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Abstract

Historically, VFR flight planning has been accomplished using an E6B flight computer, paper chart, and navigation plotter. Pilots have used these tools to determine the course, speed, and fuel required for a particular flight. These conventional tools have been a cornerstone of private pilot training for many years.

Many types of flight planning software are currently available with a great range in cost and capability. ForeFlight Mobile™ is one of the most prominent flight software applications in use today. The software provides electronic navigation charts and tools that simplify flight planning for pilots. Distance, speed, and time calculations can be handled instantaneously, applying numerous variables to a VFR flight plan.

The purpose of this study is to identify differences in pilot skills and/or knowledge when comparing conventional VFR flight planning with flight planning using ForeFlight™ software.

Keywords

Flight Planning, Flight Training, Dead Reckoning, ForeFlight™, Electronic Flight Bag

Introduction

The Apple iPad is the most prevalent device for personal and professional use, with more than 250 million units sold since they were introduced in 2010 (Twomby, 2015). Several industries have implemented tablets for data processing, including health care, education, and transportation. General aviation pilots have realized that these devices can be excellent tools for day to day flight operations. There are numerous software applications currently in use that can calculate all required flight plan data on tablet computers.

ForeFlight™ is an Apple-exclusive application and is one of the most common types of flight planning software used among pilots in training. Not only is the software common, but pilots are typically impressed with it. ForeFlight™ conducted a survey in 2012 of AOPA members relating to their satisfaction with the software. The survey indicated that the majority of Foreflight™ users (1) spent less time locating information than when using paper, (2) felt more productive in the cockpit, (3) felt more productive when preparing for a flight, (4) were able to keep

aeronautical chart information up to date, and (5) desired a mostly paperless cockpit in the future (Weihs, 2013).

The use of tablet computers as they relate to pilot performance was previously studied at Middle Tennessee State University. The study observed instrument pilot performance during instrument procedures. The participants flew instrument procedures with paper charts and with Foreflight™. Data such as heading, altitude, airspeed, and localizer course were gathered to compare the control and experimental sessions. The research concluded that when using ForeFlight™ on a tablet, "the results showed a statistically significant increase in every analyzed performance metric when using the EFB" (Haddok & Beckman, 2015, p. 1).

This technology is an excellent tool for students in training. However, aviation history is full of cautionary tales about overreliance on any flight related technology. If students no longer use conventional paper charts and E6B flight computers to plan flights, are they missing out on fundamental pilot skills and/or knowledge? The purpose of this study is to identify potential gaps in pilot knowledge if a student pilot uses ForeFlight™ for primary flight training instead of the conventional tools used in the past.

Before beginning this discussion, it is essential to note that ForeFlight™ does not claim to provide training and/or education on aeronautical charts or flight planning procedures. In the current version of the *Mobile Pilot's Guide to ForeFlight Mobile*, the company states the objectives of the software clearly. The software is intended to "plan flights quickly, gather preflight intelligence information efficiently, and best support your type of flying" (ForeFlight, 2015). In addition, ForeFlight™ does not claim that the software is educational. On the contrary, the pilot's guide states "this guide presumes a basic level of proficiency with general iPad use and navigation" (ForeFlight, 2015 p. 16).

If a student pilot were to purchase a subscription to ForeFlight™, they would then be able to download the software and begin to use it immediately. The company encourages customers to read their pilot's guide in full, but it is not a requirement to use the application and it is doubtful that most untrained student pilots do so. The software is 100% usable after it is downloaded, and does not include any introductory tutoring. Consequently, flight instructors and aviation educators should approach the integration of this technology cautiously. Mr. Jared Lease is an Assistant Professor at LeTourneau University's School of Aviation. In reference to flight planning software, he proposes that instructors take initiative in training pilots on the using the technology: "Students need to be taught how to use technology appropriately in the cockpit under the watchful eye of an instructor rather than learn about it through trial and error" (Lease, 2015, p. 36). For example, with a standard subscription to ForeFlight™, student pilots will be provided with instrument charts. These charts should be disregarded until the student begins instrument training.

