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Acknowledgements

I would like to thank all of the authors who submitted manuscripts for the 1993 Professional Paper Presentations. Only five papers were submitted this year, of which only two were accepted by reviewers for publication, roughly half the numbers of 1992. Both numbers are disappointing, and hopefully, not representative of either the level of scholarly activity or the importance of scholarly writing to our profession. The authors, whose work appears in this publication, are to be commended for their efforts, and the entire community of aviation educators is enjoined to make similar contributions in the future.

I would also like to thank the reviewers who continue to make our blind-review process work. Each paper published in the Collegiate Aviation Review has been blind-reviewed by at least three peer-evaluators. The evaluation process provides complete papers, sanitized of author and university identification, to reviewers. The identity of the reviewers is also protected and remains confidential. The reviewers are instructed to evaluate each paper judging whether it meets acceptable standards in terms of quality in content, research methods, format, and writing style for a national professional publication.

Ballard M. Barker, Ph.D, A.A.E.
Chair, UAA Publication Committee
Editor

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CHIEF PILOTS OF REGIONAL AIRLINES PERCEIVE BASIC INSTRUMENT SKILLS AS MOST IMPORTANT WITH RESPECT TO NEED FOR ADDITIONAL TRAINING OF ENTRY-LEVEL PILOTS

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Abstract

This study was conducted to identify areas of need for additional flight training of entry-level pilots, as perceived by chief pilots employed by regional airlines. The study used the mail-survey questionnaire method to collect data from 126 randomly selected regional airlines' chief pilots, from a population of 187 ("Regional airline," 1990, Annual). The major finding was that chief pilots perceive the most important training need of entry-level pilots to be basic instrument training (flight or simulator).

Introduction

The hiring practice of the major airlines, acquiring pilots from regional airlines, places inordinate pilot-acquisition burdens on the regional airlines. Hughes (1987) wrote, "The loss of pilots to major carriers has . . . forced those regionals to cancel flights because they lacked pilots to fly the aircraft" (p. 95). Other burdens include; (a) loss of revenues, (b) customer good will, (c) canceled flights, (d) increased training costs, and (e) a series of human-factor-related airline incidents and crashes (Hughes, 1987; Proctor, 1988; Ott, 1990).

Background and Rationale of the Study

Chief pilots are considered the top pilots of airlines ("McArtor Challenges," 1987). Further, chief pilots are management personnel, knowledgeable of their airlines' operations specifications, and applicable Federal Aviation Regulations ("Jeppesen," 1981). In addition, many chief pilots are responsible for the hiring of new pilots. For these reasons, chief pilots were selected as the respondents in this study.

A pilot may have the required number of flight-time hours of experience and yet not be proficient in performing all the tasks faced by an entry-level pilot. Ott (1990) wrote, "timed-based training is deficient in that it does not measure the level of learning that has taken place" (p. 68). In addition, it was reported ("Simulators," 1988) that:

the level of learning that has taken place" (p. 68). In addition, it was reported ("Simulators," 1988) that:

> many pilot applicants are unable to pass initial screening tests, primarily because . . . 'Basic instrument skills are not as good as they were five years ago,' a regional airline instructor said, adding that 'we have to be a flight school' and teach basic attitude flying technique instead of 'teaching the aircraft to be flown.' (p. 129)

Purpose of the Study

The purpose of this study was to determine if new-hire entry-level pilots at regional airlines, certified with the necessary number of flight-time hours, need additional pilot training. And, if additional pilot training is needed, what type of training is required?

Statement of the Problem

It is possible that, in times of air-carrier-quality pilot shortage, the level and quality of the pilot's flight-training, before the entry-level hire, is not up to an acceptable standard. At issue is the practice of using flight-time hours of experience rather than the required pilot proficiencies as the main criteria in hiring new pilots (Ott, 1990, p. 68).

Review of Related Literature

Introduction

Schukert and Maples (1990) wrote, "Air transportation in America is in a state of ferment" (p. 1). This contributes to the growing demand for safety-minded, well-trained, proficient, crew-oriented, air-carrier-quality pilots. Therefore, the literature reviewed has been selected to provide a basis for determining entry-level pilot skills at regional airlines.

