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Pilot Source Study: An Analysis of Pilot Backgrounds and Subsequent Success in US Regional Airline Training Programs

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Abstract

The 2010 Pilot Source Study, commissioned to research the success of pilots in initial training for Part 121 operations, analyzed the training performance of 2,156 new-hire pilots in the years 2005-2009. Six regional airlines provided data that was mined from human resource and pilot training files. Five university researchers independently analyzed the data and integrated their results. The study expressed success in terms of fewer extra training events and fewer non-completions in regional airline training. Statistically, the best performing pilots were those who had flight instructor certificates, graduated from collegiate accredited flight programs, received advanced (post-Private) pilot training in college, graduated with collegiate aviation degrees (any aviation discipline), and had between 500 and 1,000 pre-employment flight hours. Pilot source characteristics that had no significance in regional airline pilot training success were: having a non-aviation college degree and having prior corporate pilot or airline pilot experience.

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Analysis of Pilot Backgrounds and Subsequent Success in US Regional Airline Training Programs

Public and legislative attention is currently focused on the appropriate levels of training and the qualification requirements for United States airline pilots. Involved citizens and Congress have expressed concerns about pilot performance and professionalism, issues that were highlighted by the Colgan Air (operating as Continental Connection Flight 3407) accident in a DHC-8 on February 12, 2009, outside of Buffalo, New York. The accident focused attention on whether commercial copilots are adequately prepared prior to their training at a regional airline. Prompted by the Colgan Air accident, the US House of Representatives passed the *Airline Safety and Pilot Training Improvement Act of 2009* (H.R. 3371, 2009) to amend Title 49 of the United States Code with the intent to improve airline safety and pilot training. Similar legislation was introduced in the US Senate – *Enhancing Flight Crewmembers' Training* (S. 1744, 2009) requiring the Federal Aviation Administration (FAA) Administrator to prescribe regulations to ensure that all crewmembers on air carriers have proper qualifications and experience. As of March, 2010, the language from H. R. 3371 and S. 1744 was been combined into two bills being considered by Congress under the general heading of "FAA Reauthorization," namely S. 1451(2010) and H. R. 1586 (2010).

Consequently, the FAA issued an Advance Notice of Proposed Rulemaking (ANPRM) titled *New Pilot Certification Requirements for Air Carrier Operations* (FAA, 2010). The purpose of this notice was to gather information on whether current eligibility, training, and qualification requirements for commercial pilot certification were adequate for conducting domestic, flag, and supplemental operations (FAA). The ANPRM requested public comment on the necessity to improve pilot performance and professionalism standards with specific emphasis on training for commercial pilots involved in Part 121 operations. The FAA sought input and recommendations on five concept areas, each of which included a series of questions.

In the ANPRM, Question 2A asked, "Are aviation/pilot graduates from accredited aviation university degree programs likely to have a more solid academic knowledge base than other pilots hired for air carrier operations? Why or why not?" (FAA, 2010, p. 7). To answer this question thoroughly and accurately, a consortium of educators, regional airlines, the Aviation Accreditation Board International (AABI) and the University Aviation Association (UAA) commissioned a study to determine the performance outcomes of new pilot indoctrination for first officers in Part 121 operations.

Background

Accreditation is a system for recognizing educational programs that meet a defined set of standards – granted by private organizations (AABI, n.d.). There are two types of Accreditors: (a) Institutional accreditors that review and accredit entire institutions; and (b) Program accreditors that review and accredit specific programs or subject area offerings within an institution (AABI). AABI is a program accreditor that focuses on collegiate non-engineering aviation education for both two-year and four-year programs. AABI is one of 46 specialized accreditation organizations recognized by the Council for Higher Education Accreditation (CHEA) (CHEA, 2010). In the FAA (2010) ANPRM, Question 2A requests information about

accredited aviation university degree programs; AABI is the only body that accredits aviation university degree programs.

Another organization that represents collegiate aviation is the University Aviation Association (UAA), "the voice of collegiate aviation education to its members, the industry, government and the general public" (UAA, n.d., homepage). UAA is a nonprofit organization including aviation high schools, 2-year colleges, and 4-year universities that have aviation programs. UAA represents all segments of aviation education, including flight programs. UAA is not an accrediting organization; however, many of the colleges and universities that have AABI Accredited Flight Programs are active members of UAA.

On February 19, 2010, at a combined meeting of AABI and UAA, members were challenged by the two presidents to provide collegiate aviation support for the FAA Administrator's goals on pilot qualification regulatory initiatives. This study was commissioned to research the success of new pilot indoctrination for first officers in Part 121 operations. The goal of the study was to provide empirical data concerning characteristics of the sources of pilot training that related to the pilots' success in regional airline training. The ultimate goal is to make it possible for talented young people to select "airline pilot" as an aviation career and to support the aviation industry with a strong cadre of enthusiastic candidates in the pilot supply chain. With the support of AABI and UAA, researchers from five independent universities and six regional airlines developed this study to analyze the performance data of pilots hired at these carriers between 2005-2009.

Review of the Literature

Over the years, significant research has been conducted on predicting pilot training success. Much of this research (Hunter & Burke, 1994; Carretta & Ree, 1996; Martinussen, 1996; Damos, 1996; Griffin & Koonce, 1996) focused on military pilot selection and training success. Due to the high cost of training failures and stagnant attrition numbers, militaries from numerous countries have conducted a wide range of studies to evaluate selection measures.

