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ANALYSIS OF THE EFFECTIVENESS OF ARMY HELICOPTER FLIGHT TRAINING

Michael L. Wesolek

Abstract

The purpose of this study was to examine the effectiveness of the U.S. Army's new helicopter flight training program, Flight School XXI (FSXXI), in comparison to the previous (legacy) flight training program. The goal of this research was to determine whether or not FSXXI produces graduates that become fully mission capable pilots in fewer flight hours than the legacy flight training program. Readiness level progression rates of graduates of FSXXI and the legacy flight training program were compared to determine if there was a statistically significant difference between the two programs. These data were supplemented by an instructor pilot survey and a cost comparison. The findings suggest that there was a statistically significant difference between the FSXXI graduates and the legacy program graduates, and in each of these cases the number of hours required for FSXXI graduates to become fully mission capable was lower than for legacy pilots. Additionally, there was a difference between instructors' perceptions of FSXXI and legacy pilot aptitude for the UH-60 aircraft, but there was no difference for the CH-47 aircraft. The cost comparison revealed that legacy training is substantially less expensive than FSXXI training for both types of aircraft.

The U.S. Army has recently adopted a new helicopter flight training program that is intended to produce more tactically and technically proficient aviators. The new training program, Flight School XXI (FSXXI), was established through a needs analysis that identified several shortcomings in the previous flight training program. The major concern was that aviators were trained in aircraft not currently used in the active Army. Upon completion of flight training aviators began an aircraft qualification course (AQC) in order to receive training in their primary aircraft.

FSXXI utilizes a training aircraft, the TH-67 Creek, for the first several weeks in order to build basic flying skills. The students are then transitioned to their newly assigned primary aircraft in which they receive 50-70 hours of flight training. The students' primary aircraft will be one of the five operational aircraft in the Army. As a result of the greater number of hours spent in the primary aircraft at an earlier stage in training, students should be more proficient in this aircraft upon completion of the FSXXI training program. Ultimately, the expected outcome was that aviators would become fully mission capable pilots in fewer flight hours.

The purpose of this research was to examine the extent to which FSXXI prepares individuals to advance in fewer flight hours to a fully mission capable status upon arrival to their first duty station.

Flight Training Program Background

Fundamental to this research is the structure of the flight training program in the U.S. Army and the changes that were made that led to the development and implementation of FSXXI. This will be addressed in the section that follows. It will provide an overview of the flight training program in the Army – delineating the key features of FSXXI against the backdrop of the previous training program.

Structure of the Army's FSXXI flight training program. The U.S. Army restructured its flight training program in an effort to streamline operations and produce more tactically and technically proficient aviators. Under FSXXI, students attend from 34 to 42 weeks of training culminating in the designation of Army aviator.

After completing initial officer or warrant officer training, flight students begin flight training with two weeks of ground school in which they are taught subjects in aeromedical factors, aircraft systems, and Army doctrine. The next 18 weeks consist of contact and instrument training. During this phase, students are taught how to fly a helicopter and the art of navigation by aircraft instruments only. After successful completion of the instrument phase, students move on to a basic navigation phase in which they are taught to navigate using a surface map and a compass during low level flight (10 to 50 ft above the trees). Finally,

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students move to the combat skills phase in which they begin flying the aircraft that they have been designated. Students will be assigned one of the four modernized aircraft that the Army operates: the UH-60 Blackhawk (utility/troop transport), the CH-47D Chinook (cargo/troop

transport), the OH-58D Kiowa (observation/light attack), or the AH-64A/D Apache (attack). This will become their primary aircraft. The advanced training lasts from 12 to 14 weeks depending on the aircraft.

Figure 1. Flight School XXI training progression.

The previous training program (legacy flight school). Prior to the implementation of FSXXI, the Army trained aviators in a series of phases using aircraft not currently in the Army inventory. This program was structured very similarly to the FSXXI program; however, students did not transition to advanced aircraft after initial and instrument training. Instead, they continued to the combat skills training phase in the OH-58A or UH-1H helicopter. Upon completion of combat skills training and night vision goggle (NVG) qualification, the students were designated as an Army aviators.

After being awarded Army aviator wings, aviators moved to an AQC. During the AQC, aviators received flight training in one of the Army's four advanced aircraft

referenced above. AQC lasted from 6 to 12 weeks depending on aircraft type, and entailed approximately 20-30 flight hours. The goal of AQC was to qualify an aviator to conduct basic aircraft tasks and to perform emergency procedures.

Under both programs, once aviators completed advanced training, they were assigned to an operational unit in which they received further mission training. Upon arrival at a new unit, aviators were required to demonstrate proficiency on all base tasks and unit mission tasks to an instructor pilot. Once proficient, they were considered fully mission capable pilots. The process through which aviators progress to become fully mission capable pilots is called readiness level (RL) progression.

LEGACY FLIGHT TRAINING

Figure 2. Legacy flight training progression.

Similarities and Differences Between the Programs

The similarities between the two programs can be seen within the program of instruction and aircraft used in the early stages of flight training. The sequence of training in both programs is very similar. Students move from the contact phase (basic flying skills), to the instrument navigation phase, to the combat skills and night vision goggle phases in both programs. Both programs incorporate the TH-67 training helicopter during the initial stages of flight training. This small, cost effective helicopter is used to provide basic flying skills needed in order to advance to more complex aircraft and flying techniques.

The difference in the two programs is primarily in the type of aircraft being used to conduct the flight

training in the later stages of each program. The legacy program utilizes the OH-58A or the UH-1H to train aviators during the combat skills and NVG phases. Once this is complete, the students attend AQC in which they learn to fly their primary aircraft. The students learn the aircraft systems, emergency procedures, and maneuvers as outlined in the flight training guide and aircrew training manual for that aircraft.