Entry-Level Pilot Skills

Entry-level pilot skills are skills that a competent instrument pilot needs to be a pilot or co-pilot with a regional airline. Hoyt (1967) stated, "For utility and safety, whether the aircraft are today's or tomorrow's, a pilot must be competent [emphasis added]" (p. 30). Twenty years later, at a conference held at the University of North

Dakota, Hughes (1987) related the following comments by Brady, President of Express Air 1:

> The quality of replacement pilot candidates for the regionals is down dramatically, according to Brady. His company recently installed a basic instrument simulator to check the skills of applicants. In several cases, this screening weeded out candidates who had several thousand hours in their logbooks, but could not perform such basic instrument procedures as a holding pattern entry. (p. 96)

Why then are entry-level pilot skills not as good as they were five years ago? Moll (1990) stated it this way, "Rapid promotion erodes the seasoning process, making solid pilot training at the outset more important than ever" (p. 34).

Procedures for Data Collection and Analyses

Design of the Study

This study used "The Single Cross Section" sample survey-research design suggested by Warwick & Lininger (1975, p. 57). Campbell and Katona (1966) previously had stated, "This is the method 'par excellence` for the determination of the characteristics of a population at a specific point in time" (p. 22). And, the general objective of this study was to determine if there is a need for additional training of entry-level pilots, and if so, what additional training is needed.

The dependent variable was "need for additional training of entry-level pilot." It is a dependent qualitative variable with 5 levels. These levels were rated on an ordinal scale from 1 to 6 by the respondents. The independent variable was "regional airline," an assigned rather than manipulated variable.

The Sample

The sample size used in this study was 126 United States Regional Airlines, and was the correct size, according to the sample size formula shown by the Research Division of the National Educational Association (National Education Association [NEA], 1960, December, p. 99). Summary data of the population, random sample, usable and unusable surveys returned, and non-respondents of this study are shown in Table 1.

Table 1. Summary data of the population, random sample, usable surveys returned by regional airlines, unusable surveys returned, and non-respondents of this study.

Population	Random Sample	Regional Airlines Usable Surveys	Unusable Surveys	Non-Respondents
186	126	102 (80.9)	10 (7.9)	14 (11.1)

[a]Numbers shown in ( ) are percentages based on the random sample. Because of rounding, these percentages only total 99.9.

Type of Statistical Analyses Chosen

Data obtained from the questionnaires used in this non-experimental survey-research study are appropriate for descriptive studies. In processing the data gathered, the researcher used The student edition of minitab (Schaefer & Anderson, 1989), a statistical software package.

Kruskal-Wallis H Test. This test (one-way analysis of variance for ranked data) is a rank test for k independent samples, and the most appropriate test for significance of any ranking differences in the data collected from the survey questionnaires. The Kruskal-Wallis H test was chosen because the data gathered were ordinal in nature, but not ordered.

The respondents rated each flight-training area with respect to need for additional training of entry-level pilots. The respondents used the following scale: (a) 1-No Importance, (b) 2-Little Importance, (c) 3-Some Importance, (d) 4-Important, (e) 5-Highly Important, and (f) 6-Extremely Important.

Table 2 shows the data collected from the survey questionnaires by regional airlines. There were no missing data.

Table 2. Sum of rating, mean rating, and rank of areas of flight training with respect to need for additional training of entry-level airline pilots (regional airlines).

N = 102

Area of Flight Training	Sum of Rating	Mean Rating	Rank
Basic instrument training (flight or simulator)	512	5.02	1
Cockpit or crew resource management training	371	3.64	3
Phase I or phase II simulator training	255	2.50	5
Turbo-prop/jet in-flight training	289	2.83	4
Line-oriented flight training	400	3.92	2

Analyses: Need for Additional Training

Null hypothesis. There are no differences between types of entry-level pilot training, with respect to need for additional training of entry-level pilots, perceived as most important by chief pilots of regional airlines.

Testing the null hypothesis. Table 3 shows the summary of the data gathered from the survey questionnaires, after it was ranked, for the purpose of testing the null hypothesis. The Kruskal-Wallis H test adjusted for ties was used on this data. The .05 level of significance was selected in the analysis.

The data consist of 510 ratings, 102 per area of additional flight training. These data were ranked and all ties were assigned the average of the ranks they would otherwise occupy. It was assumed, in testing the null hypothesis, that the rank sums would be equal for the five areas of training and no significant differences would be found among types of additional entry-level pilot training.

Table 3. Median, sum of rank, average rank, and $\underline{Z}$ value with respect to need for additional training of entry-level pilots (regional airlines $\underline{N}$ = 102).