In a meta-analysis of 68 published studies, Hunter and Burke (1994) utilized a method of validity generalization to assess which predictor measures were most significant. The most significant predictive measures were found in the following: quantitative ability, spatial ability, mechanical ability, aviation information, general information, gross dexterity, perceptual speed, reaction time, biographical information, and job sample. In a separate meta-analysis, Martinussen (1996) compared samples from 50 studies conducted in 11 different countries. This research found that the best predictor of pilot performance was previous training experience and a combined index utilizing cognitive and/or psychomotor tests. Carretta and Ree (1996) analyzed the role of general cognitive ability in the selection process of military pilots that could be accomplished using numerous varying batteries.

Damos (1996) presented a critical analysis of pilot selection batteries. A major concern of the author was the use of the dichotomous pass/fail outcome variable used in the majority of the research. The author argued for utilizing a more defined operational performance measure to capture the role of a pilot. Another concern in relying on a dichotomous variable as the outcome measure was the reduction in predictive validity measures (Burke, Hobson, & Linsky, 1997). Burke et al.

found that a larger sample size was needed to guarantee a respectable statistical power.

Despite the vast amount of literature relating to military pilot section, very little research was found on civilian pilot selection. In a study conducted within a collegiate aviation program; Mekhail, Niemczyk, Ulrich and Karp (2010) found significance when correlating scores obtained on the Table Reading Test to both flight hours to solo an aircraft and flight hours to obtain a private pilot certificate.

The pilot selection process at the regional airlines within the United States varies greatly from the *ab initio* training process utilized by both military and foreign air carriers. Pilots apply at the regional carriers after having obtained their pilot certifications and sufficient flight experience; thus, the selection variables differ from the traditional pilot selection studies. In a survey of key administrators at 11 regional airlines, it was found that the most important new-hire candidate traits included being a team player, being trainable, having good crew resource management skills, and having current flight experience (Fanjoy, Young, & Suckow, 2006). These traits were often assessed with a written knowledge test, a structured interview, and a flight simulator checkride. However, half of the respondents did not place a strong level of confidence on the ability of these instruments to predict candidate success.

In order to assure a better prediction of pilot success at a regional airline, Karp (2004) suggested utilizing a regional airline bridge training model. This training model would prepare collegiate flight education program graduates for a successful transition into the role of a regional pilot. This model included an integrated learning style, which would incorporate coursework beyond the basic flight training.

In a study conducted at one regional airline, Cortés (2008) correlated pilot background information to the subsequent success in initial training at the airline. The background variables mined in this study were the following: source of flight training, type of college degree completed, possession of a flight instructor (CFI) certificate, and total flight experience. Cortés defined success in initial training at the airline by the number of extra training events that a pilot required to complete the training program. It was found that the group with the best overall success at the regional airline consisted of individuals who graduated from an AABI Accredited Flight Program, possessed a CFI certificate, and had fewer than 500 hours of total flight time. The least successful in initial training were those trained at a commercial flight school or a Part 61 Fixed Base Operator (FBO).

Research Questions

As a means to expand upon the research concerning pilot selection at the regional airlines, this study answered the following research questions:

1. What were the characteristics of pilots who were hired by the US regional airlines between 2005-2009?
2. How did these characteristics relate to their success in regional airline training programs?

Methodology

Participants

On February 19, 2010, at a combined meeting of the Aviation Accreditation Board International (AABI) and the University Aviation Association (UAA), a study was commissioned to research the success of new pilot indoctrination for first officers in Part 121 operations. Six regional airlines participated by providing access to their human resource and pilot indoctrination files; the regional airlines were American Eagle Airlines, Atlantic Southeast Airlines, Cape Air, Horizon Air, Mesa Airlines, and Trans States Airlines. Seven colleges or universities, matched with these airlines, assisted with data collection. The research project studied the performance of 2,156 new-hire pilots in the years 2005 – 2009.

Procedures

There were three constraints on the study: (a) a requirement that all variables had to be common among the six regional airlines so their data could be combined; (b) an agreement that the analyzed dataset would not have identification data for a specific pilot or airline; and (c) a requirement for researchers to collect and analyze the data with a neutral perspective that did not attempt to favor any interested party.

SurveyMonkey (2010) was selected as an online data collection device because it uniformly organized the data, automatically collected the data in a spreadsheet, and provided a common vehicle for transmitting de-identified data from the regional airlines to the principal investigator. Representatives from the partner universities (professors, graduate research assistants, or interns) entered the airline data into SurveyMonkey. These data had to be mined from two separate departments in the regional airlines – the Training Department and the Human Resource Department.

Demographic data were gathered for the subject pilots, including: year hired, college degree, name of college, name of degree, military background, where the pilot received advanced (beyond private pilot) training, whether the pilot had previous experience as a flight instructor, total flight hours at the time of indoctrination, and previous experience as a corporate or airline pilot. To de-identify the data, two variables (whether the degree was in an aviation concentration, and whether the degree was from an AABI Accredited Flight Program) were derived so that the "name of college" and "name of degree" data could be removed. The outcomes studied were: (a) how many times did the pilot need to repeat the elements of indoctrination training, and (b) whether the pilot completed the full training program at the airline. The individual pilot and airline information are de-identified in the study.

