# Workforce competencies: what makes a competent certified flight instructor?

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**ABSTRACT**

Certified Flight Instructor (CFI) competence is a complex of factors that make for both difficult definition and problem application in training. This paper examines CFI issues. It examines what research has been published on CFI competencies and also points out what is missing in the literature. This paper is important because it summarizes what little is known from research about CFIs.

Keywords: CFI, competency, workforce development, professional development, knowledge workers

## INTRODUCTION

Largely unexamined in the literature are the competencies of the Certified Flight Instructor (CFI) who teaches basic, primary flying skills. The reasons for this gap in research are found in current literature on primary flight instruction as it relates to competencies: how they are defined, identified, and evaluated. The question of how competency is discussed at minimal, successful, and exemplary levels is addressed, as well as what tools and approaches have been developed to determine these levels. The outcomes of this paper point to problems and implications for CFI instruction and learning. In addition, research gaps have been found instructive in pointing to basic operating assumptions about competency in the CFI field and deficits in those assumptions, allowing this study to project further research.

The purpose of this study was to identify and examine the scholarly literature on competencies associated with the teaching professional, the Certified Flight Instructor (CFI), and specifically, the CFI responsible for providing primary training to candidate pilots of single-engine airplanes. CFIs who teach primary, single-engine flying are often the first flight instructors to meet flight students; they offer *ab initio*, from-the-beginning, training, education, and development (Fanjoy, 2000, p. 39). Here CFI refers to FAA-certified, primary flight instructor for single-engine, land airplanes.

The specific direction of this study was to examine and compare literature germane to a workforce definition of "competency" (both general and explicit) compared to the FAA definition for the CFI, both in theory and application. The present state of competencies as understood within the CFI field was then reviewed, followed by several leading tools and approaches developed to identify, measure and assess competencies within the CFI field.

At present, the Federal Aviation Administration (FAA), as arbiter for CFI standards, has issued regulations on competency for CFIs that are not consistent with Rothwell's definition of competency (1999, 2004, 2010); the *Aviation Instructor's Handbook (AIH)* (FAA, 2008a) outlines skills, knowledge and conduct but without being consistent with Rothwell's definition.

Primary flying skills are very important to a pilot. No matter how sophisticated an airplane a pilot flies through his or her career, the fundamentals of flight do not change. Much like a sophisticated reader still must parse the alphabet to read Hamlet, the four forces in flight and rudimentary skills to own them are constant and must be learned first and solidly before the slings and arrows of more complex aircraft can be tackled and must be solidly mastered as the bottom building block of flight knowledge or disaster will ensue (FAA, 2008a).

Flight instructor trainees, as part of their FAA curriculum, study the Thorndike Law of Learning that specifically addresses primary skill learning for a pilot. The primacy law portion of Thorndike's law states that "the state of being first often creates a strong, almost unshakable impression and underlies the reason an instructor must teach correctly the first time and the student must learn correctly the first time" (FAA, 2008a, p. 2-11). What are the implications of this primacy law?

An example from flight history can address this question. Flight accidents are dramatic events that raise questions about effective training. On February 12, 2009, 50 people perished in an airplane crash in Buffalo, New York. According to the National Transportation Safety Board probable cause report (National Transportation Safety Board, 2010), the accident was ascribed to "the captain's inappropriate response to the activation of the stick shaker, which led to an aerodynamic stall from which the airplane did not recover" (p. 1). Stall training is in lesson Four of the private pilot learning process as described in the *Airplane Flying Handbook (AFH)* (FAA,

2004, p. 4-1). Question: Is it possible that the CFI who taught this captain primary flying skills did not adhere to the primacy law? Knowing if an airplane you are flying is stalling and what to do about it is a rudimentary skill. An error at this rudimentary flying skill level is akin to having a swimmer student forget to breathe air while swimming. Breathing air is likely in the first few lessons in swimming training, and it should be, possibly, imperative that the student owns this skill and never forgets it. Is it possible that this captain's primary CFI was incompetent? Would a swimming instructor who fails to ingrain that breathing air is important to swimming be an incompetent instructor?

In another case, on August 29, 2006, 50 people perished aboard Comair Flight 5191 at Bluegrass airport in Lexington, Kentucky when the airplane attempted a takeoff on the wrong runway, a runway half as long as the runway cleared for takeoff and only half the length needed for this aircraft to function. According to this NTSB probable cause report, the reason was stated as "the flight crew member's failure to use available cues and aids to identify the airplane's location on the airport surface during taxi" (NTSB, 2006, p. 1). Airport marking training is in lesson Fourteen of the private pilot learning process as described in the *Pilot's Handbook of Aeronautical Knowledge (PHAK) (*FAA, 2008b, p. 14-5). Again, is it possible that the primary CFI who trained the accident-pilot was deficient in the competencies to do so, or failed to do so competently? Did the pilot not learn this lesson adequately the first time, as dictated by the primacy law?

To address this question, we need to begin with the standards for identifying competency. There are many workforce standards and definitions for the term "competency." Dubois and Rothwell (2004), in one case, define competency as "characteristics that individuals have and use in appropriate, consistent ways in order to achieve desired performance…including knowledge, skills, aspects of self-image, social motives, traits, thought patterns, mind-sets and ways of thinking, feeling and acting" (p. 16). But there exists an enormous gap between this workforce-definition of competency and the way the FAA defines competency. Missing from the FAA definition are just those criteria used to describe "aspects of self-image, social motives, traits, thought patterns, mind-sets and ways of thinking, feeling and acting" (p. 16).

In either case, one goal is to produce an exemplary performer from the novice status. This is, of course, only one potential goal. There can be other goals, too, such as to raise a productivity bar or to avoid failure competencies, but neither of those outcome goals seems germane to this study.

The FAA (2016) outlined its eligibility requirements, aeronautical knowledge, and flight proficiency for which CFI candidates must show "competency" to earn a CFI license. In the *AIH* (FAA, 2008a, p. 8-2), the FAA offers its own examination of CFI qualifying competencies. The handbook's authors state that a CFI must be thoroughly familiar with all systems in the aircraft in which he or she is teaching and that a strategy for teaching should include remembering they are role models to the students, and therefore should demonstrate good aviation sense. The handbook also offers guidance on the skills good CFIs must attain. In addition to people skills, subject-matter expertise, management skills, and assessment skills, the flight instructor must also follow a code of conduct that includes the added responsibility of molding an "aviation citizen" (p. 4-3).

A whirlwind of questions follows. If high-profile accident-pilots were good aviation citizens would that have precluded their accidents? Are pilot-error accidents like these the result of bad or less-than-standard initial training at all? Also, are these competencies minimum job requirements? If they are, what is necessary to be a successful CFI and what are the

competencies of an exemplar (understood to mean best-in-class) CFI? For that matter, what *is* a successful CFI if not an exemplary CFI? Overall, the literature suggests these are assessed in the same way. In contrast to conventional exemplar discovery, task-based to determine top performers versus polling incumbents to identify those at the top and the rationale for what makes them behave that way, the CFI literature conflates these measures. Some experts might argue that the real problem is that there are no agreed-upon performance standards for pilots. You can't have an exemplar if you can't agree on what top performance is, let alone average or entry-level performance. However an entry level CFI must be exemplary, as in "best-in-class", by definition, and by law.

Learning is a change in behavior (FAA, 2008a, p. 2-16) and behavioral change is the route to expertise (p. 2-27). It is the job of the CFI to help students learn to avoid errors (p. 2-29), and both previously mentioned, disaster-causing, errors, as determined by the FAA, should have been learned and eliminated in the first few lessons of flight training (2004, p. 4-1). If flight instructing is liable for these accidents, can better instruction prevent the likelihood of simple but catastrophic mistakes like these? If primary instruction is the root cause of accidents like these, the larger question to be posed is, what makes a competent CFI? It does seem evident that there is more to competencies of exemplary CFIs than the FAA has identified, meaning that its present set is necessary but neither sufficient nor fully explanatory.