Additional Training Area	Median	Sum of Rank	Ave. Rank	Z Value[a]
Basic instrument training (flight or simulator)	380.5	38764	380.0	9.54
Cockpit or crew resource management training	289.0	26379	258.6	0.24
Phase I or phase II simulator training	189.5	16710	163.8	-7.02
Turbo-prop/jet in-flight training	189.5	19584	192.0	-4.87
Line-oriented flight training	289.0	28868	283.0	2.11

[a]Indicates how the average rank for that group differs from the average rank for all groups. The average rank for all groups = 255.6.

The calculated H corrected for ties was 138.8. The distribution of H approximates the distribution of χ^2 with ($\underline{k}$ - 1) $\underline{df}$. For $\underline{k}$ = 5, $\underline{df}$ = 4, a χ^2 = 9.49 is required for significance at .05 level. Since 138.8 is > 9.49, for $\underline{df}$ = 4, $\underline{p} < .05$, the null hypothesis was rejected.

Ten Wilcoxon rank sum tests were used as Post-Hoc tests for comparing all possible pairs of flight training areas. One seeks the normal deviate $\underline{Z}$ when using these tests. The results of these Wilcoxon tests are shown in Table 4.

The null hypothesis under test here, in using the Wilcoxon rank sum test, is that the medians of the paired flight training areas are equal. A $\underline{Z}$ value of ± 1.96 is required for significance at the .05 level.

"Basic instrument training (flight or simulator)" was compared to (a) "cockpit or crew resource management training," (b) "phase I or phase II simulator training," (c) "turbo-prop/jet in-flight training," and (d) "line-oriented flight training." The respective $\underline{Z}$ values obtained were 6.37, 9.91, 8.75, and 5.09, $\underline{p} < .05$ for each pairing. The null hypothesis was rejected in each of these cases.

The degree of association between the areas of need for additional training of entry-level pilots, is reflected in the variation in the rank sums. The null hypothesis under test here is that no association exists between the training areas, with respect to need for additional flight training. To test the null hypothesis the mean rho was found by the doing a Spearman rank-order correlation coefficient test on the 10 possible pairs of data, see Table 5. The rho mean value was then tested for significance by using a _t_.

Findings: Need for Additional Training

The null hypothesis was rejected as a result of the Kruskal-Wallis H test. This result indicated that at least one pair of types of entry-level pilot training, with respect to need for additional training, was not from the same population. As a result of the Post-Hoc tests, the null hypothesis was rejected for all but two possible pairs of types of pilot training, with respect to need for additional

Table 4. Calculated _Z_ values for training area (TA) matrix with respect to need for additional training of entry-level pilots (regional airlines _N_ = 102).

	TA-2	TA-3	TA-4	TA-5[e]
TA-1[a]	6.37*	9.91*	8.75*	5.09*
TA-2[b]		4.94*	3.44*	1.25
TA-3[c]			1.38	5.95*
TA-4[d]				12.34*

[a]TA-1 = Basic instrument training (flight or simulator).
[b]TA-2 = Cockpit or crew resource management training.
[c]TA-3 = Phase I or phase II simulator training.
[d]TA-4 = Turbo-prop/jet in-flight training.
[e]TA-5 = Line-oriented flight training.
*$p < .05$

Table 5. Calculated ρ values for training area (TA) matrix with respect to need for additional training of entry-level pilots (regional airlines _N_ = 102).

	TA-2	TA-3	TA-4	TA-5[e]
TA-1[a]	0.107	0.155	0.142	0.049
TA-2[b]		0.381	0.388	0.197
TA-3[c]			0.482	-0.062
TA-4[d]				0.100

Note. rho mean = 0.194
[a]TA-1 = Basic instrument training (flight or simulator).
[b]TA-2 = Cockpit or crew resource management training.
[c]TA-3 = Phase I or phase II simulator training.
[d]TA-4 = Turbo-prop/jet in-flight training.
[e]TA-5 = Line-oriented flight training.

training, as perceived by chief pilots of regional airlines. The result of the Spearman rank-order correlation coefficient test shows that the null hypothesis could not be rejected. Therefore, the obvious associations between the two pairs of areas of need for additional training of entry-level pilots, as previously noted, were insignificant when tested with the other flight training areas.

