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A STUDY OF THE EFFECT OF TIME ON THE INSTRUMENT SKILL OF THE PRIVATE AND COMMERCIAL PILOT

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by

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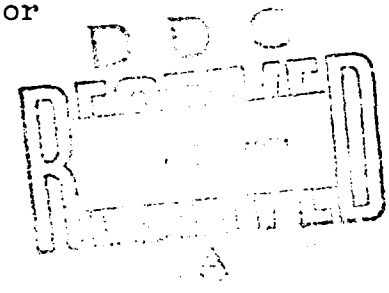

Prepared For

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ABSTRACT

This study was performed to determine the effects of time on the instrument flying skill of the private and commercial pilot. Seventy pilots who have had their licenses from six months to nine years were used as subjects. Results show that there is an apparent decline in instrument proficiency with time for both the private and commercial pilot. During this project, the proficiency deficit was regained with an average of 2-1/2 hours flight instruction plus 50 minutes ground instruction for the private pilot, and 1-1/2 hours flight instruction and 25 minutes ground instruction for the commercial pilots.

Equations were determined statistically which permit a prediction of the instrument skill of both the private and commercial pilots. This predicted score, together with the requirement that a pilot have at least 1.5 hours/year of instrument experience, indicated in sixty-nine of the seventy subjects, whether the pilot would be required to have additional instrument instruction. Curves are provided which, when used in conjunction with the predicted score, yield statistical approximations for the instruction time required to return the pilot to the level of instrument skill equivalent to the "average" pilot.

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1. INTRODUCTION

1.1. Background - Research on the instrument proficiency of pilots was initiated some 35 years ago. [1] In 1934-35, T. Lee, Jr. of the Boeing School of Aeronautics, trained sixteen students, first on instruments and later in contact flying. The results were so successful that Mr. Lee concluded: "We are now so completely sold that we believe all students taking instruction for long-time courses, such as our Airline Pilot Course, should begin their flight instruction under the hood."

In 1953, M.L. Ritchie, and A.L. Michael studied the effects of transfer from instrument to contact flight training. Two groups of flight-naive students were taught to fly straight and level and to make 180° turns -- one group flew contact and the other group on instruments. After achieving a stated level of proficiency, the groups were changed so that the contact group now learned to fly the maneuvers on instruments and the instrument group learned on contact. Results indicated that initial instruction on instruments facilitated subsequent instruction on contact but initial instruction on contact actually interfered with subsequent instruction on instruments.

In 1955-56, the University of Illinois studied the feasibility of incorporating both instrument and contact flight training into the time limits of the University's approved private pilot syllabus without interfering with the student's contact flying ability. All of the eighteen students tested reached the required contact proficiency. In addition, they had reasonable proficiency in controlling the aircraft under simulated instrument conditions in a modified Link Operational Flight Trainer (1CA-2). It was concluded that simultaneous instruction on instrument and contact flying is feasible in a regular course of instruction. Such instruction not only promotes rapid learning of both instrument and contact skills but it encourages a favorable attitude toward instrument flying.

Approximately two years later, West Virginia University, under the sponsorship of the Link Foundation and in cooperation with the FAA, conducted a study [2] using 10 subjects with no previous flight experience. The method of simultaneous contact-instrument

1. Williams, Jr., A.C., Houston, R.C., and Wilkerson, H.E., "Simultaneous Contact-Instrument Flight Training", University of Illinois Bulletin, Volume 53, No. 42, January 1956.

2. Seltzer, L.Z., "Experiment in Contact-Instrument Flight Training", West Virginia University Engineering Experiment Station, 1958.

instruction was employed, that is, each maneuver was practiced under the hood and with visual reference during the same lesson. The results of the project indicated that this procedure was not only successful but that the incorporation of the instrument instruction did not add to the total flying time required by the students to prepare for the private pilot flight test. A few of the subjects were given an additional 20 hours of instrument flight instruction and practice. While the subjects did not have the number of hours required for an instrument rating, each of them was able to pass the instrument rating flight test. The obvious conclusion was that some instrument training was beneficial and should be included in the early stages of flight instruction.

West Virginia University conducted another project in 1959 [3], also sponsored by the Link Foundation and in cooperation with the FAA, which was designed to determine if there was any correlation between the amount of previous VFR (Visual Flight Rules) experience of a pilot and the number of hours of instrument instruction required to develop the same minimum proficiency attained by the subjects of the 1957 project. The results indicated there was indeed a relationship. It was found that the more experience a pilot has before being exposed to instrument flight instruction, the greater is the amount of instruction that he will require.

In 1961, the FAA recognized the results of the preceding projects when it amended Part 61 of the FAR's so that commercial pilot certificate applicants must have at least 10 hours of instrument instruction (five with an Instructor and five with an Instrument Instructor) before they could be certified. The new regulation for the private pilot applicant was that he be required to demonstrate his ability to perform normal flight maneuvers and to recover from critical flight attitudes solely by reference to flight instruments.

1.2. Present Study - The five earlier studies attempted to combine IFR (Instrument Flight Rules) and VFR training with the object of ensuring that every new pilot will be able to control the airplane without visual references outside the aircraft.