Methodology

This study compared the flight planning process outlined in the FAA's (2016) most recent

edition of *The Pilot's Handbook of Aeronautical Knowledge* with the same process as accomplished by ForeFlight™ on an iPad. When describing the process with ForeFlight™, the most recent edition of *The Pilots Guide to ForeFlight Mobile* was referenced. For both examples, a list of the required skills was developed. These lists were then compared to determine any discrepancies.

Results

Conventional VFR Flight Planning

Typically, VFR course planning involves the use of paper charts, navigation plotters, and E6B flight computers. The FAA's (2016) *Pilot's Handbook of Aeronautical Knowledge* explains VFR course planning using these tools. The full flight planning process involves seven skills associated with these tools in order to plan a VFR flight appropriately. These steps are included in pages 15-20 of the FAA's *Pilot's Handbook of Aeronautical Knowledge.*

Figure 1. Sectional chart, E6B flight computer, and navigation plotter: traditional flight planning tools. (Photo credit Babb 2016.)

Federal Aviation Regulation 61.105 (b) (4) requires that private pilots be trained on dead reckoning. "Dead reckoning is navigation solely by means of computations based on time, airspeed, distance, and direction" (FAA, 2016, p. 16-13). The typical VFR course planning process is outlined in Figure 2. The FAA's *Pilot's Handbook of Aeronautical Knowledge* explains the VFR course planning process using these conventional tools in Figure 3. All of this data is typically recorded by a VFR pilot on a navigation log. The FAA's navigation log is shown in Figure 4. Using an E6B, paper chart, and navigation plotter, a pilot determines a true course, wind correction angle, and then factors in magnetic variation and magnetic deviation to arrive at the compass heading. The compass heading (CH) is the direction the aircraft should be flying in the air to arrive at the desired destination. In addition to course planning, the E6B flight

computer is also used to determine the estimated time enroute (ETE) and projected fuel burn for the flight. This information is required preflight action, which directly relates to minimum departure fuel and weather forecasts for the flight.

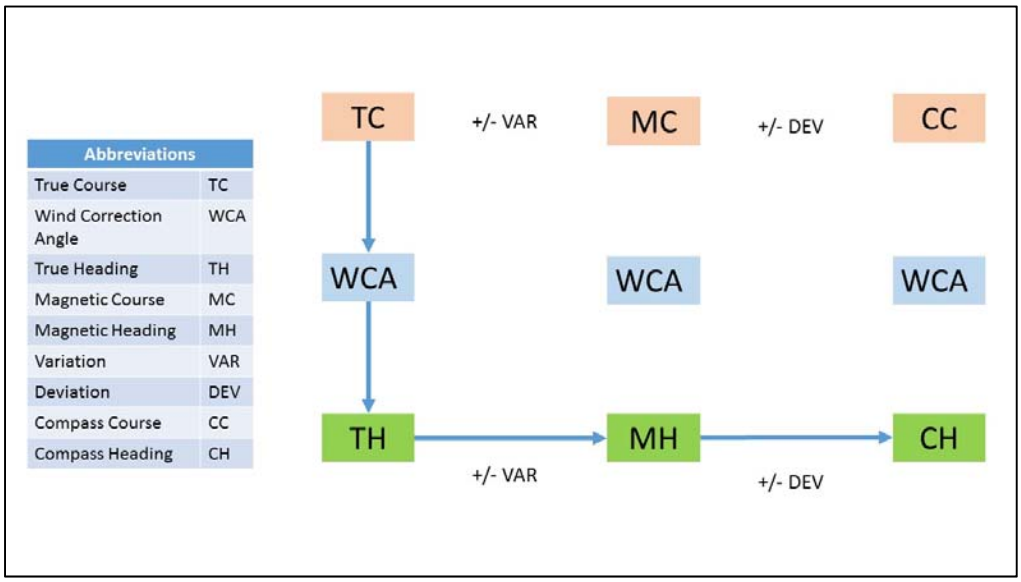


Figure 2. Summary of VFR course planning steps and definitions described by the FAA (2015).