Discussion and Recommendations

On the basis of this study's findings the following discussion and recommendations are made:

Many proficient entry-level pilots with only a few hundred flight-hours, who are pursuing an airline career, lose their instrument skills by the time they meet the total time/hours requirement of regional airlines. As pointed out in the study, the additional flight training needed is basic instrument flight training. Apparently these entry-level pilots lose their instrument proficiency (instrument skills) because they neglect basic instrument flying in order to accumulate the required flight time needed to be hired by regional airlines. Therefore, it is recommended that:

1. Colleges and universities with professional pilot training programs should investigate the feasibility of flying internships, for commercial and instrument certificated flight students, with air-taxi/charter companies. Flight internships should be considered even if a second pilot is not required under certification of the aircraft, or the regulations under which the flight is conducted.

2. The FAA should be petitioned to establish an addendum to Part 61.51, Pilot logbooks. The addendum should address internship flight-students from FAA approved flight schools, whereby they may log the experience or training while occupying a command seat of an air-taxi/charter flight, even if a second pilot is not required under certification of the aircraft, or FARs the flight is conducted under.

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EFFECTIVENESS OF COMPUTER-BASED FLIGHT SIMULATION

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Abstract

The study measured the transfer effectiveness ratio from a computer-based flight simulation to a Link GAT I generic flight training device. The computer-based simulation consisted of Microsoft Flight Simulator software run on an IBM PS/2 Model 80 integrated with a set of Microflight Simulator flight controls by Wagner Computer Products.

There were 71 volunteer subjects who had zero flying experience piloting an airplane or using Microsoft Flight Simulator. Their ages ranged from 16 to 71. The subjects were randomly divided between a control group and an experimental group. The experimental group consisted of 29 subjects who flew a basic attitude instrument pattern first on the computer-based flight simulator to private pilot criterion, then again in a Link GAT I flight training device to the same criterion. The control group consisted of 33 subjects who flew an identical basic attitude instrument pattern to criterion in the GAT I flight training device only. The experimental group was compared to the control group using a transfer effectiveness ratio. It was determined that one hour of training using computer-based flight simulation resulted in a saving of 22.8 minutes of training in the Link GAT I, yielding a transfer effectiveness ratio value of 0.38.

Introduction

Over the past 30 years flight training devices have evolved from rudimentary analog procedures trainers to highly sophisticated digital flight simulators. Today's simulators are functionally indistinguishable from the specific aircraft they simulate. The evolution of flight simulators has been coordinated by the FAA and spurred onward by the air carriers and military because they had the resources to do so. General aviation, or that segment of aviation that is neither military nor air carrier, has had neither the organization or financial capability to participate in the development of the engineering criteria, rules and procedures which now govern flight simulation. As a result aircraft-specific flight simulators have evolved to a degree of technological sophistication and fidelity that requires an initial investment which, in many cases, exceeds the cost of the aircraft being simulated.

For the most part light aircraft simulation was limited to a few dedicated companies with minimal research and development resources. This resulted in the development of flight training devices in which form followed function. In other words, the level of the device's fidelity was considered with respect to the training task it would address. The engineering orientation of these companies was to produce a low-cost training device that had sufficient fidelity to assure appropriate cause and effect relationships among the instruments and controls. The validity of this design orientation was further supported by Smode and Hall (1975) when they emphasized that training device design should be concerned with transfer of training. They argued that while the engineering approach to simulator fidelity is physical correspondence with the actual aircraft, it was more appropriate that the level of fidelity required should be determined by that which was actually necessary to promote learning. This very serious question of just how much fidelity is actually necessary to assure adequate transfer of training continues to plague the engineering-oriented National Simulator Program of the Federal Aviation Administration. The truth is there are numerous works which indicate that simulation fidelity need not be particularly high to accomplish a positive transfer of training (Povenmire & Roscoe, 1971; Valverde, 1973; Swezey, 1989).

General aviation flight training device manufacturers subscribed to that orientation until the advent of the low-cost microprocessor. The flexibility afforded by the microprocessor caused both training device engineers and customers to seek greater and greater fidelity, but not necessarily for the right reasons. The engineers had a new found power in the microprocessor which afforded them the ability to increase fidelity through software improvement rather than the more costly hardware improvements. The customer, on the other hand, began demanding greater fidelity because students frequently complained that the training device didn't fly like the airplane. Unfortunately, the concept of what was necessary to assure transfer of training became lost in the shuffle as labor intensive programming costs began to cause the price of low-cost training devices to double and even triple. While these modern flight training devices do not even begin to approach the initial cost of the multi-million dollar flight simulators, it is not uncommon for the cost of a generic, single engine flight training device to exceed $50,000; with options it can easily exceed $100,000. A few, very large general aviation flight schools may be able to justify the expense but most cannot. Clearly, there is a need for a lower-cost flight training device.