Five independent university researchers from Arizona State University, Auburn University, Embry-Riddle Aeronautical University, Southern Illinois University, and the University of North Dakota independently analyzed the data using the SPSS data mining and statistical analysis software and integrated their results through a series of conference calls. Consensus among the researchers was reached by a process that considered inputs from each researcher, reconciled any conflicting arguments, and concluded that there was no opposition to substantial results

and conclusions. Additionally, a draft of the report was sent to their constituents requesting comment and feedback; there were no responses that would invalidate the results.

Limitations

There were limitations on the type and amount of data that could be collected from a rich source of human resources and training data maintained by airlines. Data were collected from six airlines on new-hire pilots in the years 2005-2009; however, incomplete data sets from several airlines prevented an analysis by year hired.

Since there were no standard pilot evaluation processes or uniform training records, data were mined from an assortment of records – both paper and electronic. Some data were not available at all of the carriers. Additionally, airline human resources and training personnel rightfully guarded company records and required stringent control and protection of their data, even after researchers were granted access to some of it. Consequently, the study was limited to pilot characteristics and success data that were common across all six airlines.

Effect size (Cohen's *d* for *t*-tests and ANOVA; Cohen's *w* for Chi-Square) was included in the reporting of all significant results. Although the null hypothesis significance tests showed that the means were significantly different; the effect sizes were small to modest, meaning that the factor accounted for a small or modest percent of the relationship between pilot source data and regional airline training data. Small effect sizes were anticipated for this study because, in many cases, the outcome variables (associated with regional airline training) were removed by several years from the income variables (associated with the source of a pilot's foundational training). According to Trusty, Thompson, and Petrocelli (2004), "Small effect sizes for very important outcomes can be extremely important, as long as they are replicable" (p. 110).

Results

The six regional airlines and their affiliated institutions entered 2,187 records into the online data collection device. Several records were purged because they contained obvious data entry errors (duplicate records, blank records, etc.), leaving 2,156 valid records for data analysis. The records from the six airlines were combined into a single dataset and all identifying information was removed. In the following analysis, the statistical assumptions and conditions were met unless otherwise noted.

Outcome Variable: Extra Training Events

The dependent variable, *Extra Training Events*, as suggested by Cortés (2008), was defined as, "How many repeat training events at your airline did this pilot require BEFORE IOE (Initial Operating Experience)? NOTE: Training events - anything that required a PASS grade (Ground Schools, Exams, Procedure Trainers, Simulators, LOFT, etc.)". The variable, *Extra Training Events,* is described in Table 1.

Table 1

Extra Training Events

Extra Training Events	
Mean	0.950
Median	0
Mode	0
Standard Deviation	1.537
Range	12
Minimum	0
Maximum	12
Count	2156

Since the Pilot Source Study was a large sample (N = 2156), the variable was treated as a scale variable and parametric tests were considered robust. Graphical analysis of Extra Training Events suggests that one-tail *p* values are appropriate (Motulsky, 1999). According to Motulsky, for large samples (> 100) the *p* value will be nearly correct even if the population is fairly far from Gaussian.

Outcome Variable: Completions

The dependent variable *Completions* was defined as, "Did this pilot complete the training with your airline (including IOE)?" The dependent variable *Completions* was not parsed because the airlines would not disclose reasons for non-completion. The dichotomous variable *Completions* is described in Table 2.

Table 2

Completed Training (Including IOE)

Completed Training (Including IOE)			
Yes		2035	94%
No		121	6%
	Total	2156	100%

Predictor Variable: Flight Instructor

The independent variable Flight Instructor was defined as, "INSTRUCTOR: Was this pilot an FAA certificated flight instructor (CFI, CFII, MEI, etc.?)." Of the 2,156 pilots, 1,583 (73%) were certificated flight instructors and 573 (27%) were not. Flight Instructor has confounding variables, most notably the number of hours spent in flight instructing. In a follow-on question, the surveyor instrument collected

Hours-of-Dual-Given; however, excessive missing data made *Hours-of-Dual-Given* unreliable.

A Chi-Square test of significance compared *Completions* for pilots who were flight instructors and for pilots who were not flight instructors. In Table 3, the results show that pilots who were not flight instructors had comparatively more non-completions.

Table 3

Comparison of Number of Completions Between Flight Instructors and Other Pilots

Completions		Flight Instructor (YES)	Flight Instructor (NO)
Complete (YES)	Observed/Expected	1509/1494	526/541
	χ^2 Contribution	1%	4%
Complete (NO)	Observed/Expected	74/89	47/32
	χ^2 Contribution	25%	69%

χ^2 (1,1) = 9.884, p = .0017, Cohen's w = .068.

A two-sample one-tailed *t*-Test (assuming unequal variances) tested for differences in *Extra Training Events* between pilots who were flight instructors and pilots who were not flight instructors. Table 4 displays the results – Pilots who were flight instructors had fewer *Extra Training Events* than pilots who were not flight instructors.