## DEFINITIONS

The following key terms are central to this paper and the issues explored.

**Exemplary performer**: "Best-in-class or most productive workers" (Rothwell & Lindholm, 1999, p. 91). "Competencies of exemplary job incumbents and competencies of average performers are determined by a focus group formed of experienced, exemplary job incumbents" (p. 98). Although this is only one way to identify exemplary performers, as there are others described in the literature, this is the definition most relevant to this review.

**Gold Standard:** "Competencies of exemplary job incumbents as well as competencies of average performers are determined by a focus group formed of experienced, exemplary job incumbents" (Rothwell & Lindholm, 1999, p. 98). "What we are interested in is the difference between competencies of the most productive (exemplary) and the average (fully successful)" (Rothwell, paper comment, March 29, 2017).

**Job competency**: "An underlying characteristic of an employee (i.e., motive, trait, skill, aspects of one's self-image, social role, or a body of knowledge) that results in effective and/or superior performance in a job" (Boyatzis, 1982, p. 20).

**Successful performer: "**Fully-successful performer: An experienced worker who is not best-in-class" (Rothwell & Lindholm, 1999, p. 91). "Fully successful performers are those incumbents who meet job standards but are not outstanding" (Dubois & Rothwell, 2004, p. 22). "The point is that a fully successful performer is out of the training period for the job" (Rothwell, paper comment, March 29, 2017).

## METHOD

The ultimate goal of this study was to examine competency as it relates to the CFI role. Articles, guides, handbooks, and monographs were reviewed as they reflected on competencies and their influence on the workforce, and specifically, what CFI competencies look like, tools for

analyzing competencies among CFIs, tools being developed to aid CFI competency identification and assessment, and tools for predicting successful outcomes for CFI practice, including teaching to technical innovations.

The search for research articles was conducted using bibliographical databases available through the University Libraries system. Two bibliographical databases were used: Air University Library Index to Military Periodicals (AULIMP) and Google Scholar. Articles were identified using key phrases such as "flight instruction," "aviation learning," and "aviation instructor competency". Once a central body of literature had been identified, articles were chosen for this study if first, they had been peer-reviewed and second, were based on qualitative or quantitative research. Articles and texts were also chosen after a bibliographic analysis of relevant works conducted to highlight additional relevant works—that is, a snowball strategy in which article bibliographies were searched to highlight any additional potential candidates for this literature review, and then those lists were reviewed, and so forth—correcting for redundancy. Titles identified in these bibliographies were subsequently entered into Google Scholar to identify other potential articles by the same author(s). Something on the order of seventy-five items were located and reviewed.

Once articles were selected, they were sorted into three sets: first, literature regarding competencies (the umbrella concept); second, articles regarding CFI competencies (a far smaller set); and third, articles describing tools developed by industry stakeholders to improve and assess competency among primary CFIs (a more specialized subset).

## RESEARCH QUESTIONS

Three basic questions guided this study:

1. How is competency defined overall in the workforce literature?
2. What is a definable list of competencies for flight instructors?
3. What tools and approaches are being developed to improve and assess competencies of CFIs and outcomes?

Suggestions based on these findings are intended to guide future consideration of competencies in this employment area.

## COMPETENCY

Here we take a look at the overall area of workforce competencies, the current state of competencies for CFIs, and those tools and approaches developed and deployed to assess and improve CFI competency outcomes.

The initial task of this study was to define workforce competency in general and chart relationships to CFIs in particular. CFI competency ranges from basic knowledge and a broader proficiency profile up to exemplary characteristics, building out to all supporting aptitudes, attitudes, and behaviors, within context, level, and type. These factors determine how competency can be identified, measured and assessed. These factors, however, have been difficult to track for CFIs. For example, one insistent problem in CFI competency is that the double role of pilot and pilot-teacher is a limited population, but at the same time, the "most valuable resource" in flight operations (Henley, 1991, p. 330).

The dual typology of successful versus exemplary are key but not clearly defined; these are intuitive and applied as peer process through praxis; the way learning and application are

consistently practiced by incumbents. The FAA definition is narrow—eligible, knowledgeable, proficient, appear as average, but operate on the same level as exemplary, "Best-in-class or most productive workers" (Rothwell & Lindholm, 1999, p. 91). Successful and exemplary are conflated categories, without attempting to distinguish and develop levels from entry through superior to exemplary (an attempt that incurs attendant costs), despite the fact that there is no requirement in the competency world to break out levels of competency.

One core problem is in studying outputs (student performance), especially considering students have multiple CFIs across their training careers, creating unclear causality. In training, the CFI seems to bear responsibility for student success or failure, introducing a causation fallacy (FAA, 2008a, p. 7-2). Of course, outcomes depend on what decision-makers are trying to accomplish with a competency model. If they are trying to improve productivity, then they may well want the difference. However, since productivity doesn't appear to be a priority of the FAA but instead, safety, the point is moot.

How is competency defined overall in the workforce literature? Several interpretations and definitions of what exactly "competency" means have been reviewed, as well as the genesis and evolution of these definitions (Dubois & Rothwell, 2004, p. 17). Dubois and Rothwell arrived at two schools of thought concerning differences in competency interpretation—one in which competency is limited to knowledge skill, and attitude—the cognitive, psychomotor, and affective domains; the other is broader, including the first and also characteristics that support performance: knowledge, skill, attitude plus motivation, and personal traits leading to successful performance (p. 19). Workforce competencies then "are characteristics that individuals have and use," their "knowledge, skills, aspects of self-image, social motives, traits, mind-sets, and ways of thinking, feeling and acting" (p. 16).

Substantial attention has been paid to the competency studies with attention to the distinction between successful (average) versus exemplary (outstanding) performance (Rothwell & Sredl, 2010, p. 92). The key to competency-based testing is to define both ends of the continuum (with average at mid-range). The industry must evaluate performance by outcomes as well as what differentiates the two from basic to best. In addition, competencies vary widely relative to different environments and settings (Boyatzis, 1982, p. 21), and distinctive types and levels of competencies have implications for the way each can be measured and assessed (p. 25). The key to competency-based thinking is to first define both an exemplary performer and a fully successful performer and to address the differences and evolution involved in the transition from good to best (see definition section, Chap. 1). Performance or results distinguish good from best. Since some competencies can be taught but others must be hired for, it is not always possible to raise all workers to the level of exemplary performance. Conceptually, however, you could start with identifying good and superstar performer. Another way is to focus on the work: define in measurable ways what good and exemplary job performances are in flight instruction, and then identify individuals who match up to those definitions.

Dubois and Rothwell (2004, p. 22) stated that the best-in-class performers, i.e., exemplars, might be up to "20 times more productive in achieving work results or outputs compared" (p. 22) to fully successful performers. Engaging in the exercise of pinpointing differences between good and exemplary performers offers valuable insights into performance effectiveness issues with profound impacts on the nature of a range of employment categories. Here, the identification and application of competencies would enable either the consistent selection of individuals who already function at the exemplar level or their development to that

level. An industry must constantly determine which competencies can be developed and which must be hired for.

Often choosing exemplary performers involves stakeholders in the evolutionary process of deciding on a gold standard of performance. Exemplar incumbents then scrutinize their peers to define an exemplary performance by focusing attention on key outputs of the targeted job or occupation. Then they identify the key competencies of those performers, observes Rothwell & Lindholm (1999, p. 99).