FSXXI students attend the combat skills and NVG phases of training in their primary aircraft, which results in substantially more flight time in this aircraft. FSXXI students graduate from flight school with fewer overall flight hours than legacy graduates but have more flight hours in their primary aircraft.

FLIGHT SCHOOL XXI COMPARISON

LEGACY FLIGHT TRAINING					
Pre Flight 2 Weeks	Primary 10 Weeks	Instruments 8 Weeks	Basic Combat Skills 12 Weeks	AQC Weeks	TOTAL IERW Weeks
	TH-67		UH-1	UH-60 6	UH-60 38
			OH-58C	CH-47D 10	CH-47D 42
FLIGHT SCHOOL XXI					
Pre Flight 2 Weeks	Primary 10 Weeks	Instruments 8 Weeks	Basic TF NAV 2 Weeks (TH-67)	Aircraft Qual & Advanced Combat Skills/ Night/NVG	TOTAL IERW Weeks
	TH-67			UH-60 12	UH-60 34
				CH-47D 14	CH-47D 36
FS XXI Redesign					

Figure 3. Side-by-side comparison of Legacy flight training and Flight School XXI.

Desired Performance Outcomes

The formal objectives of the AQC are to graduate aviators that have met the minimum standards as set forth in the flight training guide and aircrew training manual for that aircraft. These are outlined in detail, to include the task, the conditions under which the maneuver should be performed, and the minimum standards for the execution of the maneuver.

The formal objectives of FSXXI are to graduate aviators that are at a proficiency level of RL 2. This is the level an aviator is designated after they have demonstrated proficiency at base tasks, but before they have demonstrated proficiency at unit mission tasks (Aviation Training Brigade, unpublished slide presentation, February 2005). The aviator should be able to exceed the standards set forth by the flight training guide and aircrew training manual for that particular aircraft. The goal is to graduate aviators that are substantially more proficient than graduates of the AQC (Colonel Semmens, personal communication, June 2005).

Research Questions

Although the Army has determined the need for an improved flight training program, FSXXI has not been

evaluated to determine if it is able to deliver the intended performance outcomes. This research examined the rate at which individuals advance to fully mission capable status by comparing the rate at which individuals advance through the different readiness levels for FSXXI graduates versus those trained via the legacy flight training program. Additionally, with the ultimate goal for this program aimed at providing a more effective and innovative means to prepare aviators for the increasing complexity of Army aircraft and high mission demands, this research examined these differences with respect to (a) perception of instructor pilots regarding the extent and manner in which FSXXI was achieving its intended purposes, and (b) a cost comparison of both programs.

The specific research questions were:

- 1) Does FSXXI produce more proficient aviators who progress through the readiness levels in fewer flight hours than graduates of the legacy flight training program?
- 2) What are the perceptions of instructor pilots who have conducted end of course evaluations of FSXXI and legacy flight training program students with regard to the extent to which the FSXXI flight training program is

meeting its intended goals?

3) Is the FSXXI flight training program more cost effective than the legacy flight training program?

Review of the Literature

Part one of the review consists of a discussion of experiential learning theory as it applies to formal and informal learning. Part two links experiential learning theory with FSXXI.

Experiential Learning Theory

Scholars have tended to use the term experiential learning in two contrasting contexts (Brookfield, 1983). The first deals with the type of learning undertaken by students who are given a chance to acquire and apply knowledge, skills, and aptitudes in an immediate and relevant setting. Based on this definition, experiential learning involves a "direct encounter with the phenomena being studied rather than merely thinking about the encounter, or only considering the possibility of doing something about it" (Borzak, 1981, p. 9). This type of learning is sponsored by an institution and might be used in training programs for professions such as social work and teaching or in training that requires structured learning as well as physical manipulation training. The second context in which experiential learning is often used reflects learning through life events (Houle, 1980). This type of learning is informal and is a result of involvement with everyday experiences.

The origins of experiential learning. The origins of experiential learning can be traced to the early 1900's in the work of John Dewey. Dewey argued that the most important concern in experiential learning is the meaning of the events. He felt that experiencing events in life is unavoidable; therefore, in order to learn from these events we must make sense of them. Dewey (1925) asserted that experiential education begins with a concrete experiences

that are processed by the learner and result in useable knowledge.

In the 1940's and 1950's, organizational theorist Kurt Lewin proposed that experience was tied to personal and organizational development. He also noted that such development occurred when groups or individuals set goals, used prior experiences to create a theory, applied the new theory in their work, and then adjusted their goals and theories based on the outcome of their new experience (Lewin, 1952).

In the 1970's, David Kolb refined Lewin's theory and developed the experiential learning cycle. He suggested that learning is the process in which knowledge is created through a transformational cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb & Fry, 1975). According to Kolb, experiential learning is the creation of learning and understanding through the student's engagement in the four stages of the experiential learning cycle.

Kolb and Fry (1975) proposed that the learning cycle can begin at any one of these four stages and that it should be approached as a continuous process with no beginning or end. Although the process can begin at any point, the learning often begins with a person carrying out or participating in a particular event or concrete experience. The next step is to understand the effects of a particular situation so that if the same actions were taken under the same circumstances, the learner might be better equipped to anticipate the outcome. The third step is to understand what has happened and form an abstract concept. The final step is its application through action in a new circumstance within the range of generalization. Experiential learning can be viewed as a circular process, and in instances where learning has taken place, as a spiral.

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Figure 4. Kolb's experiential learning cycle (adapted from Kolb, 1984).