Table 4

Comparison of Extra Training Events Between Flight Instructors and Other Pilots

	Flight Instructor (NO)	Flight Instructor (YES)
Mean	1.14	0.88
Variance	2.60	2.26
Observations	573	1583
df	955	
t Stat	-3.987***	
P(*T*<=*t*) one-tail	0.00004	
Cohen's *d*	.167	
t Critical one-tail	1.65	

****p* < .001.

Predictor Variable: AABI Accredited Flight Program

AABI Accredited Flight Program was derived from three entries in the online data collection device: (a) "COLLEGE: What college/university did the pilot graduate from? If unknown, enter U." (b) "DEGREE TYPE: What undergraduate degree did the pilot have?" and (c) "DEGREE NAME: What was the name of the undergraduate college degree? If unknown, enter U." These three entries were compared against the list of AABI Accredited Flight Programs dated September 18, 2009, provided to the researchers by AABI. It is important to note that AABI accredits programs, not institutions; so a pilot was counted in AABI Accredited Flight Program only if that pilot graduated from a college or university on the list *and* if the pilot's degree type and degree name matched the program name of the AABI Accredited Flight Program on the list. Of the 2,156 pilots, 616 (29%) were graduates of AABI Accredited Flight Programs, while 1,540 (71%) were not.

A Chi-Square test of significance compared *Completions* for pilots who graduated from AABI Accredited Flight Programs and all other pilots in the dataset. The results in Table 5 show that graduates of AABI Accredited Flight Programs had comparatively fewer non-completions.

Table 5

Comparison of Number of Completions Between AABI Graduates and Other Pilots

Completions		AABI (YES)	AABI (NO)
Complete	Observed/ Expected	601/581	1434/1454
(YES)	χ^2 Contribution	4%	2%
Complete	Observed/Expected	15/35	106/86
(NO)	χ^2 Contribution	67%	27%

χ^2 (1,1) =16.434, p = .00005, Cohen's w = .087.

A two-sample one-tailed *t*-Test (assuming unequal variances) tested for differences in *Extra Training Events* between pilots who graduated from AABI Accredited Flight Programs and all other pilots in the dataset. Table 6 shows the results – Pilots who graduated from AABI Accredited Flight Programs produced fewer *Extra Training Events*.

Table 6

Comparison of Extra Training Events Between AABI Graduates and Other Pilots

	AABI (NO)	AABI (YES)
Mean	1.08	0.64
Variance	2.69	1.42
Observations	1540	616

df	1545
t Stat	6.09***
P(*T*<=*t*) one-tail	0.0000
Cohen's *d*	.307
t Critical one-tail	1.65

****p < .001.*

Predictor Variable: Source of Pilot Training

The independent variable, Source of Pilot Training, was defined as, "PILOT TRAINING: Where did this pilot get Advanced Pilot Training (beyond Private Pilot)?" The entries for advanced pilot training were: College = 994 (46%); Military = 55 (3%); Non-college Part 141/142 = 670 (31%), and Non-college Part 61 = 437 (20%). It should be noted that college flight programs are also taught under Part 61, Part 141, or Part 142; however, those data were not collected for this study.

A Chi-Square test of significance compared *Completions* among the four sources of pilot training – Table 7. Post hoc analysis (χ^2 Contribution) shows two significant results: pilots trained in Colleges had comparatively fewer non-completions and pilots trained in Non-college Part 141/142 programs had comparatively more non-completions.

Table 7

Comparison of Number of Completions Based on Sources of Pilot Training

Completions		College	Military	Non-college (Part 141 or 142)	Non-college (Part 61)
Complete	Observed/ Expected	966/938	49/52	612/632	408/413
(YES)	χ^2 Contribution	3%	1%	2%	0%
Complete	Observed/ Expected	28/56	6/3	58/38	29/25
(NO)	χ^2 Contribution	46%	9%	37%	3%

χ^2 *(3,1) = 30.163, p = .00000, Cohen's w = .118.*

A one-way Analysis of Variance (ANOVA) tested for differences in *Extra Training Events* among the four sources of pilot training. The results, shown in Table 8, suggest that pilots trained in Colleges had fewer *Extra Training Events* than pilots trained in Non-college Part 141/142 programs ($p < .001$) and pilots trained in Non-college Part 61 programs ($p < .05$).

Table 8

Analysis of Variance for Extra Training Events Based on Source of Pilot Training

PILOT TRAINING	Mean	SD	N		
College	.76	1.29	994		
Military	1.16	1.69	55		
Non-college Part 141/142	1.16	1.72	670		
Non-college Part 61	1.04	1.69	437		
Source of variation	*SS*	*df*	*MS*	*F*	Sig.
PILOT TRAINING	72.66	3	24.22	10.39***	.000
Error	5017.03	2152	2.33		
Total	7037.00	2156			
Cohen's *d*	.139				
Scheffe Tests		Significance			
College vs. Non-college Part 141/142***		.000			
College vs. Non-college Part 61*		.016			

**p < .05. ***p < .001.*

Predictor Variable: Aviation Degree

Aviation Degree was derived from a comprehensive variable in the online data collection device: "DEGREE NAME: What was the name of the undergraduate college degree? If unknown, enter U." A pilot was counted in Aviation Degree, if that pilot earned any degree that contained words like aviation, flight, airport, pilot, etc. It is important to note that this variable contained a wide variety of aviation disciplines; these were not all flight degrees. Of the 2,156 pilots, 1,144 (53%) had aviation degrees; the other 1,012 (47%) had either a non-aviation degree or no degree.