In this study, competency was defined as an observable knowledge, skill, attitude, or behavior that enables one to perform the activities of an occupation (Sleezer, Russ-Eft, & Gupta, 2014, p. 149). Also, competency may be a motive, trait, or aspect of self-image, social role, or a body of knowledge they rely on (Boyatzis, 1982, p. 23). These two sentences actually appear to be contradictory. Is a competency defined by the Sleezer definition or does it go beyond that and include Boyatzis' definition? Clearly, there is a difference in opinion about the underlying philosophy of what a competency is among experts in the field. Perhaps, it is both. Nonetheless, competency identification results from identifying behaviors, observable actions, or tangible results produced by their use in the work as it is performed (Rothwell & Lindholm, 1999, p. 98).

Competency studies are important because they are research-based descriptions of what professionals must know, do, and/or feel to succeed in their work (Rothwell & Sredl, 2010, p. 92). How does competency measurement relate to competency assessment? Are they the same thing? More importantly, do competencies actually exist beyond skills and knowledge as demonstrated by measurable tests? And can standardization of terminology in parsing what competency means be achieved?

In this regard, Dubois and Rothwell (2004) explain how difficult it would be to move from a traditional system to a competency-based system in which "pinpointing and building competencies that go beyond knowledge, skills and attitude to include motivation levels, personality traits, awareness of bodies of knowledge, or any of those variables that may be developed and which distinguish exemplary from fully successful performers" (p. 130). One method they describe is in developing a model wherein performance is analyzed, organization and individual requirements are examined, and focus is directed at exemplary performance instead of minimum performance requirements (p. 136).

Nevertheless, competency is a social and empirical concept, meaning that comparing the best instance of that performance with what is typical derives comparative judgment about the worth of performance, says Gilbert (2007, p. 29). However, in multi-faceted jobs, codifying what is exemplary can be complex. Boyatzis specifies that to define competencies, we need to understand their place within a working system (1982, p. 22). To understand any competency, therefore, it must be considered in context. Work always performs within context: the occupation, industry, regional, national, and company cultures must all be examined as they contribute to the concept, goals, and application of competency. This means that competency is a systems study, related to levels, purposes, situations, and varieties of performance within a systems context. In fact, studying competencies means studying human performance in the context of the total system.

## CFI COMPETENCIES

What, therefore, is a definable list of competencies for CFIs? Although the US Department of Labor makes industry information available about CFIs as a subset of commercial

pilots, as of August 2016, no search had revealed a competency model or list for either. This absence of a competency model appears to anchor many of the research and practice difficulties concomitant to the field. Crow, Niemczyk, Andrews, and Fitzgerald (2011, p. 2) and Henley (1991, p. 320) pointed to the paucity of scholarly works on CFI competencies—a matter of concern since "dedicated flight instructors are the most valuable resource in the flight system" (Henley, 1991, p. 330). However, to understand how competency works in the CFI field, one must start from its beginning to see that not much has changed in its 100 year history.

## CFI COMPETENCY HISTORY

About a century ago, in the fall of 1916, in the European theatre of the Great War, British fighter pilots fought courageously but to little avail against their better-trained adversary. The need for replacements sapped the British pilot-force greatly, and reinforcements being sent to the front were seldom prepared for the vicious environment awaiting them. Enemy German pilots shot down British pilots so disproportionately and quickly by German Fokker aircraft and more importantly better trained pilots, that new replacements were simply referred to as "Fokker Fodder" (Tredrey, 1976, p. 33) typically lasting only a few weeks before perishing in aerial combat (Tredrey, 1976, p. 52). One officer of the British Royal Flying Corps, Commander of Squadron 60, Robert Smith-Barry made the observation that the trouble was not the competence of the fighter pilots themselves, but the competencies of the RFC instructors who had sent them (O'Kiely, 1992, p. 144). Some pilots had been sent to the front with as little as 7 hours of flight experience (Smith-Barry, 1917). Interestingly, however, the vast majority of RFC deaths occurred in training (Morley, 2006; Nellesen, 2009) before the "Fokker Fodder" had a chance to even see the deadly front.

In Smith-Barry's view, RFC instructors were inferior and ineffective teachers. Current instructors, he pointed out, were either new pilots waiting to go to the front with very little flying experience or were injured pilots just back from the front, ineligible to fly at the front, essentially, in the prevailing view, useless for any other flying duties other than training (Tredrey, 1976). In most cases, as a result of their circumstances, instructors did not have any interest in flying, much less training-flying. The natural result was that their attitudes and dissatisfactions reflected in the pilots they turned out (MacLeish, 1917). The surfeit of dislike towards training flights and student pilots manifested itself in the nickname instructors had for student pilots, "huns", the derogatory term usually reserved for enemy German combatants (MacLeish, 1917).

Smith-Barry wrote to General Trenchard at command that the remedy to badly and under trained replacement pilots would be better, more competent instructors, and a school for instructors staffed with front-line squadron pilots, seasoned veterans, (Tredrey, 1976, p. 54; O'Kiely, 1992, p. 144) to help new instructors become better, more confident pilots, so that they could teach with confidence and ease, and also be given definite lines upon which to instruct in an effort to generate a positive attitude and behavior, an *esprit de corps*, amongst the instructors, "improving the atmosphere surrounding the whole business of instruction. It is suggested that the mental attitude towards flying of an instructor is reflected in all the pilots he turns out" (Taylor, 1958, p. 75; Tredrey, 1976, p. 54).

In 1917 exemplary instructor performance could be depicted in the instructors whose students learned enough to be shot down least and prior to which survive training. If competencies are characteristics that individuals use, their "knowledge, skills, aspects of self-

image, social motives, traits, mind-sets, and ways of thinking, feeling and acting" (Dubois & Rothwell, 2004, p. 16), then the recipe for this is described in a report by a pupil of Smith-Barry's, a successful instructor, himself, as: "(a) Interest in their pupils and their work. (b) Ability to fly well and easily by themselves. (c) The power to impart knowledge to others, and (d) Satisfaction with their jobs, and with their interest centered wholly in instructing and not in getting to, or away from France" (MacLeish, 1917, p. 23). This report, by the way, found in the National Museum of the Marine Corps at Quantico was written by an RFC graduate and then used as a basis for US military flight training design and then was used again in the public sector as private pilot training companies emerged after the war (Taylor, 1958).

A little more than a century later, the Federal Aviation Administration (2017) outlines the areas of operation and tasks in which instructor candidates must show competency in order to earn the CFI license. Speaking with two distinguished domain experts in the field, however, (D. Powell, personal communication, October 13, 2014; N. Kruse, personal communication, October 28, 2014) both of whom are CFIs with thousands of hours of CFI experience and are also both responsible for hiring and developing other CFIs, "Gut Feeling" is the word they use to describe the difference between successful and exemplary CFIs regarding their competencies; moreover, these experts say, those "Gut Feelings" evince well beyond FAA competencies whether employee CFIs will be exemplary. After all, that is exactly what hiring CFIs look for, exemplary CFIs, not "ok" ones. Competencies are general but must be made measurable through behaviors, behavioral anchors, work outputs or work outcomes. Gut feeling is general but cannot be measured in its current form (Rothwell, paper comment, March 29, 2017). Little is done now, say those experts, to identify, hire, educate or develop competencies in CFIs, the FAA's descriptions and "gut feeling" notwithstanding. In addition, both experts expressed that Smith-Barry's age-old competency philosophy is still valid today. Hiring of flight instructors is done much the same as was done by Smith-Barry; potential CFI hires are routinely taken out on an interview ride in a training aircraft, during which the hiring pilot observes the candidate's flying ability, skills and knowledge, aspects of self-image, nerve, amiability, attitudes, beliefs, mind-sets, and ways of acting. Smith-Barry found useful placing the aircraft in an unusual attitude and starting a conversation with the candidate; he judged a candidate to prove unsuitable if the candidate would "cling to the side with unintelligent expression instead of conversing fluently and with confidence" (Smith-Barry, 1917, p. 3), not hiring those candidates who were "short of nerve or… showed no aptitude for flying. Of the latter, more chance was given to those who appeared to be desirable officers, and to those who appeared to have the necessary pugnacity of temperament" (p. 3). Today, say those experts, is no different. Powell tells how in his interview flight the CFI employer opened the canopy of the plane in mid-flight, a very disruptive situation, all of the paper in the plane flew out of the cockpit. The hiring CFI then asked, "What would you do now, if your student did this while you were instructing?" There was only one correct answer. Any answer other than laughter and total control of the situation, an exemplary response, would result in not being hired.