Experiential Learning and Army Flight Training

Experiential learning is at the core of the Army's FSXXI aviator training program. Kolb's (1984) four stage learning cycle based on experience, reflective observation, abstract conceptualization, and active experimentation can be applied to aviator training. Although his experiential learning theory can be applied to both of the Army's flight training programs, FSXXI enables students to practice flight maneuvers more frequently in their primary aircraft. Legacy flight school students gain general flying proficiency in training aircraft, but they lack the repetition in their primary aircraft. This is important because although aircraft adhere to the same general aerodynamic principles, flight characteristics vary among aircraft types. Thus, according to Kolb's model, flight students should benefit from both programs. However, FSXXI students should be more proficient in their primary aircraft because of the increased number of flight hours in the aircraft.

Concrete experience is essential in flight training in order to begin the learning process. The Aviation Instructor's Handbook (FAA, 1999, p. 1-3) states that, "It seems clear enough that the learning of a physical skill requires actual experience in performing that skill. Student pilots learn to fly aircraft only if their experiences include flying them." Once the students have physically manipulated the controls and experienced a flight maneuver, they can move to the next step in Kolb's experiential learning cycle.

During the second step (observation and reflection)

the students reflect on the flight maneuver that was performed. They will evaluate their performance and determine what shortcomings might exist. Once this has been accomplished, they will move to the next step in which abstract concepts will be formed. The formation of abstract concepts enables the students to devise a course of action that will address the shortcomings that were identified in the previous step. Once these concepts have been developed, the students move to the next step in order to experiment with the newly developed concepts.

The fourth step, testing in new situations, allows the students to test the concepts developed in the third step. This experimentation leads to a concrete experience in which the students begin the entire process over again. This process will continue until the students have mastered the maneuver or the process is intentionally broken.

By continuing the experiential learning process, the students are able to refine their skills through repetition. The Aviation Instructor's Handbook underscores this by stating:

The principle of exercise states that those things most often repeated are best remembered...The human memory is fallible. The mind can rarely retain, evaluate, and apply new concepts or practices after a single exposure...Every time practice occurs, learning continues. The instructor must provide opportunities for the student to practice. (FAA, 1999, p. 1-5)

Research indicates that experiential learning programs have the potential to create significant learning (Fisher-Brillinger, 1990; Maxwell, 1997). Army flight training draws from several learning theories, to include experiential learning. However, flight training, and more specifically military flight training, requires unique training methods. The Federal Aviation Administration (FAA) handbook incorporates techniques to help guide flight instructors and outlines the role of experiential learning in aviator training. Students are able to progress through Kolb's experiential learning cycle to refine their flying skills. The literature supports these concepts presented in the Aviation Instructor's Handbook.

Research Methodology

Flight School XXI is consistent with many of the concepts addressed in the FAA's Aviation Instructor's Handbook (FAA, 1999). Learning as a result of experience describes the process by which students learn through reflection on every event they encounter. This concept is supported by Cantor (1995) who states that experiential learning is a process through which people acquire competencies through their experiences, comparing their newly acquired knowledge to their past experiences.

While experiential learning theory has received considerable attention in the research literature (Galloway & Goldenberg, 2004; Gosen & Washbush, 2004; Henderson, 2004), and continues to be well supported as the basis for curriculum and instructional design in many educational settings (Hornyak & Page, 2004; Ziff & Beamish, 2004), its application has not been empirically examined within the context of military flight training. Given the relatively high cost of aviator training in both civilian and military flight training programs, the effectiveness of this approach to military flight training is worth studying.

Sample

Two groups were included in the current research: Army flight training graduates and their instructors. The primary population of interest was individuals who were graduates of the U.S. Army Flight Training Program and had been designated as Army aviators between the years 2000 and 2005. Within this population there were four sub-groups: UH-60 Flight School XXI graduates, UH-60 legacy flight school graduates, CH-47 Flight School XXI graduates, and CH-47 legacy flight school graduates. Each aviator had successfully completed Army flight training, through FSXXI or the legacy flight school, for either the CH-47 or UH-60 aircraft. In addition to completing flight training, each aviator had been assigned to at least one duty station following flight training and had progressed through the readiness levels to achieve fully mission capable status for day/night and night vision goggle flight modes. The entire population consisted of approximately 400 UH-60 FSXXI graduates, 2500 UH-60 legacy flight school graduates, 250

CH-47 FSXXI graduates, and 1600 CH-47 legacy flight school graduates. In order to determine the sample size required to perform these analyses, a statistical power analysis was conducted using the Sample Power (Version 1.0) computer program (Borenstein, Rothstein, & Cohen, 1997). The analysis was conducted specifying desired power of .80, an α level of .05, and medium effect size estimates ($f = .25$) for the two main effects and the interaction. With these specifications, 32 subjects per cell would be required to obtain a power of .80, for a total sample size of 128 (i.e., 32×4) for each 2×2 Analysis of Variance (ANOVA). Because different samples of pilots were employed for the CH-47 Chinook and the UH-60 Blackhawk training programs, a total of 256 subjects were required (i.e., 64 CH-47 legacy flight school pilots, 64 CH-47 FSXXI pilots, 64 UH-60 legacy flight school pilots, and 64 UH-60 FSXXI pilots). The sample for the current research consisted of a randomly selected subset of the total population. The random selection was accomplished through a random number generator (Randomizer.org, 2005) that produced a set of ten numbers ranging from zero to nine. These numbers were used to select flight records based on the last number of the aviator's Social Security Number. Records were selected based on the first number produced by the random number generator. Once all the records containing the first number in the set produced by the random number generator were exhausted, the process began again using the second number in the set. This process continued until a sample of 260 participants was selected. Of those, 65 were UH-60 FSXXI graduates, 65 were UH-60 legacy flight school graduates, 65 were CH-47 FSXXI graduates, and 65 were CH-47 legacy flight school graduates.