A Chi-Square test of significance compared *Completions* between pilots who graduated with a degree in aviation and all other pilots in the dataset. The results in Table 9 show that pilots who graduated with a degree in aviation had comparatively fewer non-completions; pilots with degrees other than aviation or with no degree had comparatively more non-completions.

Table 9

Comparison of Number of Completions Between Pilots With an Aviation Degree and Other Pilots

Completions		Aviation Degree (YES)	Aviation Degree (NO)
Complete	Observed/Expected	1095/1080	940/955
(YES)	χ^2 Contribution	3%	3%
Complete	Observed/Expected	49/64	72/57
(NO)	χ^2 Contribution	44%	50%

χ^2 (1,1) = 8.127, p = .0044, Cohen's w = .061.

A two-sample one-tailed *t*-Test (assuming unequal variances) tested whether there was any difference in *Extra Training Events* between pilots who graduated with a degree in aviation and all other pilots in the dataset. The results, depicted in Table 10, show that pilots who graduated with a degree in aviation had fewer *Extra Training Events* than other pilots in the dataset.

Table 10

Comparison of Extra Training Events Between Aviation Graduates and Other Pilots

	Aviation Degree (YES)	Aviation Degree (NO)
Mean	0.87	1.04
Variance	2.12	2.63
Observations	1144	1012
df	2047	
t Stat	1.71*	
P(*T*<=*t*) one-tail	0.04	
Cohen's *d*	.110	
t Critical one-tail	1.65	

**p < .05.*

Predictor Variable: Total Flight Hours

The independent variable, Total Flight Hours, was defined as, "HOURS: How many Total Hours did the pilot have at the beginning of training with your airline?" Six entries in Total Flight Hours had missing data; thus N = 2150. This scale variable is described in Table 11. Since the variance and range were so wide-ranging, the researchers agreed to treat Total Flight Hours as a categorical variable, also described in Table 11. The categories were chosen to be factors of 1,500 hours, the total pilot time required for an Air Transport Pilot certificate under Part 61.159.

Table 11

Total Flight Hours Described as a Scale Variable and Categorical Variable

Total Flight Hours (Scale Variable)	
Mean	1,312.51
Median	913
Standard Deviation	1,618.05
Variance	2,618,088.43
Range	21,498
Minimum	178
Maximum	21,676
Count	2,150

Total Flight Hours (Categorical Variable)	
Range	
178 to 500 Hours	405
501 to 1,000 Hours	780
1,001 to 1,500 Hours	459
> 1,500 Hours	506

A Chi-Square test of significance compared Completions based on the number of Total Flight Hours. The results in Table 12 show that pilots with 501 to 1,000 total flight hours had comparatively fewer non-completions.

Table 12

Comparison of Number of Completions Based on Total Flight Hours

Completions	HOURS	0-500	501-1000	1001-1500	> 1500
Complete	Observed/ Expected	387/382	753/736	422/433	466/477
(YES)	χ^2 Contribution	0%	2%	2%	1%
Complete	Observed/ Expected	18/23	27/44	37/26	40/29
(NO)	χ^2 Contribution	6%	38%	28%	23%

χ^2 (3,1) = 17.242, p = .001, Cohen's w = .089.

A one-way Analysis of Variance (ANOVA) tested for differences in *Extra Training Events* among the four categories of Total Flight Hours. The results, shown in Table 13, suggest that pilots who had 501 to 1,000 total flight hours had fewer *Extra Training Events* than pilots with > 1,500 total flight hours.

Table 13

Analysis of Variance for Extra Training Events Based on Total Flight Hours

TOTAL FLIGHT HOURS	Mean	SD	N		
0 to 500	.92	1.42	405		
501 to 1000	.85	1.34	780		
1001 to 1500	.96	1.56	459		
> 1500	1.12	1.85	506		
Source of variation	*SS*	*df*	*MS*	*F*	Sig.
TOTAL FLIGHT HOURS	23.39	3	7.80	3.31*	.019
Error	5058.28	2145	2.36		
Total	7022.00	2149			
Cohen's *d*	.079				
Scheffe Tests	Significance				
501 to 1000 vs. >1500	.022*				

*$p < .05$.

Predictor Variable: College Degree

The independent variable, College Degree, was defined as, "COLLEGE DEGREE: Did this pilot have a college degree (any discipline) at the beginning of training with your airline? NOTE: Consider completed undergraduate degrees only." The only data entry options for College Degree were: Associate Degree, Bachelor's Degree, or No Degree. Of the 2,156 pilots, 245 (11%) had an Associate Degree; 1,563 (73%) had a Bachelor's Degree; and 348 (16%) had no degree.

A Chi-Square test of significance compared Completions among the three options for College Degree. The results, $\chi 2$ (2,2) = 2.41; p = .300, showed that no relationship existed between the number of non-completions and the Types of College Degrees.

A one-way Analysis of Variance (ANOVA) tested for differences in Extra *Training Events* among the three entries for College Degree (Associate, Bachelor's, None). The results, $F(2, 2153) = 1.16$, p = .315, show no difference in the number of *Extra Training Events* based on having an Associate, Bachelor's (any discipline) or no college degree.