In the selection of CFI applicants, current literature reveals that a fair amount of latitude is given to acceptable competencies beyond the FAA requirements, giving way to "gut feelings". This has changed little since the beginning of organized flight instruction.

In his "General Methods of Teaching Scout Pilots" (1917), Robert Smith-Barry, wrote, "Those who were turned out, either they were short of nerve, or they had no aptitude for flying… Generally, but not always, it has been found possible to come to a decision as to whether to keep

on an officer (potential flight instructor) or not after about an hour and a half's dual control…(interview ride)" (p. 3).

## CURRENT CFI COMPETENCY

True competency lists are not about work activities, but about what characteristics novice to superstar performers (i.e., exemplars) share. These are the yardsticks set by what results are looked for, then de-engineered by working backwards from these empirical examples (Dubois & Rothwell, 2004, p. 245). The issue in identifying both successful and exemplary performers is to isolate the criteria for success in a job as the first mandate, you define job performance and then study the people who get that performance to get the competencies. We have to ask: how do we know what a successful CFI is when we see one at work? If there is only a single way to know success, is it that successful CFIs' students have never been involved in an accident, incident, or pilot deviation in a lifetime of flying? Is it possible to explain an extraordinary pilot like Chesley Sullenberger and his Miracle on the Hudson by examining his trainers? In an interview with Air & Space, Mr. Sullenberger testified that his first CFI was very much intrinsic to his success in the miracle-moment (2009).

On what basis is performance then measured? And how are the involved variables to be weighted? And, most important, how do we insure that these criteria are workable and predictable? A single study would not suffice; first, competencies would have to be identified, second, the behaviors so linked; third, levels of behavior examined, with appropriate validation.

The CFI brings individual capabilities to this job—the competencies (Boyatzis, 1982, p.12). The specialized knowledge of the CFI required by the FAA, assessed via written and oral tests, and evaluations of practical knowledge, can be considered threshold competencies (FAA, 2017), and only a subset of the competencies necessary to be successful, let alone exemplary. Beyond these threshold competencies, even the (baseline) successful CFI understands human behavior, the learning process, effective communication, the teaching process, assessment, and risk management—all in addition to the specialized knowledge necessary to flight-instruct (FAA, 2008a, p. 2-16). For an integrated competency model, motivation, efficiency, orientation, proactivity, self-control, self-efficacy, stamina, adaptability, and impact on others (Boyatzis, 1982, p. 196) would need to be integrated into the FAA definition of a CFI. Behavioral Event Interviews, qualitative interviews designed to reveal the competencies, would be a suggested research route.

Returning to the baseline requirement for competency, the CFI is responsible for training, educating, and developing student pilots (FAA, 2008a, p. 7-9). Besides being a safe pilot, the flight instructor must be a trainer and educator (p. 4-3). For candidates to be eligible to apply to become CFIs, they must be "at least 18 years old, able to read, speak, write, and understand English, hold either a commercial pilot certificate or airline transport license in an aircraft category appropriate to the flight instructor rating sought, and have been endorsed by an authorized instructor " (FAA, 2017, p. 1). They must also have at a very minimum 250 hours of flight experience as a pilot. The FAA tests eligible CFI candidates by two written exams: the *Fundamentals of Instruction* test and the *CFI Knowledge Test* (FAA, 2017). These tests were developed at the examiner level as based on the experience of those examiners (J. Seibolt, personal communication, August 11, 2016).

In addition to the written tests, there are an oral and then practical (flying) examination the candidate must pass in order to earn the CFI license. "There are currently 27 Practical Test

Standards, which cover testing for pilots. Their publication dates range from 1998 to 2013. Their Areas of Operation, Tasks, and performance standards were generated by FAA Inspectors whose deep backgrounds in the relevant disciplines provided the basis for the content of the PTSs. Incident, accident, or other types of data were not used in the formation of the PTSs" (J. Seibolt, personal communication, August 11, 2016).

Section 3(c) of the 1926 Air Commerce Act states "The Secretary of Commerce shall regulate and provide periodic examination and rating of airmen serving in connection with aircraft of the United States as to their qualifications for such service" (Committee on Interstate and Foreign Commerce, 1943, p. 2). "Such examination shall be based upon the character, physical fitness, training and practical experience of the airmen" (Comm. IFC, 1943, p. 11).

In fact, a review of the background of the FAA standard reveals the underlying assumptions driving its CFI requirements. The charter document written in 1938 and then amended in 1943, a bill HR 1012, amendment to the Civil Aeronautics Act of 1938, states,

The instructor rating and the corresponding regulatory required that no person may give flight instruction unless he possesses one were established for an entirely different purpose than the classification of pilot certificates and the ratings which I have discussed. They were created in order to keep the pilot from becoming a public hazard by undertaking operations for which his skill and experience did not fit him. The instructor rating, on the other hand, is designed to promote safety by permitting only those of demonstrated ability to teach students, thus improving the caliber of the student pilots who are permitted to fly solo. An instructor rating may be secured only after passing a rigid flight test to determine whether the applicant has the extraordinary flying ability which must be required of an instructor and also has the ability to impart his knowledge of flying to students. (p. 30).

This passage clarifies the intent of the creators of the FAA that only exemplary instructors would be allowed. An examiner, a flight instructor deemed experienced enough by regulators to know what an "extraordinary flying ability" looks like, would test and assure CFI candidates' competencies. Here the challenge is to distinguish the functional differences between exemplary and fully successful (average) competence under the FAA demand for "extraordinary" flying and teaching performance within the same pilot. Exemplary can only be distinguished from fully successful when we have pinpointed the measurable components of job performance and then identified objectively who secures that job performance most often. To the FAA, however, is experience the sole identifier?

So these standards of performance are set for exemplars by exemplars. This somewhat lengthy explanation should show how the FAA developed these tests. There was no research conducted because none was indicated--it was their own professional experience that provided the intuitive awareness and measures of how competency is to be judged.

In addition, an FAA examiner, an FAA employee, or private FAA designee engages in a thorough oral examination followed by a flight exam, during which the examiner can interview the candidates to see whether the candidate has teaching ability, knowledge, and skill (Crow et al., 2011). The Practical Test Standards (FAA, 2011) is a listing of acceptable test performance outcomes in these competencies.

And most notably for this occupation, CFI competencies include the ability to train students to engage in life-and-death decision-making judgments. Gilbert (2007) addresses this issue in his development of a "measure of competence, the ratio of the exemplar's performance to typical performance, the PIP (Potential for Improving Performance)" (p. 30).

In a comparison across different professions, the potential for improved performance among CFIs (included in the full set of all airline pilots) as they graduate as novice CFIs is the very lowest (1 on a scale of 30); all student CFIs must be trained at an exemplar level, exemplar level is a confusing concept here when there is no objective measure for CFI performance (Gilbert, 2007, p. 43). To have an exemplar, usually, implies someone is more productive than someone else. To know what productivity *is*, you must have some kind of objective measure of performance. In fact, one could argue, if there has been no research, there is no way to know what is exemplary or not unless the standard of exemplary is "keep people from dying when they fly" (Rothwell, paper comment, January 11, 2017). The FAA's perspective, however, is that there is no performance less-than-perfect acceptable for a CFI, thus the underlying question of whether competency-based approaches make sense to the CFI field. There is an abundance of research opportunity within this paradox.