In addition, a group of flight training instructors was surveyed. The population of interest here was the entire group of all U.S. Army aviation instructors who have instructed student aviators on the UH-60 Blackhawk and the CH-47 Chinook helicopters, and who have performed end-of-course evaluations on pilots from both the AQC (legacy) and FSXXI. The sample included in the research consisted of 40 instructor pilots (20 UH-60 and 20 CH-47) assigned to the Army Aviation School at Fort Rucker, Alabama. The participants were randomly selected from all available instructors present for duty on the day the survey was administered. Twenty instructors from each aircraft (CH-47 and UH-60) completed and returned the survey.

Data Collection Tools

Readiness levels. Readiness Level 3 (RL3) is the classification of aviators when they are initially assigned to a unit following flight school. With this classification, the pilot usually trains for day/night flight. The pilot will be evaluated by an instructor pilot (IP) on all base tasks. Base tasks are those tasks that are common to every unit (e.g., normal take-off, normal landing, and emergency

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procedures). When pilots attain proficiency at these tasks, they progress to RL2. RL2 tasks are mission-oriented tasks specific to the unit (e.g., hoist missions, over water flight, and rappelling). When pilots are proficient at those maneuvers, they are progressed to RL1. RL1 is considered to be a fully mission capable pilot for the designated mode of flight. At that point, the process of progression from RL3 to RL2 to RL1 is repeated for NVG flight. For the purposes of this research Time 1 refers to the time required to progress from RL3 to RL2 and Time 2 refers to the time required to progress from RL2 to RL1.

The quantitative data for this research were collected through an archival review of individual aviator flight records. Flight hours required to progress through the readiness levels are annotated in the aviator's individual flight records by the IP conducting the readiness level progression. These hours were extracted from the records of graduates of both flight training programs. A target of at least 64 participants from each category was set in order to obtain an estimated power level of .80.

Instructor pilot survey. Additional data for this research were collected via a researcher developed survey. The survey was administered to 20 UH-60 and 20 CH-47 IPs assigned to the USAAVNC at Fort Rucker, Alabama. The IPs were asked to evaluate the quality of training for both FSXXI students and legacy flight school students through a set of three questions using a five point Likert scale as either "strongly agree," "agree," "neither agree nor disagree," "disagree," or "strongly disagree." The ratings on these three items were summed to produce two composite ratings: instructor perception of FSXXI and instructor perception of legacy flight training. Higher ratings equate to higher perceived quality of training.

The survey instrument was evaluated in a preliminary study. Ten IPs were given the survey instrument to review. Upon the completion of the initial review, the IPs were interviewed individually in an effort to determine whether or not the survey instrument would collect the desired data. During the interviews each question was addressed and the IPs were asked to elaborate on what information they felt the question was attempting to collect. All ten gave similar responses that were congruent with the information that the survey instrument was intended to collect. Thus the instrument was judged to have face validity.

Cost comparison. A cost comparison, rather than a cost analysis, was chosen to compare the costs of training aviators under each of the flight training programs explored in this research. The purpose of this portion of the research was simply to compare the costs of the training programs rather than to make an assessment of each program based on

its cost.

Cost comparison data were collected from the Fort Rucker Budgeting Office. The primary data were the cost per hour of training for the legacy flight school and FSXXI, and the average number of hours required to train a pilot in the two programs. These data were based on FY 2005 costs.

Limitations

The survey instrument used to collect data on IP attitudes relied on a subjective evaluation of the student by the instructor. Its limitations are those common to all rating-based measures which are undertaken in the absence of an objective benchmark (Bem, 1967; Greenwald, Brock, & Ostrom, 1968). Additionally, data were collected from a limited number of military installations in the continental United States due to the deployment of many units to a combat zone. The data were collected from aviation units located within the continental U.S. No data were collected from overseas units or units based in the U. S. that were deployed to an overseas location.

Results

Statistical Analyses

All inferential analyses were conducted using an α level of .05 and two-tailed tests. Separate analyses were conducted for the CH-47 Chinook and UH-60 Blackhawk aircraft, and for the day/night and NVG training scenarios. For each aircraft and training scenario, a 2 x 2 repeated-measures ANOVA was conducted. The within-subject factor was Time (Time 1 versus Time 2), and the between-group factor was training type (legacy flight school versus FSXXI). Since this was a quasi-experimental design, the between-subjects factor can best be conceptualized as a blocking (rather than treatment) variable.

UH-60 aircraft. Table 1 presents progression through readiness levels as a function of training system for day/night and NVG scenarios. Examining the mean time to progression through Time 1 for the day/night scenario indicates that FSXXI pilots appear to have progressed more quickly, with a mean of 10.11 hours as opposed to 13.73 hours for legacy flight school pilots. The same trend appears to exist for the progression through Time 2, with FSXXI pilots taking an average of 8.27 hours compared to the 9.00 hours for legacy flight school pilots. Examining the means for the NVG scenario similarly indicates that FSXXI pilots appear to have progressed faster than the legacy flight school pilots both through Time 1 (with a mean of 7.62 for FSXXI pilots compared to 8.96 hours for legacy flight school pilots) and through Time 2 (with a mean of 10.48 hours for FSXXI pilots compared to 12.24 for legacy flight school pilots).