Predictor Variable: Military

The independent variable, Military, was defined as, "MILITARY: What prior military experience did this pilot have?" The tallied results for Military were: None - 1941 (90%); Military Aviator, Pilot (Fixed Wing) – 61 (2.8%); Military Aviator, Pilot (Rotary Wing) – 7 (.3%); Military Aviator, Non-Pilot (e.g., NFO, WSO, Bomb-Nav) – 18 (.8%); and Military, Non-Aviator – 129 (6%). Of the 2,156 pilots, only 68 were former military pilots. Of note, the small number of military pilots (N = 68, 3% of the dataset) in this group corroborates the belief that military pilots usually seek employment with the major airlines rather than with the regional airlines.

A Chi-Square test of significance compared *Completions* among pilots with prior military experience and all other pilots in the dataset. The results, χ^2 (1,1) = 0.839; p = .360, show no difference in completions between pilots with or without military experience.

A two-sample one-tailed *t*-Test (assuming unequal variances) tested whether there was a difference in *Extra Training Events* between pilots with previous military experience (M = 1.04, SD = 1.56), and all other pilots in the dataset (M = 0.94, SD = 1.53). The results, $t(262) = 0.42$, $p = 0.34$, show that pilots with prior military experience had the same number of *Extra Training Events* as other pilots in the dataset.

Predictor Variable: Previous Experience as a Corporate or Airline Pilot

The independent variable, Previous Experience, was defined as, "PREVIOUS EXPERIENCE: What previous corporate or airline pilot experience did this pilot have?" The selections for Previous Experience were: None, Previous Corporate Pilot, or Previous Airline Pilot. If the pilot had previous airline experience, a follow-up question asked, "If Previous Airline Pilot, what airline?" The qualitative data from this follow-on question was deleted from the dataset because the answers were indiscriminate and because the data held potential identification information. The tallied results for Previous Experience were: None:1658 (77%); Previous Corporate Pilot:148 (7%); and Previous Airline Pilot: 350 (16%).

A Chi-Square test of significance compared *Completions* among the three categories of previous experience. The results, χ^2 (2,1) = 4.76; p = .092, show that pilots with previous airline or corporate experience had the same proportion of non-completions as pilots with no previous experience.

A one-way Analysis of Variance (ANOVA) tested whether there was a difference in *Extra Training Events* among the three categories of Previous Experience. The results, $F(2, 2153) = 2.51$, p = .081, show that pilots with previous airline or corporate experience had the same number of *Extra Training Events* as pilots with no previous experience.

Summary and Discussion

The 2010 Pilot Source Study began with the following research questions: (a) "What were the characteristics of pilots who were hired by the US regional airlines between 2005-2009?" and (b) "How did these characteristics relate to their success in regional airline training programs?"

Characteristics of New-hire Pilots

The data that described the characteristics of pilots, who were hired by the US regional airlines, resides in the individual airline's human resources department in the form of pilot applications; interviews; and, in some cases, simulator evaluation reports; psychological test results; medical evaluations; etc. Because of the assortment of the data sources, the sensitivity of the data, and the need for uniformity of data; the pilot characteristics examined in this study are a small sample of the abundant data that may be available.

Using the data from the 2,156 pilots at the six contributing airlines, the characteristics of pilots who were hired between 2005 and 2009 by the US regional airlines were:

- 1,563 (72.5%) received a bachelor's degree, while 245 (11.36%) received an associate degree, and 348 (16.14%) had no degree at all.
- 1,144 (53.1%) had a degree in an aviation discipline.
- 616 (28.6%) were determined to have a degree from a collegiate flight program that was accredited under the Aviation Accreditation Board International (AABI) Program Criteria for Flight Education (AABI, 2008).
- 215 had a military background of which 68 (3.2%) were military pilots.
- 994 (46.1%) received their advanced pilot training (beyond Private Pilot) in a collegiate flight program (conducted under Part 61, 141 or 142); 670 (31.1%) received their advanced pilot training in non-college flight programs (conducted under Part 141 or 142); 437 (20.3%) received their advanced pilot training in non-college flight programs (conducted under Part 61); and 55 (2.6%) received their advanced pilot training in the military.
- 1,583 (73.4%) were flight instructors.
- All had records of accumulated flight hours that ranged from 178 to 21,676 hours, broken into four categories with the following distributions:

    1) 0 to 500 hours: 405 (18.8%)
    2) 501 to 1,000 hours: 780 (36.3%)
    3) 1,001 to 1,500 hours: 459 (21.3%)
    4) Above 1,500 hours: 506 (23.5%)

- 1,658 (76.9 %) had no prior corporate pilot or airline pilot experience, 350 (16.2%) had prior airline pilot experience, and 148 (6.9 %) had prior corporate pilot experience.

Another way to describe the characteristics of the 2,156 pilots in this study is that more than half of them had a baccalaureate degree, had an aviation degree, were flight instructors, had 1,000 or fewer hours of flight time, and had no prior airline pilot or corporate pilot experience.