It was also microprocessor technology which made possible the video games that evolved into computer-based flight simulation. These new CBFS systems consist of representative flight simulation software which is operated on a personal computer. Several of today's CBFS software packages subjectively appear to have both good handling and performance characteristics which, within limits, improve as the computer's clock speed and graphics quality increase. If such CBFS devices offer a positive transfer of training to the airplane they could be readily adopted by general aviation flight training operations because of their low initial cost, typically less than $5,000, and very low direct operating cost of pennies per hour.

While little research has been done in the area of CBFS, one project stands out. Hampton (1991) compared three training devices: The Link GAT I, the Frasca 141, and a CBFS system consisting of an IBM PC-XT computer with RGB color monitor integrated with a Novel Twist Cockpit Procedure Trainer and Flight Deck Software's Instrument Flight Trainer software. Among other issues, his research included basic attitude instrument flying training. He found that the Novel Twist CBFS provided basic attitude instrument training to at least the same standard as the GAT I and Frasca 141.

Purpose

The purpose of this study was to determine if Microsoft Flight Simulator, a commercially available software game, combined with a set of Microflight Simulator flight controls manufactured by Wagner Computer Products, had sufficient transfer of training value to warrant further research on the subject. For simplicity and cost considerations transfer of training was measured between the CBFS and a Link GAT I flight training device rather than an actual aircraft.

Method

Subjects

Seventy-one subjects were used in the project and recruited through an advertisement in the local newspaper. The advertisement stated that the university was conducting flight simulation research and sought subjects at least 16 years of age with no piloting experience. Respondents included local residents, university students and staff, and a few individuals from outlying towns. The age range for the 23 female and 48 male subjects was 16 to 71. See Table 1 for the distribution by age and gender of the 62 subjects who completed the project. In the interest of good will, the few individuals who applied that did have flying experience were allowed to participate without their results being recorded.

Table 1 Distribution by Age and Gender of Subjects Who Completed the Project

AGE	FEMALE N = 19	MALE N = 43
16	01	
17		02
18	05	12
19	06	19
20	05	07
21		02
22	01	
33	01	
37		01

Of the 71 subjects, nine were unable to complete the project leaving 62 subjects (19 female and 43 male). Five control group subjects were eliminated because they demonstrated progressively worse control of the Link GAT I resulting in the instructor making the subjective decision that further attempts on the part of the subject to reach criterion would be fruitless. See Table 2 for the total times of the individual control group subjects at the point of termination.

Table 2 Prematurely Terminated Control Group Subjects - Total GAT I Time at Point of Termination

Subject	Total GAT I Time
1	70 min, 45 sec
2	58 min, 00 sec
3	64 min, 15 sec
4	55 min, 00 sec
5	60 min, 15 sec

Four experimental group subjects were unable to complete the project. Two subjects experienced motion sickness in the Link GAT I and were unable to complete that portion of the session. The computer-based flight simulation (CBFS) and GAT times for the first subject were 18 minutes 30 seconds and 14 minutes 30 seconds respectively, and 39 minutes 15 seconds and 41 minutes 45 seconds for the second subject. One experimental group subject successfully completed the CBFS training but exhibited progressively worse handling during the Link GAT I phase. The instructor terminated the subject's session at a GAT I time of 28 minutes 30 seconds; the subject's CBFS time was 39 minutes 30 seconds. One experimental group subject was never able to control the CBFS and was eliminated from the project.

Flight Instructor

The role of the flight instructor was pivotal to the success of the project. Recommendations set forth by Payne (1982) regarding the flight instructor as researcher were followed with the result that the same flight instructor was used throughout the life of the project from concept development through data collection. The instructor held an FAA flight instructor certificate for airplane single engine land and instrument, and was a graduate research assistant employed by the project.