Table 1

Progression in the UH-60 Aircraft as a function of Scenario (Day/Night and NVG) and Training System

Scenario	Training System			
	<u>Legacy Flight School</u>		<u>FSXXI</u>	
	Mean*	SD	Mean*	SD
Day/Night				
Time 1	13.73	4.36	10.11	2.39
Time 2	9.00	3.58	8.27	2.50
NVG				
Time 1	8.96	4.43	7.62	1.87
Time 2	12.24	2.54	10.48	1.03

* *Flight hours required*

Two ANOVAs were performed on these means in order to determine the statistical significance of the observed differences for UH-60 aircraft. The first ANOVA examined data from the day/night scenario, and the ANOVA source table for this analysis is shown in the upper portion of Table 2. The main effect for time was statistically significant, $F(1,128) = 83.46, p < .0005$, indicating that the progression through Time 1, statistically, was significantly longer than the progression through Time 2. Similarly, the main effect for program (legacy flight school versus FSXXI) was statistically significant, $F(1,128) = 22.90, p < .0005$. Examining the means in Table 1 indicates that FSXXI pilots progressed more quickly than legacy flight school pilots. Finally, the interaction between time and program was statistically significant, $F(1,128) = 16.15, p < .0005$,

indicating that the difference between the two programs was not the same for Time 1 and Time 2.

The second ANOVA performed on data from the UH-60 aircraft considered the NVG scenario, and the ANOVA source table is shown in the lower portion of Table 2. The main effect for time was statistically significant, $F(1,128) = 83.61, p < .0005$, and the means in Table 1 indicate that progression through Time 1 was faster than progression through Time 2. The main effect for program was statistically significant, $F(1,128) = 19.45, p < .0005$. Examining the means in Table 1 indicates that FSXXI pilots progressed faster than legacy flight school pilots. The interaction between time and program was not statistically significant, $F(1,128) = .39, p = .533$.

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Table 2

ANOVA Source Table for Analysis of Readiness Level Progression on UH-60 Aircraft Comparing Time 1 and Time 2 Between FSXXI and the Legacy Flight School

	Sum of Squares	df	Mean Squares	F	p	Power
Day/Night						
Program Effect	308.04	1	308.04	22.90	<.0005	1.00
Error (Program)	1721.99	128	13.45			
Time Effect	702.58	1	702.58	83.46	<.0005	1.00
Program X Time Interaction	135.94	1	135.94	16.15	<.0005	.98
Error (Time)	1077.48	128	8.42			
NVG						
Program Effect	155.53	1	155.53	19.45	<.0005	.99
Error (Program)	1023.32	128	8.00			
Time Effect	611.42	1	611.42	83.61	<.0005	1.00
Program X Time Interaction	2.86	1	2.86	.39	.533	.10
Error (Time)	936.00	128	7.31			

CH-47 aircraft. Table 3 provides descriptive statistics for the progression times on CH-47 aircraft. The same trends observed for UH-60 aircraft are observed for CH-47 aircraft. For day/night flying, FSXXI pilots progressed more quickly through Time 1 (with a mean of 12.14 hours) than legacy flight school pilots (with a mean of 17.68 hours). FSXXI pilots also progressed more quickly through Time 2 (with a mean of 11.70 hours) than legacy

flight school pilots (with a mean of 12.97 hours). For NVG flying, FSXXI pilots progressed more quickly through Time 1 (with a mean of 9.18 hours) than legacy flight school pilots (with a mean of 9.97 hours). FSXXI pilots also progressed more quickly through Time 2 (with a mean of 10.08 hours) than legacy flight school pilots (with a mean of 13.70 hours).

Table 3

Descriptive Statistics for Day/Night and Night Vision Goggle (NVG) Readiness Level Progression in the CH-47 Aircraft

	<u>Legacy Flight School</u>		<u>FSXXI</u>	
	Mean*	SD	Mean*	SD
Day/Night				
Time 1	17.68	3.34	12.14	2.70
Time 2	12.97	3.27	11.70	2.88
NVG				
Time 1	9.97	2.68	9.18	1.90
Time 2	13.70	2.77	10.08	1.57

* Flight hours required

As was the case with the UH-60 aircraft data, two ANOVAs were performed on data from CH-47 aircraft. The first ANOVA considered progression times for the day/night scenario. The ANOVA source table is shown in the upper portion of Table 4. The main effect for time was statistically significant, $F(1,128) = 54.14, p < .0005$, and the means in Table 3 indicate that progression from RL3 to RL2 (i.e., Time 1) was slower than progression from RL2 to RL1 (i.e., Time 2). The main effect for program was also statistically significant, $F(1,128) = 69.93, p < .0005$, and the means in Table 3 indicate that pilots in FSXXI progressed more quickly than pilots in legacy flight school. The interaction between time and program was also statistically

significant, $F(1,128) = 37.07, p < .0005$.

The second ANOVA for CH-47 aircraft data was performed to examine progression times for the NVG scenario, and the ANOVA source table is shown in the lower portion of Table 4. The main effect for time was statistically significant, $F(1,128) = 73.23, p < .0005$, and the means in Table 3 indicate that it took longer to progress through Time 2 than Time 1. The main effect for program was also statistically significant, $F(1,128) = 55.15, p < .0005$. The means in Table 3 indicate that FSXXI pilots progressed more quickly than legacy flight school pilots. Finally, the interaction between time and program was statistically significant, $F(1,128) = 27.39, p < .0005$.

