20 hours in the 737 Max AATD, 10 hours in the right seat, and 10 hours in the left seat. While we do not intend for the student to be type trained in the 737 Max, we want each and every student completely capable of performing turbine engine starts, system operation, taxi, FMS programming, emergency and abnormal procedure response, and demonstrate CRM proficiency using a series of scenarios in three of the transport category aircraft courses in the Professional Pilot program.

Another area that must be discussed is the role of electronic flight bags (EFB) and their use in training in our evolutionary cockpit training model. Traditionally, we taught students to navigate using pilotage, then dead reckoning, then electronic navigation using the VOR, ILS and the ADF platforms. Enter again the quickening pace of technology innovation, and we see the

Global Positioning System (GPS) navigation devices taking a prominent place in aircraft cockpits and we see the FAA rapidly decommissioning both VORs and NDBs and hear that the FAA will start decommissioning some ILS systems giving way to WAAS based RNAV-GPS approaches to near ILS accuracy. At the same time, we see paper sectional charts disappearing from pilot's hands and being replaced by iPads utilizing Foreflight or Garmin Pilot. How do these innovations affect training? What new training methodologies should we employ to keep our students prepared for the future?

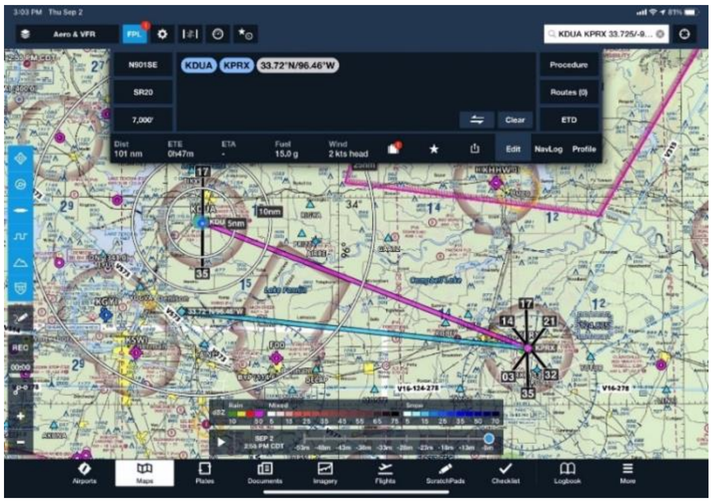

Figure 6. Foreflight on an iPad as an EFB

It was predicted in 1999 that by 2010, 90% of US aircraft would have GPS units installed (United States General Accounting Office, 2000). It is not known the accuracy of that prediction or where we stand in 2021, but for discussion purposes, let's assume that 65% of aircraft equipped with electrical systems have a panel-mounted GPS navigation unit. What does that mean for pilot training? Do we stop teaching pilotage and dead reckoning techniques? How do we ensure that previously trained pilots can operate safely in the modern National Airspace System (NAS) using the growing popularity of GPS navigation? How do we ensure that pilots can transition from paper-based VFR and IFR charts over to electronic versions based upon iPad or tablet-based systems using Foreflight or Garmin Pilot?

Southeastern Oklahoma State University is maintaining the strategy that we will continue to train Private Pilots to fly with traditional navigation techniques using pilotage and dead reckoning using sectional charts and nav logs before transitioning them to use GPS navigation and EFBs in the cockpit. We are developing a standardized transitional approach for doing this so it is covered in collegiate courses, in pre and post briefings, and then in the cockpit to ensure the highest degree of safety and flight proficiency. Once we transition a student to using a panel-mounted GPS having an EFB backup instead of paper charts, we have to ensure that they are trained and prepared for in-cockpit issues such as device overheats, dead batteries, and other issues that could affect flight safety. Having a cockpit backup strategy was never so important in our training environment. It is part of our risk management process and a critical part of our Safety Management System (SMS). We must prepare pilots to actively manage their navigation process and not just navigate staring at a "magenta line" on the GPS panel. We do not believe that we can do that effectively without training them in the traditional pilotage and dead reckoning models first.

In summary, Southeastern is actively designing a collegiate training environment that prepares our students in the most robust and worldly manner possible. We are upgrading our equipment, our Standard Operating Procedures (SOP), and our training curriculum to prepare our graduates for operating in the real world. We do not believe that our cockpit evolutionary strategy is holding on to the past, but rather we believe that it is boldly bridging the past to the future for our students and our graduates. We anticipate our hiring industry partners will agree and appreciate this for many years to come.

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