The objective of the current study is to determine the effect of time on the instrument skill of the private and commercial pilot, and not how the pilot initially attained that level of skill. An applicant for certification as a private or commer-

3. Seltzer, L.Z., "Elementary Instrument Flight Training of Certificated Pilots", West Virginia University Engineering Experiment Station, 1959.

cial pilot must demonstrate a given level of instrument skill in order to obtain certification. It is logical to assume, however, that the performance of a pilot in a skill area such as flying solely by reference to flight instruments may deteriorate with time if periodic practice and updating of this skill is not accomplished. One would like to determine how long after certification a non-instrument rated pilot loses this instrument skill. In addition, it should be determined what type, how much, and how often periodic practice or updating should be accomplished to re-attain acceptable skills.

The primary objective of this study therefore, is to obtain a satisfactory and reliable determination of the degradation of instrument skill of the private and commercial pilot over an established time period. Secondary objectives are to correlate this loss of skill with both total instrument time and that accrued since certification. Finally, the study seeks to provide a means of determining further training requirements to return the pilot to a level of skill at least equal to that attained for initial certification.

2. PARTICIPANT SELECTION PROCEDURES

The FAA Data Automation Center supplied a listing of all private and commercial pilots within Missouri and Illinois. It was from this list that the qualified pilots were selected.

There were 29,362 pilots in Missouri and Illinois listed with the FAA. Of these, seventy were selected as participants under the criteria mentioned below.

A mailing list was compiled of those residing within both 50 and 100 mile radii of Parks Bi-State Airport. Within a radius of 50 miles there were 2,738 private and 420 commercial pilots. All of the 420 commercial pilots and 396 of the private pilots were sent letters explaining the program and soliciting their participation.

From this mailing, there were 232 returns (28.4%). Of these, 106 (45.7%) met the criteria set up for selection. The usable return was 13.0% of the total inquiry.

An additional mailing was sent to the 176 commercial pilots within the 50-100 mile radius soliciting their participation since the earlier response from pilots with more than 5 years since certification did not provide an adequate supply of qualified subjects.

Both mailings included separate introductory letters for both the private and commercial pilots (Appendix A-1 and A-2) and a questionnaire to be returned (Appendix A-6). The pri-

mary information sought through the questionnaire was the type(s) of license(s) held; the date(s) of certification; type(s) of aircraft in which currently qualified; the date and class of last physical; the total number of hours flown; and the total number of instrument hours flown, both before and after certification.

In general, pilots certified prior to 1960, those holding instrument ratings, and former military pilots were not eligible.

Exceptions concerning former military training were permitted in order to fill as many of the time slots as possible. Three pilots originally licensed prior to 1960 but whose licenses had lapsed and been reissued in or since 1960 were allowed to participate. Another pilot was working towards an instrument rating, but had only six hours of instrument time in the seven years since his commercial license was issued. He was, however, permitted to participate in this study.

Information regarding other licenses, currency of license, etc., is given under the comments heading in Table I.

A final criterion for selection was the subject's availability for check rides and instruction.

Table II indicates both the preferred and the actual distributions of pilots according to time elapsed since licensing.

It should be noted that it was difficult to locate commercial pilots with more than four years elapsed time since licensing (ETSL) so a number of slots were unfilled. Two reasons for this may be that most commercial pilots who fly for hire obtain their instrument license within a few years after receiving their commercial ticket, and that those commercial pilots who have not received their instrument license usually do not fly for a living and are not very proficient. For the latter reason many did not wish to participate and demonstrate their lack of proficiency. A quote from one of the questionnaires is perhaps appropriate: "I am, perhaps, a good example of a person who has a commercial license but should not. I got this rating only to upgrade my flying and satisfy my ego. (I) Never used the rating. (I) Did not get it with any view toward a vocation in flying. I might be an accident looking for a place to happen because although I have practically no instrument time in the last four years (1 hr. instruction(I really do believe I can fly one (airplane) on instruments and would have no qualms about doing it if necessary. I have flown many times in very marginal conditions feeling secure in this belief."

All pilots who were rejected received a letter of regret (Appendix A-3) and those accepted were notified (Appendix A-4) when to report for their initial check ride.