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Table 4

ANOVA Source Table for Analysis of Readiness Level Progression on CH-47 Aircraft Comparing Time 1 and Time 2 Between Programs

	Sum of Squares	df	Mean Squares	F	p	Power
Day/Night						
Program Effect	753.44	1	753.44	69.93	<.0005	1.00
Error (Program)	1379.08	128	10.77			
Time Effect	431.64	1	431.64	54.14	<.0005	1.00
Program X Time Interaction	295.54	1	295.54	37.07	<.0005	1.00
Error (Time)	1020.43	128	7.92			
NVG						
Program Effect	315.26	1	315.26	55.15	<.0005	1.00
Error (Program)	731.74	128	5.72			
Time Effect	347.77	1	347.77	73.23	<.0005	1.00
Program X Time Interaction	130.07	1	130.07	27.39	<.0005	1.00
Error (Time)	607.85	128	4.75			

Instructor survey data. Recall that the second research question was: What are the perceptions of instructor pilots regarding the extent to which FSXXI is achieving its intended goals? To examine this research question, the two composite scores derived from the IP survey were compared using a paired samples t-test.

In preparation for this research, an assumption of an effect size equal to a difference of one-half standard deviation between the two composite scores, desired power of .80, and a two-tailed test with an α level of .05 was made. It was determined that 33 instructors would be required.

Forty surveys were distributed to 20 UH-60 and 20 CH-47 instructor pilots in a classroom setting. The instructor pilots were asked to complete the survey voluntarily and return it to a table in the rear of the classroom. All 40 surveys were completed and returned.

Two paired samples t-test were performed, one for UH-60 instructors and one for CH-47 instructors. Each consisted of a comparison of the reported quality of pilots in the FSXXI and legacy flight school programs. Table 5 shows descriptive statistics for the composite scores for the two types of student pilots (FSXXI and legacy flight school)

provided by the instructors of the two types of aircraft (UH-60 and CH-47).

For the CH-47, the sample means for the FSXXI pilots were higher (10.75) than for legacy flight school pilots (9.80). Similarly, for the UH-60, the sample means for the FSXXI pilots were higher (11.45) than those for the legacy flight school pilots (9.20). The paired samples t-test

for CH-47 instructors was not statistically significant, $t(19) = 1.81, p = .087$, power = .40, while the t-test conducted on UH-60 instructors was statistically significant, $t(19) = 5.77, p < .0005$, power = 1.00. This indicates that instructor ratings of pilots in FSXXI and legacy flight school differed only with respect to UH-60 aircraft, but not for the CH-47.

Table 5

Descriptive Statistics for Instructor Perceptions of the Quality of the Legacy Flight School and FSXXI Pilots

	<u>Legacy Flight School</u>		<u>FSXXI</u>	
	Mean*	SD	Mean*	SD
UH-60 Instructors	9.20	1.64	11.45	1.36
CH-47 Instructors	9.80	1.94	10.75	1.41

* Composite score derived from Likert scale on author developed survey

Cost comparison data. The third research question was: Is the FSXXI flight training program more cost effective than the legacy flight school program? Cost comparisons between legacy flight school and FSXXI based on official military estimates of training expenditures in the fiscal year 2005 are presented in Table 6. These costs are estimated based on the duration of training at the aviation school, as opposed to the readiness level training at the unit that was the focus of the first research question. The flight hour costs for each flight training program were calculated using the scheduled number of hours for each program of instruction and the hourly operating cost of each aircraft. Each training program has an established number of hours within which an average student should be able to complete the program. These training hours are aggregated by phase of training and by aircraft type for the corresponding phase of training.

The Fort Rucker Budgeting Office has determined

an hourly operating cost for each type of aircraft used during flight training. This hourly operating cost is based on scheduled and unscheduled maintenance costs, replacement parts, and fuel costs. The average number of flight hours required to complete each flight training program was multiplied by the hourly operating cost for each aircraft used during flight training. Table 6 presents the total dollar amount of the average cost for a student to attend each of the two flight training programs.

As can be seen from Table 6, the total cost of training a pilot on the UH-60 aircraft was \$202,398 for legacy flight school and \$265,236 for FSXXI, for a savings associated with legacy flight school of \$62,838 per pilot. The total cost of training a pilot on the CH-47 aircraft was \$342,708 for legacy flight school and \$508,891 for FSXXI, for a savings associated with legacy flight school of \$166,183 per pilot.

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Table 6

Total Costs of Pilot Training Based on Type of Aircraft and Training Program

	<u>UH-60</u>		<u>CH-47</u>	
	Legacy	FSXXI	Legacy	FSXXI
Initial Entry Core	\$73,920	\$73,920	\$73,920	\$73,920
Basic Navigation	-	\$11,088	-	\$11,088
Qualification and Combat	-	\$180,228	-	\$423,883
Qualification Course	\$63,480	-	\$203,790	-
Combat Skills and NVG	\$64,998	-	\$64,998	-
Total	\$202,398	\$265,236	\$342,708	\$508,891
Savings Associated with Legacy Flight School per pilot	\$62,838		\$166,183	

Note. Based on hourly costs of aircraft operation of \$2,760 for UH-60, \$6,793 for CH-47, \$924 for TH-67, and \$942 for OH-58.

Additionally, the mean number of hours required for graduates of each program to progress through the readiness levels was multiplied by the hourly cost of operating that particular aircraft. This cost was compared to the cost of both aviator training programs to determine which program is more cost effective. These findings are presented in Table 7.

The total number of hours of readiness level training was computed as the sum of Time 1 and Time 2 for day/night flying and Time 1 and Time 2 for NVG flying. These values were then multiplied by the hourly costs associated with operating each aircraft (\$2,760 for the UH-60, \$6,793 for the CH-47, \$924 for the TH-67, and \$942 for the OH-58), which of course are the same for each training program. Due to the smaller number of hours associated with readiness level training for FSXXI pilots, there is a savings of \$20,562 for the UH-60 and \$76,218 for the CH-

47 when compared to legacy flight school pilots.