Success in Regional Airline Training Programs

Because of the assortment of the data in training departments, the sensitivity of training data, and the need for uniformity of data; only two success variables were mined from all of the airlines. These key outcomes were: (a) the number of extra training events (repeats) that the pilots experienced in initial airline training before their Initial Operating Experience (IOE) and (b) whether the pilots succeeded in completing their initial pilot training (including IOE). The study found the following:

- The number of extra training events experienced by the pilots were:

    1) Zero = 1,310 (60.8%)

2) One = 257 (11.9 %)

3) Two = 298 (13.8 %)

4) Three = 136 (6.3 %)

5) Four = 75 (3.5%)

6) Greater than four = 80 (3.7 %)

- A total of 2,035 (94 %) of the new-hire pilots completed initial training with a regional airline, while 121 (6 %) did not.

Relationships Between Pilot Characteristics and Training Success

Appendix A is a statistical summary of the *2010 Pilot Source Study*. Through the application of ANOVA, Chi-Square, and *t*-Test statistics, the following conclusions were drawn about the relationship between the characteristics of pilots hired by US regional airlines between 2005 and 2009 and their success in regional airline training (as defined in the outcome variables, *Extra Training Events* and *Completions*):

Having a college degree (Associate or Bachelor's) did not produce a difference in the number of extra training events during initial training with a regional airline; nor did it produce a significant relationship with the number of non-completions in initial training. However, if the college degree was an aviation degree (any aviation discipline), then the relationship changed. Having an aviation degree produced fewer extra training events and comparatively fewer non-completions in initial training. More significantly, if pilots earned their college degree in an AABI Accredited Flight Program, they had fewer extra training events and fewer non-completions in initial training.

The source of advanced pilot training was defined in the online data collection device as "where the pilot earned his/her advanced training (beyond the Private Pilot Certificate)." Pilots, who received their advanced training in college, subsequently had fewer extra training events and comparatively fewer non-completions in regional airline training programs. Pilots with a military background did not have the same result; however, the small number of military pilots in the data set precludes any meaningful conclusions about military-trained pilots. Pilots in this dataset who received their advanced training in non-college Part 141/142 programs or in non-college Part 61 programs did not perform as well as their collegiate counterparts.

Previous flying experience, beyond advanced pilot training, produced interesting results. Pilots who attained their flight instructor certification had fewer extra training events and comparatively fewer non-completions in their initial training at the regional airline. On the other hand, having previous experience as a corporate pilot or as an airline pilot did not produce a difference in the number of extra training events nor did it produce a significant relationship with the number of non-completions in initial training.

Total flight hours was treated as a categorical variable rather than a continuous variable to negate the effects of large numbers for relatively few pilots at the top of the scale and because this study was mostly interested in the success of new-hire pilots with fewer than 1,500 hours. One category of pilots, those with 501 to 1,000 hours, had comparatively fewer extra training events than pilots in any other total flight hour category. This same category had comparatively fewer non-completions. The effect of Total Flight Hours, in order of performance was: Group 1 (501-1000 hours), Group 2 (178-500 hours), Group 3 (1001-1500 hours) and Group 4 (greater than 1500 hours). The most significant difference was between Group 1 and Group 4 for both *Extra Training Events* and *Completions*. This result is counter-intuitive; it is generally expected that more flight hours will yield better performance. Extraneous variables may be confounding the results for this cohort of new-hire regional airline pilots with more than 1,500 hours; however, no data collected for this study was able to explain the result.

Recommendations for Further Study

For further research on this subject, it may be advantageous to pursue a larger, more comprehensive study of pilots hired at regional airlines that includes more regional airlines and more pilot subjects. Expanding the current study will provide a more complete examination of the characteristics of new-hire pilots and the relationships of these characteristics to their success in initial training.

One limitation of this study was the wide array of data and the varied data storage methods among the regional airlines. Before conducting a follow-on study, it would be advantageous for researchers to conduct preliminary work with additional cooperating airlines to develop an understanding of the strengths and limitations of the data available in human resource records and pilot training records that are routinely kept by the airlines.

The *2010 Pilot Source Study* was intentionally unbranded, unsponsored, and unfunded to make the study resistive to special interest criticism. As a result, the regional airlines and the cooperating universities absorbed the financial burden of collecting and analyzing the data. Researchers should pursue funding sources for further studies; otherwise, the cost of data mining at an even larger sampling of airlines could be prohibitive.

This study was limited to examining the effects of single variables on the two outcome variables. A future study that includes multivariate analysis of the relationships of pilot characteristics to success might provide deeper insight into the subject matter.

The data suggests that there might be value added to the development of pilot skills by a comprehensive education over a 2-year or 4-year college career. This appears to be a subject ripe for further study.

The subject of pilot characteristics and their relationship to regional airline training success seems to be a fitting subject for the application of Data Envelopment Analysis (DEA) and other business models, which would assess the ability to produce a student training output with a minimum resource level, required (Cooper, Seiford, & Tone, 2007).

Because there were areas where significant positive relationships were found between a particular pilot characteristic and success in initial regional airline pilot training, it is recommended that the components of any one of those characteristics (an AABI Accredited Flight Program or advanced flight training in college) be studied for additional depth of understanding of these relationships.