Of course, there are still minimal-competence expectations. Effective performance by the CFI must be to attain specific results; students must learn skills and judgment by way of specific actions while understanding and obeying specific policies, procedures, and conditions: those stipulated by the FAA and by the laws of physics. The CFI must instill such baseline information while executing their training.

Nonetheless, the charter work for the CFI industry, the Civil Aeronautics Act of 1938, tells us that minimum performance for a CFI *is* exemplary performance. "An instructor rating may be secured only after passing a rigid flight test to determine whether the applicant has the extraordinary flying ability which must be required of an instructor and also has the ability to impart his knowledge of flying to students" (Amendment Hearing, 1943, p. 30). Exemplar is the "shop-floor practice" standard. How would exemplary versus adequate performance be measured, then? This appears to be the crux of the CFI competency issue (as well as within any job arena in which success measures are immature, unclear, unstated, or not yet researched). Steps to evaluate adequate versus sub-adequate outcomes could be measured by student outcomes like in Henley (1991). Any CFI who has less than 50% of their private pilot test applicants fail on the first attempt might be considered sub-adequate, for instance. So, is instructor performance contingent on student test passing? Is that a fair measure of instructor competence? If a teacher does everything right, does that mean an unreceptive student is absolved of all responsibility for failing a flight-test? Is there only one measure of CFI performance?

This method has proven problematic in the CFI industry because most CFIs are not tenured in their jobs and therefore will view any analysis of their output as a threat to job security, rather than an opportunity to become better performers, underlining that lack of formal scrutiny makes the field itself dangerous (Henley, 1991, p. 319). Henley also reported (1991, p. 323) that one method for evaluating instructors is based on their students' testing performance. In Canada, for instance, if an instructor shows a low success rate for student-pilot test applicants—that is, if an instructor's students are too frequently assessed as below average on their flight test tasks, the instructor can be referred for remedial instructor training. The issue with this approach, as cited earlier, is the absolute stress placed on the instructor rather than discerning the joint-operation roles of teacher and student. If instructor performance is defined in terms of student exam pass rates, then that is measurable. Of course, the problem is that it defines one individual's success in terms of another person's success. If the student is an idiot, then the instructor fails regardless of how good the instruction is or the instructor is. One might argue that instructor performance might need multiple ways to measure performance in order to

get beyond single measures. The job is too complicated to be measured adequately by one measure like student exam pass rates.

Interestingly, the FAA does have a program on the other end of this scale; it is called the Gold Seal program. One attempt to distinguish exemplary from adequate CFI's is based on the number of successful applicants a CFI sends through the private pilot exam. CFI's are rewarded with a gold seal on their CFI license if, within any 24 months, they recommend at least 10 applicants for certificate or rating tests and of those at least 80 percent pass on their first attempt (FAA, 2017).

. Rothwell and Lindholm (1999, pp. 98-99) explained that in a process-driven approach to competency modeling and a responsibilities-driven competency-modeling approach, an expert panel of supervisors or immediate organization superiors who are themselves exemplars can, by consensus, decide what key outputs or responsibilities are, and what they look like when performed by exemplars (by whatever definition), creating a gold standard by which to gauge the competencies or individual capabilities of exemplary versus adequate performers. This is competency by consensus, and forms in effect the FAA approach, the industry standard. Underlying this definition is an assumed understanding of how job performance is measured as well as perceived (and analyzed in assessment), while operating under a less-than-clear-cut and objectively defined work result.

In addressing this issue, in 2015, Beaudin-Seiler and Seiler published an article using a "gold standard" to study how reliable CFIs were at assessing maneuvers and assigning grades for flight lessons through an inter-rater reliability study in the Western Michigan University flight program.

Research objectives were to determine how closely aligned CFIs might be in assessing maneuvers and flight lessons to a "gold standard" that they developed as part of the study.

An expert committee comprising a research associate, a program manager, and one flight faculty member developed the "gold standard." The program manager and flight faculty member, both experienced CFIs, took turns performing four maneuvers: slow flight, power-on stalls, power-off stalls, and steep turns. These maneuvers were chosen because they were flying skills that could each be performed on a simulator. The maneuvers were graded to different proficiency levels. The program manager and flight faculty member individually rated the video and audio recordings of their own performances based on the school's required grading format on a scale from 1 (low) to 4 (high). "After further discussion and review, the program manager and flight faculty member agreed upon a final score for each maneuver. This established a "gold standard" for each maneuver" (p. 78). However, it was not clarified by the researchers exactly how this consensus was achieved.

Beaudin-Seiler and Seiler's 2015 study relied on a sample selection of 40 CFIs teaching in the college program. The response rate was 100% because all 40 were required to complete the exercises (p. 76).

In the methodology**,** flight students were then videotaped flying these maneuvers, and then the committee graded the videos based on the "gold standard." Next, all 40 CFIs from the program were given a thumb drive and limited information about the student in the video performing the maneuvers and asked to grade the maneuvers based on the school's required format. Levels of agreement between instructors, using the Cohen's Kappa Coefficients (which was .325) were assessed using SPSS statistical software. Initial assessments revealed that the less-experienced instructors demonstrated lower agreement with the "gold standard" than more-experienced. Also less experienced instructors simply assessed maneuvers to see whether the

minimum required was accomplished and were not grading the maneuver per se. Less-experienced instructors were more likely to give a 2 out of 4 for exemplary and for failed maneuvers. The primary limitation of the study was scope. Only one flight school was used, and only 40 respondents participated (p. 79).

The authors, in seeking the underlying logic of the grading**,** concluded that less-experienced instructors felt uncomfortable failing peers, while looking for whatever was required of a maneuver to be acceptable and then stopping there as the default, not acknowledging maneuvers better than average or even exemplary. More-experienced instructors showed the opposite behavior, being far more likely to give failing grades and exemplary grades, using the full grading scale to reflect true performance and inadequate performance. This study matters to the understanding of CFI competency identification because it shows objective, meaningful "gold standards" are difficult to derive. This difficulty can be traced to problems with standards for grades and in CFIs' lack of training in grading versus giving instruction (p. 87). This general limitation embeds in the competency measuring issue.

In the research study, the researchers suggested that future studies should focus within the same program to include practice video sessions at instructor meetings and frequent discussion between flight faculty and the CFIs to improve collaborative "gold standard" recognition for new hires. Such measures are needed to better define subjectively derived standards and agreed-upon standards to enforce the "gold standard," and to set standards for new training technologies (p. 88).

Could the difference between an exemplary and successful CFI be found in their ability to impart skills, specialized knowledge, and combination of the two by example? According to Henley, competency in flight instruction considers all the variables in the learning process, not just the psychomotor aspects (1991, p. 330). One competency, then, needed for an exemplar CFI could be the ability to be innovative because of the multifarious variables inherent in this occupation. However, Wetmore, Lu, and Bos (2008) found that maintaining a balance between standardization and innovation has been a challenge for many CFI programs. They suggest, "flight school managers must understand that their instructors cannot train student pilots above and beyond minimums unless those instructors have the freedom to try new and innovative training techniques" (p. 44).

Wetmore et al. (2008) described the training paradox of standardization versus innovation in their study. The FAA Industry Training Standards (FITS) in calling for both safety and new flight technologies, found Wetmore et al., created this conflict in philosophy. The research goal of the study was to devise a model of equilibrium to address stagnation (p. 39) and to manage the demands of change on instruction and performance.

Innovation is critical for adaptation in the CFI occupation. However, too little standardization results in lack of professionalism, or chaotic training programs. Too much standardization, however, creates unmotivated students and stagnation. Wetmore et al., from their quantitative and qualitative study of a college aviation professional pilot program, concluded this is the paradox. In the study, students' flight hours were compared to their impressions of the program's culture. The study compared quantitative logbook data to the qualitative comments generated by the survey on standardization and innovation.