The final phase of the cost comparison of the two training programs was to integrate the results from Table 6 with those from Table 7. In Table 6, it was shown that for the UH-60, a total savings of \$62,838 was attained by using legacy flight school, but in Table 7 it was shown that legacy flight school was associated with \$20,562 more in readiness level training costs than FSXXI. Therefore, the total savings associated with legacy flight school training for the UH-60 was \$42,276. A similar picture emerges in an examination of CH-47 costs. In Table 6 it was shown that the use of legacy flight school resulted in a savings of \$166,183 over FSXXI for the entire duration of training. However, in Table 7 it was shown that because of the increased number of flying hours, legacy flight school was associated with \$76,218 more in readiness level training costs than FSXXI. Therefore, the total savings associated with legacy flight school training for the CH-47 was \$89,965.

Table 7

Costs Associated with Readiness Level Training for the Participants of the Current Research by Aircraft and Program

	<u>UH-60</u>		<u>CH-47</u>	
	Legacy	FSXXI	Legacy	FSXXI
Average Readiness Level Day/Night Hours	22.73	18.38	30.65	23.84
Average Readiness Level NVG Hours	21.20	18.10	23.67	19.26
Total Readiness Level Hours	43.93	36.48	54.32	43.10
Cost per Hour	\$2,760	\$2,760	\$6,793	\$6,793
Total Cost	\$121,247	\$100,685	\$368,996	\$292,778
Savings Associated with FSXXI per pilot		\$20,562		\$76,218

Discussion*Readiness Level Progression*

The first research question was examined separately for day/night and NVG flying scenarios, and for the UH-60 and CH-47 aircraft. In each of the four analyses, there was a statistically significant difference between the FSXXI pilots and the legacy flight school pilots. The results indicated that in each of these cases the number of hours required for FSXXI graduates to progress through Time 1 and Time 2 was lower than that for legacy flight school pilots. Thus, the answer to the first research question is yes, FSXXI pilots require fewer hours to become fully mission capable than legacy flight school pilots. This was true for both the UH-60 and CH-47 aircraft, and was true for both day/night and NVG scenarios.

FSXXI's desired performance outcome of producing aviators that progress to fully mission capable pilots in fewer flight hours has been met for both types of aircraft examined in this research. Although the research question can be answered simply with a "yes," a deeper look at the readiness level progression results gives some insight into the effectiveness of the FSXXI flight training program. The first analysis revealed that the main effect for time for the day/night scenario was statistically significant for the UH-60 and for the CH-47, indicating that progression through Time 1 was significantly longer than Time 2 for both aircraft without regard for program. Additionally, for the

NVG scenario, the results indicated a statistically significant difference for both aircraft. However, these data revealed the opposite of the day/night scenario in that graduates of both flight training programs and both aircraft required more flight hours to progress through Time 2 than Time 1.

These findings may give some insight into where training should be focused during flight school. Time 1, which consists of aviator base tasks, requires more flight hours during RL progression for the day/night scenario than Time 2, which is made up of mission tasks specific to the individual unit. This leads to the question: Should more training time in flight school be focused on areas that require more flight time for RL progression? Alternatively, should the number of flight training hours for the scenarios requiring more flight hours during RL progression be increased? By shifting the focus of flight school, aviators may become less proficient in Time 1 tasks (for day/night scenarios) or Time 2 tasks (for NVG scenarios) while becoming more proficient in the tasks that required more flight time to progress through once they arrive at their unit. Essentially, the problem would not be corrected, it would simply shift from one set of tasks to the other and a gap would remain in the proficiency levels of graduates of the two programs. The shift in training focus during flight school would only serve to displace the problem rather than correct it.

However, if training hours during flight school

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remain the same for scenarios that required fewer hours during RL progression, an increase in the number of training hours during flight school in the scenarios that took more flight hours during RL progression will generate aviators that are more proficient across the board while closing the gap on the differences in the number of hours required to progress through Time 1 and Time 2 once they arrive at their unit. The focus in training would not be shifted from one set of tasks to the next, but would provide an increase in the number of flight hours during flight school for those tasks that require longer to progress through at the unit. This would allow aviators to maintain their proficiency in the tasks that required fewer hours at their unit while increasing their proficiency in tasks that required more flight hours during RL progression.

Research has demonstrated that the increased number of repetitions of any experience serves to increase learning and facilitate a higher proficiency at a task (Pimentel, 1999). As aviators are able to move through Kolb's learning cycle an increased number of times, they will refine their flying skills which will result in better performance of flight maneuvers. An increase in the number of flight hours would result in more repetition of these flight maneuvers.

Instructor Pilot Perceptions

An analysis of the IP survey data indicated that there was a difference between instructors' perceptions depending on whether they were training pilots on the UH-60 or CH-47 aircraft. Specifically, there was no statistically significant difference between instructors' perceptions of FSXXI and legacy flight school end of course performance for the CH-47 aircraft, but there was a difference for the UH-60 aircraft. For the UH-60 aircraft, instructors rated the end of course performance of the FSXXI pilots to be higher than that of the legacy flight school pilots. These findings give a mixed indication of the quality of the FSXXI program in relation to the legacy flight school. IPs that conduct training in the UH-60 aircraft were of the opinion that the FSXXI flight training program produced aviators that were more proficient during end of training check-rides than students trained in the legacy flight school. However, IPs that conduct training in the CH-47 aircraft were of the opinion that the FSXXI flight training program did not produce aviators that were significantly more proficient than graduates of the legacy flight school. This contradiction could be a result of the program of instruction for each aircraft, or possibly a result of the ease or difficulty associated with piloting a specific airframe, or both.