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Appendix A

2010 Pilot Source Study – Summary Results

INDEPENDENT (Predictor) VARIABLE	DEPENDENT (Outcome) VARIABLE	Statistical Tests	Test Statistic	Statistically Significant?	Conclusions
FLIGHT INSTRUCTOR (Yes, No) N = 2156	EXTRA TRAINING EVENTS (Range 0-12)	*t*-Test	$t(955) = 3.987$, $p < .001$	YES ***	Pilots who were flight instructors had fewer extra training events than pilots who were not flight instructors.
FLIGHT INSTRUCTOR (Yes, No) N = 2156	**COMPLETION** (Yes, No)	Chi-Square	$\chi^2(1,1) = 9.884$, $p < .01$	YES **	Pilots who were flight instructors had comparatively fewer non-completions.
AABI ACCREDITED FLIGHT PROGRAM (Yes, No, or No Degree) N = 2156	EXTRA TRAINING EVENTS (Range 0-12)	*t*-Test	$t(1545) = 6.09$, $p < .001$	YES ***	AABI Accredited Flight Programs produced fewer extra training events
AABI ACCREDITED FLIGHT PROGRAM (Yes, No, or No Degree) N = 2156	**COMPLETION** (Yes, No)	Chi-Square	$\chi^2(1,1) = 16.43$, $p < .001$	YES ***	AABI Accredited Flight Programs produced comparatively fewer non-completions
SOURCE OF PILOT TRAINING (Military, College Degree, Non-College - Part 141 or Part 142, Non-College - Part 61) N = 2156	EXTRA TRAINING EVENTS (Range 0-12)	ANOVA	$F(3,2152) = 10.39$, $p < .001$	YES ***	Pilots trained in college had fewer extra training events than non-college pilots.
SOURCE OF PILOT TRAINING (Military, College Degree, Non-College - Part 141 or Part 142, Non-College - Part 61) N = 2156	**COMPLETION** (Yes, No)	Chi-Square	$\chi^2(3,1) = 30.16$, $p < .001$	YES ***	Pilots trained in college had comparatively fewer non-completions.
AVIATION DEGREE (Yes, No, or No Degree) N = 2156	EXTRA TRAINING EVENTS (Range 0-12)	*t*-Test	$t(2047) = 1.71$, $p < .05$	YES *	Aviation Degrees produced fewer Extra Training Events
AVIATION DEGREE (Yes, No, or No Degree) N = 2156	**COMPLETION** (Yes, No)	Chi-Square	$\chi^2(1,1) = 8.13$, $p < .01$	YES **	Aviation degrees produced comparatively fewer non-completions.

INDEPENDENT (Predictor) VARIABLE	DEPENDENT (Outcome) VARIABLE	Statistical Tests	Test Statistic	Statistically Significant?	Conclusions
TOTAL FLIGHT HOURS (0-500 Hours, 501-1000 Hours, 1001-1500 Hours, >1500) N = 2150	EXTRA TRAINING EVENTS (Range 0-12)	ANOVA	$F(3,2145) = 3.31$, $p < .05$	YES *	Pilots with 501 to 1000 hours had the fewest extra training events.
TOTAL FLIGHT HOURS (0-500 Hours, 501-1000 Hours, 1001-1500 Hours, >1500) N = 2150	**COMPLETION** (Yes, No)	Chi-Square	$\chi^2(3,1) = 17.24$, $p < .01$	YES **	Pilots with 501 to 1000 hours had comparatively fewer non-completions.
COLLEGE DEGREE (Associate, Bachelor's, or None) N = 2156	EXTRA TRAINING EVENTS (Range 0-12)	ANOVA	$F(2,2153) = 1.16$	NO	Having a college degree did not produce a difference in number of extra training events.
COLLEGE DEGREE (Associate, Bachelor's, or None) N = 2156	COMPLETION (Yes, No)	Chi-Square	$\chi^2(2,2) = 2.41$	NO	There was no relationship between the number of non-completions and whether pilots had a college degree.
MILITARY (None, Military Pilot [FW], Military Pilot [RW], Military Aviator [Non-Pilot], Military [Non-Aviator]) N = 2156	EXTRA TRAINING EVENTS (Range 0-12)	*t*-Test	$t(262) = 0.42$	NO	Prior military experience had no effect on extra training events Note: The small # of military pilots (68) suggests that most military pilots go directly to the major airlines.
MILITARY (None, Military Pilot [FW], Military Pilot [RW], Military Aviator [Non-Pilot], Military [Non-Aviator]) N = 2156	**COMPLETION** (Yes, No)	Chi-Square	$\chi^2(1,1) = 0.84$	NO	There was no relationship between the number of non-completions and prior military experience. Note: The small # of military pilots (68) suggests that most military pilots go directly to the major airlines.

INDEPENDENT (Predictor) VARIABLE	DEPENDENT (Outcome) VARIABLE	Statistical Tests	Test Statistic	Statistically Significant?	Conclusions
PREVIOUS EXPERIENCE (None, Previous corporate pilot, Previous airline pilot) N = 2156	EXTRA TRAINING EVENTS (Range 0-12)	ANOVA	$F(2,2153) = 2.51$	NO	Pilots with previous airline or corporate experience had the same number of extra training events as pilots with no previous experience.
PREVIOUS EXPERIENCE (None, Previous corporate pilot, Previous airline pilot) N = 2156	**COMPLETION** (Yes, No)	Chi-Square	$\chi^2(2,1) = 4.76$	NO	Pilots with previous airline or corporate experience had the same proportion of non-completions as pilots with no previous experience.

* = Significant
** = Very Significant
*** = Exceptionally Significant