According to Wetmore's 2008 study, five research questions were investigated: "1) what are some of the indications that a flight school lacks innovation? 2) Who are the main resistors to innovation in a flight school? 3) What are the characteristics of a flight school with too much or too little standardization? 4) What are the characteristics of a flight school with too much or too

little innovation? 5) What are the benefits of a good balance between standardization and innovation in a flight school?" (p. 40).

The sample selection was from a 36-student senior class at a flight school, of which 33 volunteered to participate and completed survey instruments, a 92% response rate.

The methodology was to give participants a survey "consisting of four sections: (a) general information such as total time, dual time, Pilot in Command (PIC) time, number of weeks in the program, and details about the types and numbers of certificates earned; (b) flight training program questions concerning such subjects as flight instruction, aircraft, scheduling, maintenance, finance, academics, advisement, and flight school culture; (c) blank sheet of paper entitled "comments"; and (d) spreadsheet for the recording of logbook information such as total flight time versus calendar time, flight training delays, stage checks, and check-rides" (p. 40).

The study's main limitation was narrow focus, with only one class sampled of students in the program, and, the authors noted, "a broader survey that involved other classes might reveal how flight students' attitudes toward the program have evolved as they passed through the system," and that, "A broader survey of other college aviation programs would be required to determine if the results of this study are applicable to the collegiate flight training industry as a whole" (p. 41), though these insights could by themselves enrich flight education in general.

Results showed that most students (a) "failed to meet the program goals; (b) used competitor flight schools to earn some of their certificates and ratings; (c) are over training for individual certificates and/or ratings; (d) are over-flying the program as a whole; and (e) are somewhat critical of the flight school management's job performance" (p. 42). The authors concluded from the data that a "healthy mix" of innovation and standardization could be found for school success where cultural values deliberately reward innovation and cultural norms actively discourage stagnation without sacrificing safety or professionalism (p. 44).

In application, findings supported a proposed model to resolve the paradox of safety versus creative adaptation to new technology. The industry standard (FAA-based) proposes safety/adaptation compatibility and coexistence through cultural change as proposed by the FITS initiative (2016). This model (p. 53, Fig. 1), "The Benefits of a Perfect Balance," allows flight schools to pursue "positive innovative learning above and beyond the minimum standard atmosphere without sacrificing safety," as performed within the framework of professionalism. Who determines that is not addressed. The forthcoming research agenda would then be to apply and test this model, within the original program and/or beyond.

## TOOLS AND APPROACHES TO IMPROVE CFI COMPETENCY

What tools and approaches are being developed to improve and assess competencies among flight instructors? Several studies identify and develop tools and approaches to enhance the CFIs ability to perform like an exemplar. Crow, Niemczyk, Andrews, and Fitzgerald (2011) studied role-playing as used to enhance the effectiveness of the CFI, and Alkov and Gaynor (1991) examined attitude changes and performance as well as the three major competency determinants of CFI performance: ability, personality, and attitude, affecting observable behavior and performance outcomes. Also, looking from a different perspective, aptitude and attitude recognition tools have been employed to predict instructor outcomes, not by attending to instructor competency but indirectly by effects on student potential.

Crow et al. (2011) examined role-playing as a perceptual learning model for enhancing the effectiveness of the CFI. The research objectives of this study were to determine whether

role-playing is an effective way to enhance CFI performance; Crow et al. reason that the very test to be certified as a CFI is a role-play in which an examiner role-plays as a student while determining if a CFI candidate can teach while flying (p. 2). This study is an observation of behaviors of CFI trainees analyzed to determine if a significant difference in trainee behaviors depended on whether the student was a peer CFI trainee or an actual flight student. Neither sample selection nor response rate are discussed by Crow et al., except to state that participants were CFIs in training holding a commercial certificate with instrument rating and were working towards the CFI certificate. These CFIs-in-training instructed either actual students or peers at the discretion of the course instructor; they were aware of being recorded (p. 6).

Methodology called for CFIs-in-training to be observed and video-recorded while they trained either actual students or their own peers in simulators (a conventional means of training). The video of their in-simulator instruction was then coded according to the instructors' behavioral patterns. Fifty-two 25-minute sessions were examined. Thirty-seven sessions were instructor trainees teaching actual students, while 15 were instructor trainees teaching a classmate by role-playing. Behaviors looked for were a set of essential instructor skills as defined by the International Board of Standards for Training, Performance and Instruction (IBSTPI), during previous research (as cited in Crow et al., 2011, p. 4). "IBSTPI gathered many different instructors from a variety of fields to develop a detailed description of the standards for instruction" (p.6). The researchers then, through subject-matter experts and observation, modified these behaviors to reflect behaviors specific to flight instructors.

In conclusion**,** the study reflected a core problem inherent in simulations, namely, that there was a statistical difference in the behaviors the instructor trainees used when teaching an actual student or a peer. Results showed a role-playing peer, examiner, or instructor may not behave like a real student, causing the behavior of the instructor to differ from when a real student was present (p. 9). It was further concluded that role-playing is simply not sufficiently realistic to be as effective as real-life roles played out in an environment grounded in those actual roles (p. 9).

In terms of limitations, the data seemed to indicate that the role-playing environment for the experiment might also not be realistic enough to have determined the true difference between simulated versus real, and the difficulties with role-playing for effective instruction. Future research plans were to attempt the same experiments, but adding a remote camera in an actual training plane rather than in a simulator (p. 10).

A different study by Alkov and Gaynor (1991) examined another domain, attitude changes and performance, using a one-tailed Wilcoxon signed rank test. Their research objectives were to examine if, of the three major competency determinants of pilot performance: ability, personality, and attitude, modification of attitude was the tool most useable to affect observable instructor behavior.

The methodology relied on surveys. Fifty-eight surveys were filled out by instructor pilots in the United States Army, Navy, and Air Force prior to being sent for a two-week training course, followed by the identical surveys again given to those same instructor pilots post-training to discover to what extent training can affect attitudes. Thirty-one items in the survey involved attitude and hazardous thought patterns used in FAA judgment assessments. N.B.: While the study references a Federal Aviation Administration's judgment training program, no specific program was either referenced or cited.

A 5-point scale was used with responses: (1) strongly disagree to (5) strongly agree. Each individual's response to an item on the questionnaire completed before the course was

subtracted from the response completed at the end of the course. The differences ranged from +4 to -4. A difference of zero reflected no change. For each item a one-tailed Wilcoxon signed rank test was performed to determine whether there had been a significant shift in response ($p < .05$). The average response on a bank of questions such as: "pilot's obligation to mention their own stress to others," or "pilot-in-command should provide clear orders," or "pilot flying should inform the other pilot of maneuvers before training," was 4.23, or "agree," but not quite as strongly as a 5. After the training attitudes had shifted an average of .32 points to 4.55.

Alkov and Gaynor concluded that this study demonstrated that among instructors, attitudes could be changed with training. This attitude training was continued for six years and in each instructor community, in which it was used, safety--as measured by aircrew mishaps--improved (p. 249).

Limitations were primarily those of assumptions, as the authors pointed out, "that an enthusiastic endorsement of a program by participants does not ensure behavioral change" (p. 250). Future investigations include a longer-term study to determine if instructors' changed attitudes would persist over time (p. 250).

## OTHER APPROCHES

Having reviewed literature on what workforce-competency is, what competency for flight instructors looks like, and what tools and approaches have been developed to improve and assess competencies for CFIs, it is clear that not only are there holes in the literature, but some of the literature is conflicting. This really matters because if experts in workforce performance claim that beneficial results accrue to an industry by raising competency levels (Dubois & Rothwell, 2004, p. 22), then this technology must be better researched within the CFI industry. While the FAA has compiled a comprehensive list of factors that comprise competencies for CFIs, including skills, knowledge, and even displayed attitudes towards students, the list is not robust enough to hold up to Dubois & Rothwell's definition (2004, p. 16). Contradicting the notion that CFI competency matters is pre-instruction, performance predictors for student pilots. What if the competency of the CFI didn't matter at all? What if student pilots' competencies were the determining factor in safe flying? Is it possible that Thorndike's law of primacy is moot?