Although both helicopters are considered to be state-of-the art, the CH-47 is equipped with features that lower pilot workload while maintaining better aircraft control. The Advanced Flight Control System (AFCS) in the CH-47 "stabilizes the helicopter about all axes and enhances control response. It automatically maintains desired

airspeed, altitude, bank angle, and heading" (U.S. Army, 2003, p. 2-5-3). The AFCS allows the pilot to fly "hands-off" while maintaining the desired flight profile. The UH-60 has a similar flight stabilization system that alerts the pilot to make corrections to maintain the desired flight profile. However, unlike in the CH-47, the UH-60 does not perform this automatically. The pilot must make control inputs to maintain or change the flight profile. The automated flight stabilization system of the CH-47 may be, in part, responsible for the perceived equality between the two flight training programs. Several studies (Krueger & Fagg, 1981; Reardon et al., 1997) conducted by the U. S. Army Aeromedical Research Laboratory at Fort Rucker have concluded that fatigue due to workload can adversely affect an aviator's proficiency. The automation provided by the CH-47's AFCS may reduce pilot workload and increase proficiency.

Cost Comparison

For the third research question, the cost of flight school pilot training was integrated with the costs associated with readiness level training at the unit for the pilots in the current research. Based on these estimates, legacy flight school training was substantially less expensive than FSXXI training. However, due to the fact that fewer hours of readiness level flight training were required for FSXXI pilots, the cost advantage of the legacy flight school program was diminished, but it remained substantially less expensive. This was true for both UH-60 and CH-47 aircraft. This raises the question, is the cost associated with FSXXI worth the fewer hours required to progress aviators when they arrive at their first duty station?

Although FSXXI has been shown to produce aviators that progress to a fully mission capable status in fewer flight hours, it has also been shown to cost more than the legacy flight school. This increased cost may be acceptable if Army leaders feel that the speed in which aviators progress to fully mission capable status outweighs the increased cost. On the other hand, the cost savings associated with the legacy flight school could allow the Army to train more aviators for the same financial expenditure. For example, the Fort Rucker Master Schools List showed that there were 138 students attending the CH-47 FSXXI training program and 562 students attending the UH-60 FSXXI training program during the 2006 fiscal year (Rucker, 2005). The FSXXI training program will cost \$23.7 million more than the legacy flight school to train the same number of UH-60 pilots. The CH-47 FSXXI training program will cost \$12.4 million more than the legacy flight school. This would result in a total difference of \$36.1 million. If the Army solely utilized the legacy flight school to train its aviators, it would be able to graduate 33 more CH-47 pilots and 117 more UH-60 pilots at the same cost as the FSXXI training program.

Comparison of Findings with Past Research

The findings of this research support the experiential learning theory that learning based on practical experiences is highly effective where complex skill sets must be learned and retained. Empirical studies (Harris, 2004; Larson, 2004) have determined that knowledge is gained through "concrete experiences" and that in some instances experiential learning is the most effective way of learning. The practical experience that aviators gain through hands-on flight training in the cockpit could not be learned in the classroom. Aviation, as with many other fields of study, requires practical training outside the classroom in order to build proficiency. For example, medical practitioners receive a significant amount of their training through supervised clinical experience. Many of these experiences cannot be duplicated in a classroom setting or even through simulation. For this reason, many medical, business, and vocational training programs rely heavily on practical training exercises.

Aviation training, and more specifically military aviator training, is a vocational training program that exclusively trains adult learners. Adult education seems well suited for experiential learning programs. Research has indicated that adults learn effectively through experiences that involve the whole person (Fisher-Brillinger, 1990). Military flight training fits this mold. Military aviators have a vested interest in succeeding during flight training because it is not only a training program, but a career as well. Army aviators are soldiers for whom flight training is not just a profession, but a way of life. The training they receive while attending flight school may save their lives or the lives of others in combat or emergency situations. In essence, lives could depend on their success as aviators.

Recommendations for Future Research

This research focused on the CH-47 and UH-60 FSXXI training programs. Future research should include the AH-64 and the OH-58 helicopters. By including these

aircraft in future studies, a comprehensive evaluation of FSXXI could be conducted.

Also, research examining the mission requirements of the different field units in the Army should be conducted. The mission of every aviation unit in the Army varies to a certain degree. These mission variances may affect the time required for aviators to progress to fully mission capable status. An examination of the adaptability of each training program to individual unit requirements may assist Army leaders in determining the value of the FSXXI program.

Conclusion

This research attempted to evaluate the effectiveness of the FSXXI flight training program in comparison to its predecessor, the legacy flight school. The objective of the research was to compare readiness level rates of graduates of each training program to determine which aviators were able to become fully mission capable pilots in fewer flight hours. Although the main objective of this research was to determine the most effective flight training program, it also compared the attitudes that instructor pilots have toward the programs as well as the cost of training an aviator in each program.

The research revealed that the FSXXI training program produced aviators that progressed to fully mission capable status in fewer flight hours. However, the cost associated with FSXXI is higher than the legacy flight school, bringing into question its overall value. This was supplemented with a survey that collected data on instructor pilot attitudes toward both training programs. The findings indicated that the instructor pilots' perceptions of the programs differed according to type of aircraft. CH-47 instructors reported that both programs produced aviators of relatively equal proficiency, while UH-60 instructors reported that FSXXI graduates were more proficient. This research was the first empirical examination of the effectiveness of the FSXXI flight training program. →

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