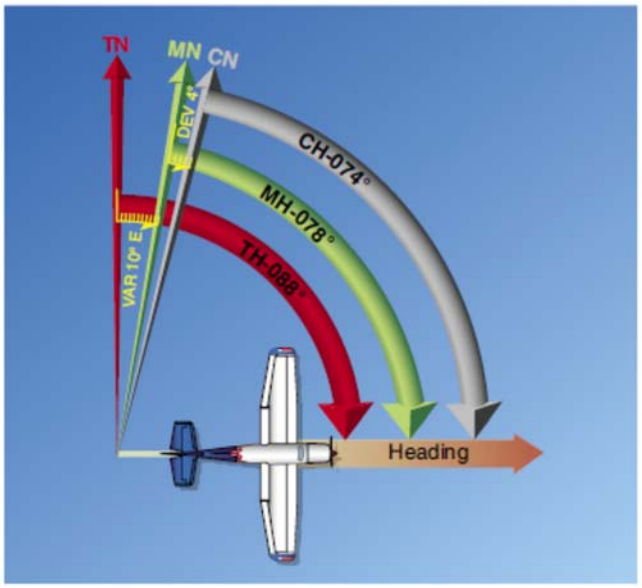
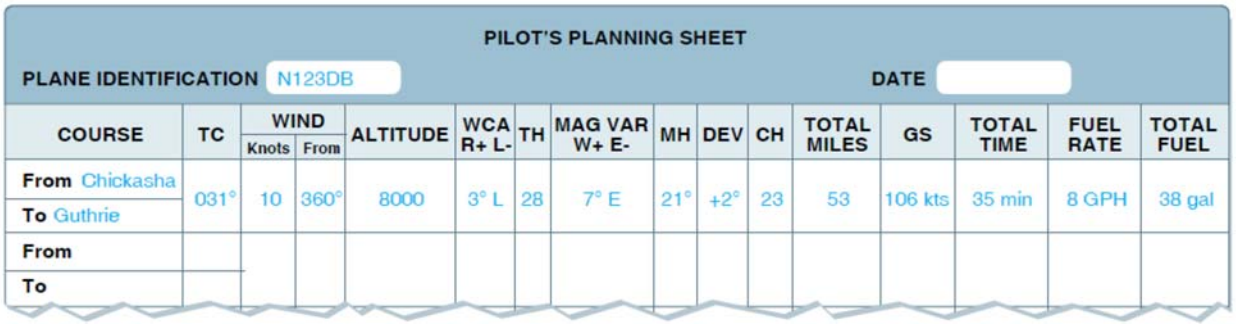


Figure 3. VFR course planning summary from the Pilot's Handbook of Aeronautical Knowledge (FAA, 2015, Figure 16-16).



PILOT'S PLANNING SHEET

PLANE IDENTIFICATION N123DB DATE

COURSE	TC	WIND Knots	WIND From	ALTITUDE	WCA R+ L-	TH	MAG VAR W+ E-	MH	DEV	CH	TOTAL MILES	GS	TOTAL TIME	FUEL RATE	TOTAL FUEL
From Chickasha To Guthrie	031°	10	360°	8000	3° L	28	7° E	21°	+2°	23	53	106 kts	35 min	8 GPH	38 gal
From To															

Figure 4. Excerpt from the FAA's "Pilot's Planning Sheet" or navigation log from the Pilot's Handbook of Aeronautical Knowledge (FAA, 2016, Figure 16-26).

Learning how to flight plan with these conventional tools requires practice. A summary of all related VFR flight planning skills when using conventional tools is shown in Table 1. Each skill has specific challenges, such as interpretation of the scales on an E6B (skill 6) or the accurate use of nautical miles instead of statue miles on the navigation plotter (skill 2). These dead reckoning skills relate to many other aviation topics and provide a foundation of aviation knowledge (Zitt, 2016).