Apparatus

A reconditioned Singer Link GAT I was used as a substitute for an aircraft to keep project costs within budgetary constraints. It was determined that the GAT I would be a reasonable choice of available training devices to be used in the project because prior research by Povenmire and Roscoe (1971) into its effectiveness in routine primary flight training indicated that the GAT I has a transfer effectiveness ratio to the aircraft of 1.0 up to approximately 11 hours of training. The GAT I incorporates three axes of motion (pitch, roll and yaw) and an instrument panel common to light, single engine aircraft including flight instruments, system instruments, electronic navigation equipment, and communication radios. The analog attitude instruments include: Attitude indicator, vertical speed indicator, heading indicator and airspeed indicator.

Prior to using the GAT I the experimental group used a CBFS system utilizing the Cessna 182 option of Microsoft Flight Simulator Version 3.0 software. The program was run on an IBM PS/2 Model 80 with 16 Mhz, -386 processor and VGA color graphics monitor. A set of Microflight Simulator Model A-300, Version 3 flight controls manufactured by Wagner Computer Products was integrated with the IBM computer. The Microflight Controls were a representative array of single engine aircraft analog controls including yoke, rudder pedals, throttle, propeller, and mixture. It also included flap and gear switches. These controls interfaced with the Microsoft Flight Simulator software to provide representative cockpit instrument and control inputs and displays.

Procedure

Experimental Procedure

Seventy-one subjects were divided into two groups: An experimental group and a control group. All subjects were given a Subject Informed Consent Form to verify they had no previous flying experience, to obtain a consent signature, and to collect data.

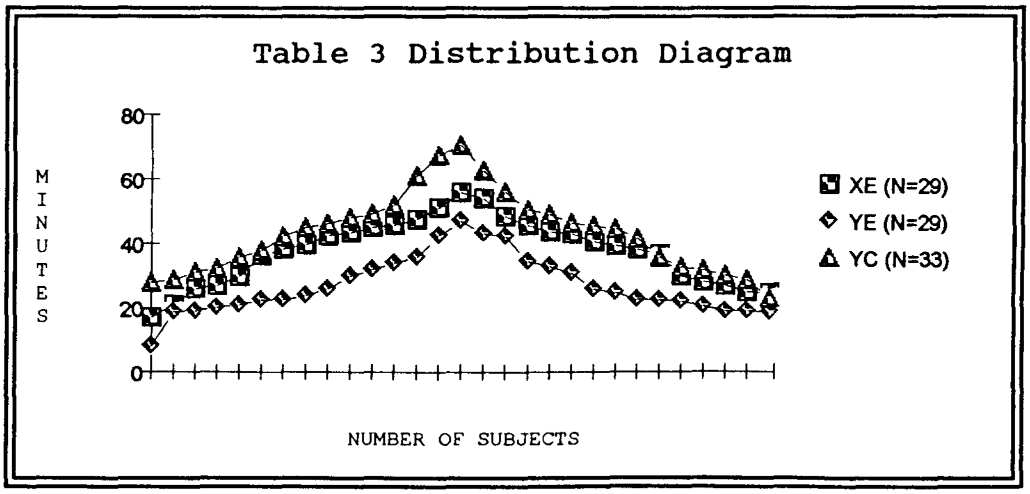
Subjects in the experimental group were given a written description in sufficient detail to assure the necessary knowledge of how to operate the CBFS controls. They were also given the opportunity to ask the instructor specific questions as necessary however subjects were not allowed to practice with the CBFS prior to the beginning of data collection. For the purpose of this experiment the subjects were only required to use the attitude indicator, vertical speed indicator, heading indicator, airspeed indicator, yoke, throttle and rudder pedals.

Once an experimental group subject understood the purpose of the appropriate flight controls and instruments as subjectively determined by the instructor, they were given a basic attitude instrument flight pattern to fly. The instructor preset the program so the simulated aircraft was at the appropriate altitude and in the appropriate configuration to maintain straight and level flight. The subjects were then given control of the simulation and performed as many repetitions of the pattern as necessary to reach criterion. Criterion was achieved when the subject could successfully fly the entire pattern as depicted within Federal Aviation Administration Private Pilot Flight Test Guide criterion, as follows:

Altitude:	+/-	100 feet
Heading:	+/-	10 degrees
Airspeed:	+/-	10 knots
Bank Angle:	+/-	10 degrees

The total practice flight time required to successfully complete one pattern within established criteria was recorded for each subject and is depicted in the distribution diagram in Table 3.