Attempts have been made to analyze the prospective student pilot's success chances from the platform of pre-training competency. This has occurred more often in military pilot selection due to the high cost of pilot trainee washout, report Hunter and Burke (1994). With regard to civilian pilot selection, however, Mekhail, Neimczyk, Ulrich, and Karp did a collegiate study in 2010.

Their research objectives were to determine the validity of a paper-based assessment measure, the Table Reading Test, to measure pilot candidates' potential to succeed in flight training (p. 101). Mekhail et al. continue,

> Although there are several different test instruments used for pilot selection, almost all measure cognitive ability, conscientiousness, or job knowledge. The focus of this study was to determine the validity of a paper-based assessment measure, the Table Reading Test (TRT) (Damos, 2004), to assess an individual's perceptual speed, or how rapidly one perceives and processes, in this case, visual information. Damos has previously validated the TRT for airline pilots; therefore the focus of this study was the validation of the test for *ab initio* pilots (p. 101).

Sample selection occurred between fall 2005 and fall 2008, from freshman students enrolled in an aviation program at a university. Of 277 students who took the Table Reading Test (TRT), data could only be used from 116 due to incomplete flight records, coming to a response rate of just 42% (p. 107).

Methodology was to administer TRTs over a four-year period initially each semester. The test is a perceptual speed test comprising 50 multiple-choice questions. Subjects were given only nine minutes to complete the test, which by design should be impossible to complete in that time frame. Flight performance data was then requested from the pilot candidates from their logbooks and from school records. Specifically requested were times in flight hours to solo and time to private pilot certification.

Mekhail et al**.** concluded that the TRT succeeded as a predictor of student pilot success. The better student pilots did on the test, the fewer the number of hours they took to be proficient to solo an airplane and take and pass the Private Pilot Practical Exam: Time to Solo: ($r = -0.228$, $p < 0.024$), Time to Private: ($r = -0.754$, $p < 0.001$), and GPA: ($r = 0.283$, $p < 0.002$) (p. 110).

The study was limited by inconsistencies in logbook entries; some students rounded sub-hours to the nearest hour. Also some students changed instructors during the study period; some indicated they had three sequential instructors, which may have caused them to fly additional hours to get mutually acclimated (p. 110).

Future study will be in predicting the degree to which the TRT scores can foretell future pilot performance, focused up through advanced rating including CFI and just the private pilot certification (p. 110).

This correlative study perhaps also showed that CFI competency matters less than the perceptual speed of the student pilots. Wilson studied other predictive qualifiers for success.

Wilson (2013) examined predictive signs of success in the Minnesota State University Aviation program for pilot selection using personality measures including the Five Factor Scale, Cockpit Management Attitudes Questionnaire, Self-Monitoring Scale, an Integrity Scale, and cognitive measures including Block Counting, Rotated Blocks, and Numerical Reasoning. Wilson hypothesized for the research objectives that those who scored high for extroversion and conscientiousness, and low in neuroticism, would be positively correlated with high performance; high scores in professionalism would correlate well with high performance; and that high scores in special and numerical reasoning would be positively correlated with high performance as well (p. 12).

Forty-two pilots from Minnesota State's Aviation Department were selected to participate as subjects; however, only 24 contributed valid responses, due to incomplete data, yielding a response rate of 57% (p. 16).

The methodology for testing the three hypotheses was a two-part pencil assessment: a timed mathematical test including block counting and numerical reasoning, and an untimed personality battery and a review of instructors' ratings of each individual.

An analysis of the hypotheses led the researcher to several conclusions: First, students who more closely resembled a profile with higher levels of conscientiousness, high extraversion, and low neuroticism would perform better overall than those who did not fit, were tested. Bivariate correlation ($r=.49$, $p<0.05$) was found between extraversion and a component of performance measure. However, a linear regression was observed between conscientiousness and decision-making and situational awareness (**$\beta=.31$, $p=.17$; $\beta=.26$, $p=.26$).**

Second, students with high professionalism would outperform those with low professionalism. Using a Cockpit Management Attitudes Questionnaire (CMAQ) to approximate

professionalism, there was significant correlation between high CMAQ and a component of performance (r=.57, p<.01).

Third, spatial and numerical reasoning would correlate positively with performance. In a block-counting test versus in-flight situation, positive correlation was found (r=.45, p<0.5). However, rotated blocks showed linear regression predicting decision-making (**β=.36, p=.12**).

Wilson concluded that, while personality characteristics played a role in understanding student performance results overall, they did not support personality-performance correlation in an aviation setting (p. 25). Limitations of the study included a small sample size, with incomplete data, reducing sample size considerably (p. 25). Future studies will examine the relationship between assertiveness and flight performance, via the Five Factor Scale, CMAQ, block counting and rotated block measures (p. 25).

Research questions in another study, by Intano and Howse (1992), looked at predicting performance in Army aviation flight training by having prospects take a battery of tests to discriminate among low-time pilot trainees. Originally, Intano, Howse, and Lofaro in 1991 developed a battery of tests to discriminate among low-time, 100-day trainees to determine which track of advanced aviation training would be most appropriate for them individually. The battery of tests was written by using subject-matter expert (SME) opinions, and an evaluation of successful pilots in each track. Each track involved the use of one of four rotary-wing aircraft for both advanced training and career path. Intano and Howse attempted to predict overall aviation candidates' training success by reinventing the battery of tests as the Multi-Track Battery Test (IERW-MT). Intano and Howse wanted to determine whether performance measures including flight and academic grades, attrition, and training setbacks could be predicted with the IERW-MT-renamed MTTB. While helicopters and fixed-wing, single engine airplanes are different classes of aircraft, because this study references prospective pilot selection tools, it seemed germane

Sample selection was made from a pool of 3000 subjects, graduates from 40 Army Aviation Centers between 1989 and 1990. No reason was given for the group's selection.

Methodology included testing each aviator candidate between day one and ten in their aviation training, prior to the candidate flying a helicopter. They are tested on two separate days in two-hour testing periods each. The MTTB included testing of cognitive ability, perceptual, psychomotor, and multi-tasking, attitudinal and motivational domains (1992, p. 907). Thereafter, academic evaluations (EA), flight evaluations (EF), and two composite grades: primary overall grade (POAG) and primary overall flight grade (POFG) were compared to a predicted grade, the culmination of MTTB scores and Forward Stepwise Multiple Regression, to predict future success.

Intano and Howse concluded that the study showed flight-student performance could be predicted at an early stage and provide a useful management tool for identification of students with low probability of successfully completing flight training (p. 909) (candidate screening). However, there were limitations to the results, namely that teaching-to-criteria may have produced higher than usual academic grades, and assessment instruments designed for non-dichotomous performance measurement. Also, flight grades seemed, after inspection of the regression formulas, to depend heavily on the sub scores of the Complex Multi-tasking Battery test, whereas the prediction of academic grades is more dependent on the Complex Cognitive Abilities Battery sub scores; therefore, prediction of composite grades is better than prediction by individual grades of which they're comprised (p. 909). Future research will be organized to minimize differences in sample sizes.

## CFIS AND COMPETENCY

This literature review shows competency understanding to be an array of hard-to-soft attributes, from hard skills to behaviors. Each area demonstrates an array of gaps in research. For CFIs, the FAA's standards and expectations seem intuitive rather than based on competency modeling; they have no successful-exemplary definition, nor do they have any substantive research towards the identification, measurement, assessment or development of tools or approaches to improve competencies for CFIs. Other ways of understanding competencies that have been attempted within the CFI community include standard versus innovative, gold standard, personality traits, self-image, and attitude.