Table 1: Skill Summary for VFR Flight Planning with Conventional Tools

Skill	Description
1	Ability to use navigation plotter and sectional chart to determine true course (TC)
2	Ability to use navigation plotter and sectional chart to determine distance
3	Acquire FAA approved weather information, specifically a winds aloft forecast
4	Interpretation of winds aloft data to include interpolation of wind direction and velocity
5	Ability to use E6B to calculate true heading (TH)
6	Ability to use E6B to calculate ground speed
7	Interpretation and application of magnetic variation to determine magnetic heading (MH)
8	Interpretation and application of magnetic deviation to determine compass heading (CH)
9	Ability to use the E6B to calculate estimated time enroute (ETE)
10	Ability to use the E6B to calculate fuel burn

A pilot in training must develop these skills to proficiency in order to earn a private pilot certificate. The current Airmen's Certification Standards reflect the same requirement as the FAA's previous Practical Test Standards (PTS) for the private certificate. A private pilot applicant must exhibit satisfactory knowledge of the elements related to cross-country flight planning (FAA, 2011, FAA 2016). This requires fundamental knowledge on basic navigation and application of that knowledge to an ever changing set of flight circumstances. A private pilot must be proficient with the E6B, sectional charts, and navigation plotter in order to perform flight planning with conventional tools. Electronic E6Bs have been in use for decades, but when used, they require the use of the navigation plotter and sectional chart for a complete VFR flight plan.

VFR Flight Planning with ForeFlight Mobile

The same process will be described using a tablet computer with ForeFlight™ software. It is assumed that the software has internet connectivity. The software itself is discussed at length in the *Pilot's Guide to ForeFlight Mobile*, but the guide does not display all VFR flight planning information as shown on the FAA's navigation log in Figure 4. The guide mentions the "route line" which is shown in purple, but does not clearly show its purpose (Figure 5). To the untrained eye, it could be a true course or a magnetic course. This reveals one discrepancy between the two processes.

In order to plan a VFR flight course with ForeFlight™, the student begins by holding a finger on the departure airport to select the point of departure. A menu comes up with options, and the pilot selects the departure airport. A similar process allows for selection of the destination airport.

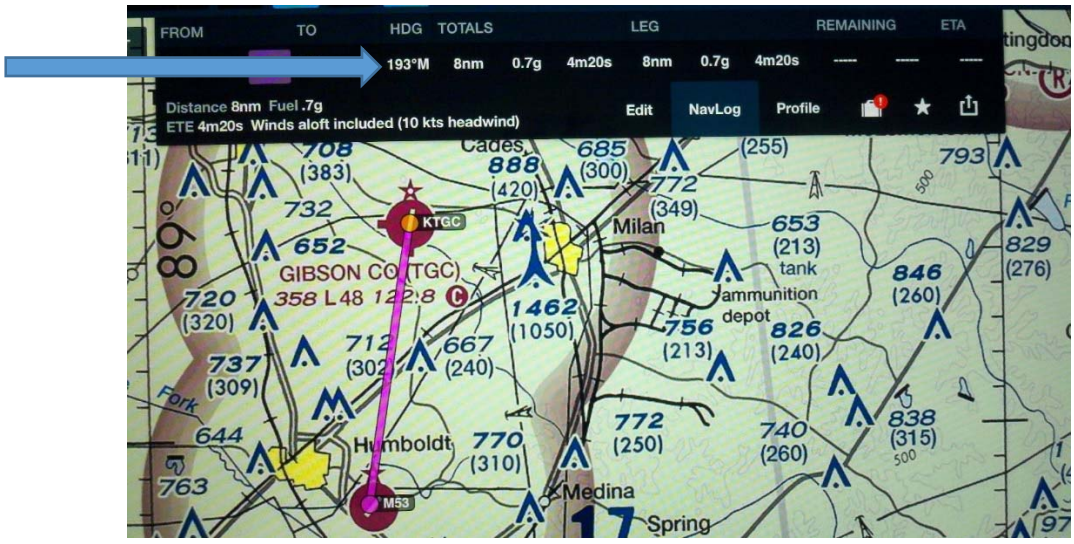


Figure 5. Route Line (purple) and magnetic heading (indicated with the blue arrow) from ForeFlight™.

The software immediately draws a route line. The software's navigation log at the top of Figure 5 provides the pilot a magnetic heading as indicated under the HDG title as "193M". In VFR flight planning, any heading already has winds applied. The software automatically applies current and accurate wind data for a particular altitude to the true course. Then, instantaneously, the software applies magnetic variation to the true course to arrive at the magnetic heading. Apart from selecting airports, the software does these steps without any additional pilot action. As shown in Figure 6, this leaves only one step to be applied by the pilot to determine compass heading.