Both groups were given a written description of how to operate the Link GAT I generic flight training device. Once a subject understood the purpose of the appropriate individual flight controls and instruments as determined subjectively by the instructor, they were given the basic attitude instrument flight pattern to fly. The instructor preset the GAT I at the appropriate altitude and in the appropriate configuration to maintain straight and level flight. The subjects were then given control of the GAT I and performed as many repetitions of the pattern as necessary to reach criterion.



Both groups where given the same opportunity to learn the function of the instruments and controls, both flew the same pattern, and all subjects performed as many repetitions as necessary to complete one pattern within Private Pilot criterion. The total practice flight time required to reach criterion was recorded for each subject and is depicted in the distribution diagram in Table 3.

Data Collection and Reduction Procedure

The basic attitude instrument flight pattern form also served as a standardized data collection form. The instructor timed the duration of each pattern to the nearest quarter of a minute and entered it on the form. Each control group subject had a single statistic (Yc) indicating the total time required to achieve criterion in the Link GAT I. Each experimental group subject had two statistics: Total time to criteria using CBFS (Xe) and total time to criteria in the Link GAT I (Ye).

To determine transfer of training effectiveness, a transfer effectiveness ratio (TER) formula developed by Povenmire and Roscoe (1971) was employed. It was originally developed to meet the needs of a study measuring transfer of training from a flight training device to an aircraft. Transfer effectiveness ratio indicates time saved in the transfer (or operational) task, divided by the time required in the training device.

For the purposes of this study the TER will take into account the total duration of all pattern repetitions required to successfully complete one pattern within the criterion. The TER is calculated by the following formula:

$$TER = \frac{Yc - Ye}{Xe}$$

Where:

Yc = Control group average time in minutes of practice required to reach criterion in the GAT I.

Ye = Experimental group average time in minutes of practice required to reach criterion in the GAT I.

Xe = Experimental group average time in minutes of practice required to reach the criterion using CBFS.

A positive number indicates there is some training benefit. Zero, or a negative number, indicates there is no training benefit. For instance, a TER of 0.5 would indicate that one hour of training with the experimental method would save approximately one-half hour of training utilizing the control group method.

Results

The 29 experimental subjects (Xe) had a cumulative time of 18 hours 10 minutes (18.2 hours) to criterion using the computer-based flight simulation software. This produced an average of 0.63 hours per subject to criterion. The same group had a total of 12 hours 42 minutes 30 seconds (12.7 hours) in the GAT I (Ye) to criterion which produced a 0.44 hours per subject average to criterion. The 33 control group subjects who were only exposed to the GAT I had a cumulative time to criterion of 22 hours 19 minutes 45 seconds (22.3 hours) or an average per subject time of 0.68 hours.

Xe	Ye	Yc
N = 29	N = 29	N = 33
18:10:00	12:42:30	22:19:45
18.2/29 = 0.63	12.7/29 = 0.44	22.3/33 = 0.68

Using the transfer effectiveness ratio the data indicate that one hour of CBFS is equivalent to 0.38 hours of GAT I in the tasks researched.

$$(Yc - Ye) / Xe = TER$$

$$(0.68 - 0.44) / 0.63 = 0.38$$

Discussion

Interpretation and Conclusions

The purpose of the study was to determine if Microsoft Flight Simulator combined with a set of Microflight Simulator flight controls by Wagner Computer Products offers sufficient training effectiveness to warrant further research. A transfer effectiveness ratio of 0.38 indicates that one hour of practice on the CBFS system saved the subject approximately 23 minutes (0.38 hours) of comparable practice time in the Link GAT I flight training device. The training value for the zero-time pilot in the type of basic attitude flying training studied suggests a CBFS system has practical and cost-effective training value. It is the opinion of the researcher that the TER obtained in the study indicates sufficient effectiveness to warrant further investigation into the transfer effectiveness from computer-based flight simulation to an aircraft.

Recommendations

Further research should be conducted to determine the transfer effectiveness ratio to an actual single engine trainer aircraft. Possible areas to research include:

1. Introduction and practice in the use of basic aircraft controls and instruments in the visual control of the aircraft by zero or low experience student pilots.

2. Introduction and practice in the use of basic aircraft controls and instruments in restricted vision aircraft attitude instrument control by zero or low experience student pilots.
3. Introduction and practice of instrument flying terminal procedures by students training for the instrument rating.
4. Introduction and practice of instrument flying enroute procedures by students training for the instrument rating.

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