In addition, there is some scope and validity for tools in role-playing and attitude modification. Beyond knowledge and skill, attempts have been made to set the standard of "exemplar" for CFIs through role modeling and conduct code covering interpersonal, management, and assessment. In addition, studies have been run of student competency to outcomes that show bias of pre-selection for caliber may negate the need for any CFI competency identification, measurement, or assessment altogether.

The main research opportunity, however, is the issue to operationally define the FAA's intuitive standards (gut feeling) and traditions by a competency-based needs assessment. This need extends past the FAA technical standard as the platform for learning innovation and evaluation. Future research recommendations are based on: 1) The starting gap, the gold standard from which to reverse-engineer competency identification by industry consensus to seek common key outputs; 2) Organization development narratives (critical incident and critical requirements) across industries (e.g., expert systems): sample questions and potential sponsors for large-scale studies.

In this chapter, future studies are proposed to expand upon CFI competency identification, definition, modeling, assessment, etc. Attempts have been made so far to parse the understanding of competencies, and much more can follow.

## COMPETENCY

"Competency, competencies, competency models, and competency based training are Humpty-Dumpty words meaning only what the definer wants them to mean," (Rothwell & Lindholm, 1999, p. 91) because of procedural and philosophical differences between those developing and defining their use. However, competency can be defined as an array of traits; some hard and easily defined like skills and provable knowledge; whereas others are more challenging to objectively define such as personality traits, aspects of self-image, and attitudes (Dubois & Rothwell, 2004). But in any case, definitions across the board focus on individuals who perform exceptionally well at their work, beyond mere job descriptions.

Competencies of trainers have been widely studied: Arneson et al. (2013); Bernthal et al. (2004); McLagan (1983); McLagan (1989); Pinto and Walker (1978) and Rothwell et al. (1999), to name a few, but CFI competencies have not been so widely studied.

A synthesis of the literature shows that despite the shortage of overall scholarly work on CFI competencies, still, key points have been addressed. The FAA has devised a list of skills and knowledge to be an effective CFI; however, its regulations and advice seem based on the gut feelings of examiners and experienced CFIs (or expert intuition), not on competency modeling.

Also, identification and examination of exemplary versus successful performance appear to be a neglected domain. A few competencies have been singled out, notably innovation versus standardization. These were addressed as conflicting personality traits; however, both must be included the CFIs' competency list (Wetmore, Lu, & Bos, 2008). A "gold standard" was derived in one study to decide what an exemplary versus fully functional CFI looked like (Beaudin-Seiler & Seiler, 2015) but this was on a small scale. Selection of an expert panel of organization superiors (as exemplars), tasked to decide what key outputs and responsibilities are and what they look like when performed by exemplars versus fully successful CFIs, was itself very limited (though might be indicative).

Despite the core literature reviewed, there is a notable dearth of study on the personality traits, aspects of self-image, and attitudes associated either with the successful or the exemplary CFI. Two tools developed to help improve competency for CFIs were examined, role-playing by Crow et al. (2011) and training to affect attitudes of CFIs by Alkov and Gaynor (1991). Both studies had the inherent limitations of subjectivity and scope.

However, a few tools and approaches have been developed to sidestep the necessity of CFI competencies altogether by going directly to student pilot competencies. Aptitude tests by Mekhail et al. (2010) and Intano and Howse (1992), and personality tests by Wilson (2013) show that it might not matter what kind of competencies CFIs have. By prescreening student pilots better, a fully successful performing CFI or an exemplar CFI's output would be the same and dependent on their students' competencies altogether.

Dubois and Rothwell's *two* schools of thought concerning differences in competency interpretation—one in which competency is limited to knowledge and skill, the other in which competency can include any characteristic that supports performance (2004, p. 19) and the FAA list of competencies for CFIs can be rendered down and understood to be comprised of some similarities. Competencies are broad but must be made measurable somehow. Normally, a competency can be something like "management skill," but the behavior or output makes it more specific and recognizable. The underlying concept may be that all CFIs are exemplary CFIs and must exhibit competencies such as:

1. Being mindful that they are always role models to the students, and therefore should demonstrate good aviation sense at all time; besides:
2. People skills,
3. Management skills,
4. Assessment skills,
5. Following a code of conduct that includes the added responsibility of molding "aviation citizens."

## FUTURE RESEARCH

Is "gut feeling" a more accurate word to use when assessing characteristics that affect CFI performance? In view of the literature, more research could be done to determine what constitutes "gut feeling," starting, possibly, with developing a competency-based needs assessment. What is basically intuitive is no doubt the core of a highly operational "expert system" that is effectively doing the job of assuring competency levels for the CFI occupation and CFI field, which is deployed during any periodic, performance reviews and on certification. In addition to a competency-based needs assessment, a thorough task analysis is needed for CFIs.

So too is a competency study of CFIs. The task analysis would tell what they do; the competency study would tell what kinds of people do it best.

In their 2015 analysis, Beaudin-Seiler and Seiler found difficulty in identifying and locating existing exemplary CFIs to set up a gold standard. This difficulty must be addressed before beginning a competency-identification (Rothwell & Lindholm, 1999) for CFIs. The ensuing phase should be assembling a team of subject experts. The process of choosing exemplary performers involves stakeholders in the industry deciding on a gold standard of performance. Exemplar incumbents then scrutinize their peers to define an exemplary performance by focusing attention on key outputs of the targeted job or occupation. Then they can identify the key competencies of those performers (p. 99).

Garud, Dunbar, and Bartel (2011) outlined a framework that showed how using narratives in organization development processes enables organization learning to make use of learned routines and judgment algorithms to respond to unusual experiences in businesses, such as the case explored in the Garud et al. study of the 3M Corporation. Flanagan's Critical Incident Technique (1954) was doubtless an indirect paradigm for Garud et al. (2011). Flanagan, too, almost 60 years earlier, used narratives in organization development as a tool for learning. One of the studies described in Flanagan's article led to a set of descriptive categories called "critical requirements" of combat leadership (1954, p. 2). Combat veterans collected narratives on behaviors, ranging from especially helpful to inadequate, finishing with answers to questions like, "Describe the officer's action. What did he do?" (1954, p. 2).

The Critical Incident Technique, born in aviation, has jumped the confines of the aviation community. This method involves evaluating narratives to collect specific behavioral facts to make inferences on requirements in many other industries (Flanagan, 1954), and to foster personal growth (Rothwell & Sredl, 2000). One recommendation would be to conduct a critical-incident, competency-needs assessment for flight instructors (selection criteria to be determined, which may be problematic given the mixed standard). When the competencies for a particular professional group must be identified, measured, and examined across many organizations, competency-based needs assessment may be called for (Sleezer et al., 2014, p. 147). Questions could include the following:

1. Tell me a story about a time when you faced the most difficult situation you ever faced in your career in the role of CFI.
2. Tell me a story about the most difficult situation you ever faced as a CFI.
3. What happened?
4. What happened as a result of your actions?
5. What were your competencies - skills, knowledge, and attitudes - that you can identify from this story?

Respondents could be given the questions orally and by text and encouraged to respond in any way they found most accessible and easy, and could be recommended to leave narratives as a voice message, a text message, or an email. Again, the initial selection basis for inclusion will be key to this process. Spencer and Spencer's book, *Competence at Work: Models for Superior Performance,* has a whole chapter on how to use critical incidents and how to analyze the results (2008); perhaps this is a great place to start.

This questionnaire could be reused and put through replication and validation tests as an independent model. A larger-scale sponsor, perhaps NASA or the National Association of Flight Instructors (NAFI), or the FAA, could be sought to do a larger-scale study. Such a study might

have the potential to clarify the boundaries important to defining objective performance standards and the levels of performance for those who exhibit them.

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