In addition, the application immediately measures the distance of a flight in nautical miles. A pilot can then enter the planned true airspeed and fuel burn in gallons per hour. This allows the application to automatically calculate a ground speed, estimated time enroute (ETE), and fuel burn. This process has been typically performed with E6B flight computers. These capabilities are built in with this type of software and could potentially make the E6B obsolete.

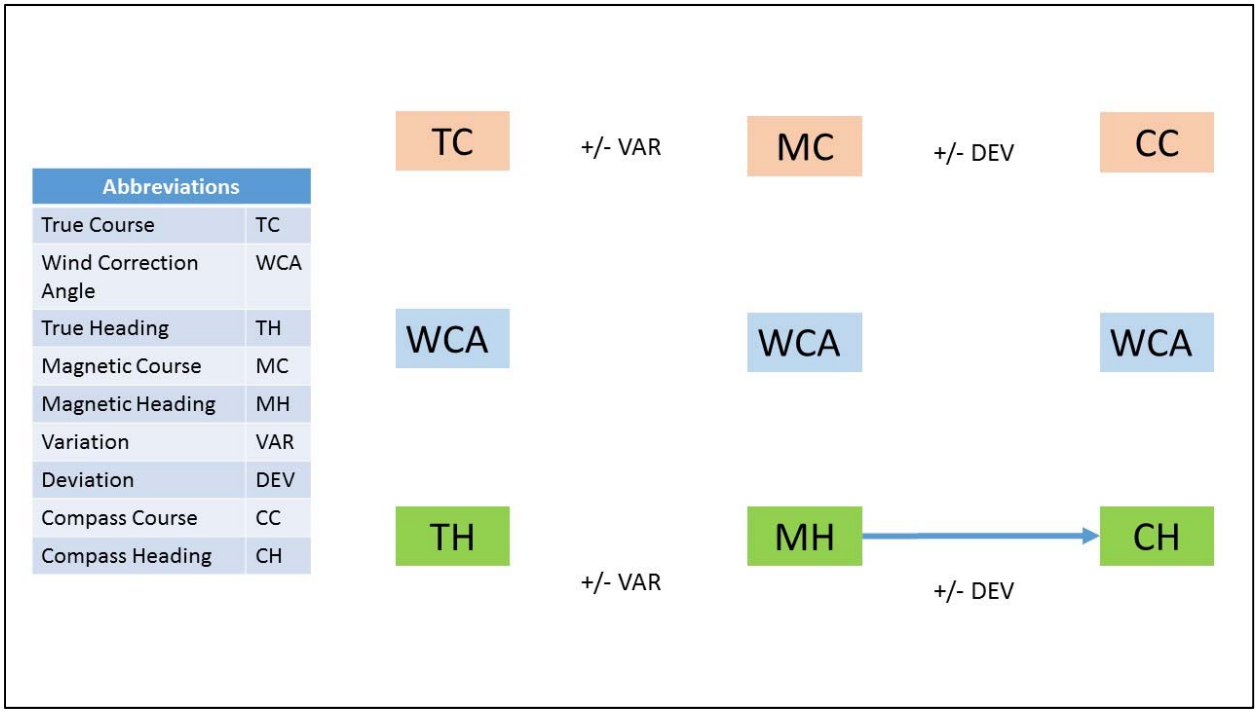


Figure 6. With ForeFlight™, only one process is left to the pilot for VFR course planning.

When using conventional flight planning tools, this process involves at least ten skills as previously identified. ForeFlight™ arrives at the magnetic heading much faster, but critical knowledge and skills are no longer necessary to calculate a magnetic heading. This could leave gaps in pilot knowledge and capabilities. See Table 2 for a summary of required skills for VFR course planning using conventional tools versus ForeFlight™.

Table 2: Required Skills for Conventional VFR Flight Planning Versus ForeFlight Mobile

Skill	Description	Conventional	FFM
1	Ability to use navigation plotter and sectional chart to determine true course (TC)	Yes	No
2	Ability to use navigation plotter and sectional chart to determine distances	Yes	No
3	Acquire FAA approved weather information, specifically winds aloft forecast	Yes	No
4	Interpretation of winds aloft data to include interpolation of wind direction and velocity	Yes	No
5	Ability to use E6B to calculate true heading (TH)	Yes	No
6	Ability to use E6B to calculate ground speed	Yes	No
7	Interpretation and application of magnetic variation to determine magnetic heading (MH)	Yes	No
8	Interpretation and application of magnetic deviation to determine compass heading (CH)	Yes	Yes
9	Ability to use the E6B to calculate estimated time enroute (ETE)	Yes	No
10	Ability to use the E6B to calculate fuel burn	Yes	No

Discussion

Pilots may consider these gaps in knowledge and skill as a major or minor issue. One can only speculate as to how many pilots would have these knowledge or skill gaps today. The results indicated that there are several skills and knowledge areas applicable to planning VFR flights using the conventional instruments. Considering these ten skills, only one is required to do the same process with Foreflight™.

If the tablet works properly and the user is trained in how to use it, the process can be completed in a much shorter time. For practical purposes, pilots should be aware of device and software limitations as well as the threat of distraction in the cockpit. The advent of smart phones and tablet computers with communication and streaming capabilities has negatively impacted public safety with respect to motor vehicle accidents. In a study in 2015, Bendak investigated the relationship between texting and driving. The research involved a driving simulator that was operated by the same subject twice, once while texting. This study found that a driver is five times more likely to cause crashes if texting while driving (Bendak, 2015). The same distractive nature of a tablet computer should be seriously considered by pilots.

Conclusion

A pilot that uses ForeFlight™ for VFR flight planning is not using many of the skills required for conventional VFR flight planning. The pilot may never develop these skills, especially if they started as a student pilot using software instead of paper charts. If a pilot uses ForeFlight™ for VFR flight planning, is that pilot practicing dead reckoning? If so, does the use of the software present acceptable dead reckoning data for instructors to train with? Regardless of the answers to these questions, the full understanding of navigation basics must still be mastered by pilots in training. This disparity should create a conversation among aviation instructors on how to proceed with training in the future. It is highly recommended to flight instructors to ask the FAA pilot examiner if it is acceptable for the applicant to use the software on a check ride.

It is recommended to ForeFlight™ that true course, wind correction, and magnetic variation information be added to the default application. The navigation log could have a "VFR mode" separate from an "IFR mode" to account for differences in types of operation. It is the pilot's responsibility to have this information, which has historically been included on the FAA's suggested navigation logs and the Pilot Training Standards (PTS) for the knowledge area of cross country flight planning. As previously stated, the Airmen Certification Standard (implemented in 2016) include the same requirement. This data is recommended to be included on any flight planning software to better represent accurate VFR flight planning information.

This research was based upon flight planning, but tablet computers are currently being used for a plethora of other data applications for flight operations. Airlines are using tablet computers to track maintenance, determine crew scheduling, gather weather data, and many other functions. Similar research could be conducted on any of these other data processes. A limitation of this study is that only Foreflight™ was evaluated. Several other flight planning software applications are available and in use, which need to be evaluated separately. It is suggested that collegiate aviation programs consider this research when determining their approach to tablet computers in the cockpit. Program administrators might decide to allow or encourage tablet use beginning with a student's first flight, or conversely, to delay the use of tablet computers until a later training phase such as the instrument rating. In either case, the decision should be made thoughtfully to ensure development of the necessary knowledge and understanding of navigational concepts. Allowing flight students and instructors the option to use flight planning software on their own may create discrepancies in the quality of flight training within the program.

Acknowledgements

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Biography

Tyler Babb is currently an assistant professor of aerospace at Middle Tennessee State University. After graduating from MTSU as a professional pilot student and then earning a Masters of Education at MTSU, he flew the Learjet 35 and Embraer Phenom 100 under Part 135 from 2008 to 2012 for a charter company in the Nashville area. Afterward, while pursuing an A&P certificate, he was hired into an administration position with the charter company. Mr. Babb joined the MTSU aerospace department in 2013. His current research interests include EFB practices and policies, as well as the evolution of private pilot navigation practices.