TABLE Ia - PILOT FURNISHED INFORMATION

COMMERCIAL PILOTS

PILOT NO.	ELAPSED TIME	TOTAL HOURS	TOTAL INSTRUMENT TIME		INSTRUMENT TIME SINCE LICENSE		COMMENTS
			AIR-CRAFT	SIMULATOR	AIR-CRAFT	SIMULATOR	
1	0.50	299.4	36.6	20.3	11.6	0.0	
2	0.50	250.0	10.5	0.5	0.0	0.5	A,F
3	0.50	300.0	52.0	1.0	0.0	0.0	
4	0.50	289.0	15.5	0.0	10.0	0.0	
5	1.00	264.3	11.5	0.0	0.0	0.0	
6	1.00	318.0	15.4	0.0	1.9	0.0	
7	1.00	348.0	12.5	10.0	12.5	10.0	F
8	1.00	80.0	8.0	25.0	0.0	0.0	C
9	1.00	435.0	11.2	3.0	0.2	2.0	
10	1.25	380.0	10.3	0.0	0.0	0.0	
11	1.25	278.0	16.2	0.0	0.0	0.0	
12	1.50	253.9	21.2	0.0	2.7	0.0	
13	1.50	322.0	27.0	23.0	6.0	0.0	A
14	1.50	315.6	38.9	0.0	28.7	0.0	E
15	2.00	317.0	10.0	0.0	0.0	0.0	C
16	2.00	322.8	22.4	22.0	2.0	0.0	
17	2.00	258.3	10.3	20.3	0.0	0.0	
18	2.00	287.0	20.3	4.5	4.4	0.0	
19	2.00	736.5	14.0	0.0	0.0	0.0	
20	2.00	324.8	12.0	2.0	0.2	1.0	A
21	2.50	816.5	76.5	65.5	0.0	0.0	
22	2.50	180.3	11.5	0.0	0.0	0.0	
23	2.50	800.0	14.0	0.0	1.2	0.0	
24	3.25	371.2	10.8	0.0	0.0	0.0	
25	3.50	504.5	13.8	0.0	0.0	0.0	
26	4.00	783.0	1.0	5.0	1.0	5.0	A,H
27	4.00	407.0	16.0	0.0	2.0	0.0	
28	7.00	802.0	14.3	0.0	6.0	0.0	A
29	7.00	1584.7	44.0	49.0	0.0	0.0	H
30	7.25	761.0	18.3	0.0	2.4	0.0	
31	9.00	535.0	16.0	0.0	16.0	0.0	D
32	9.00	1340.0	50.0	200.0	0.0	0.0	A,I
33	9.00	1160.0	2.9	1.9	2.9	1.9	

A DENOTES MULTIENGINE LICENSE
B DENOTES GLIDER PILOT
C DENOTES HELICOPTER PILOT
D DENOTES NOT CURRENT
E DENOTES INSTRUMENT LICENSE
F DENOTES INSTRUCTOR LICENSE
G DENOTES WORLD WAR II PILOT
H DENOTES REISSUE OF LICENSE
I DENOTES AIR NATIONAL GUARD MEMBER

TABLE Ib - PILOT FURNISHED INFORMATION

PRIVATE PILOTS

PILOT NO.	ELAPSED TIME	TOTAL HOURS	TOTAL INSTRUMENT TIME		INSTRUMENT TIME SINCE LICENSE		COMMENTS
			AIR-CRAFT	SIMULATOR	AIR-CRAFT	SIMULATOR	
1	0.50	69.1	2.0	0.0	0.0	0.0	
2	0.50	54.7	2.0	0.0	0.0	0.0	
3	0.50	105.2	2.5	0.0	6.4	0.0	
4	1.00	117.4	5.4	0.0	0.7	0.0	
5	1.00	85.0	4.2	0.0	0.0	0.0	
6	1.25	100.0	2.2	0.0	0.0	0.0	
7	1.50	108.0	16.0	0.0	16.0	0.0	
8	1.50	89.2	2.1	0.0	0.0	0.0	
9	1.50	95.0	0.0	0.0	0.0	0.0	
10	2.00	321.0	9.0	0.0	6.4	0.0	
11	2.00	200.0	3.0	0.0	0.5	0.0	
12	2.00	190.0	6.5	0.0	2.0	0.0	C
13	2.00	165.0	10.0	0.0	7.0	0.0	A
14	2.00	183.0	25.0	0.0	20.0	0.0	D
15	2.00	93.8	3.0	0.0	1.0	0.0	
16	2.25	156.4	8.4	0.0	0.0	0.0	
17	2.25	220.0	8.0	0.0	5.0	0.0	
18	2.50	155.0	1.7	0.0	0.0	0.0	
19	3.00	1200.0	3.0	0.0	0.0	0.0	
20	3.25	135.0	3.5	0.0	0.0	0.0	
21	3.50	135.0	2.0	0.0	0.0	0.0	D
22	3.50	193.0	4.0	0.0	1.0	0.0	
23	4.00	420.0	37.0	0.0	29.0	0.0	
24	5.00	97.7	1.6	2.0	0.0	1.0	
25	5.00	400.0	25.0	23.0	25.0	23.0	
26	5.25	269.5	14.9	0.0	2.0	0.0	A
27	5.50	611.0	13.3	0.0	9.8	0.0	
28	6.00	124.0	4.7	0.0	0.0	0.0	D
29	6.00	421.0	13.0	0.0	7.0	0.0	
30	6.00	1800.0	3.0	0.0	0.0	0.0	
31	7.00	205.0	9.0	0.0	2.0	0.0	
32	7.00	285.0	10.0	0.0	0.0	0.0	
33	7.50	140.9	4.5	1.5	0.0	0.0	
34	8.00	101.0	7.0	0.0	0.0	0.0	
35	8.50	145.0	8.0	0.0	0.0	0.0	
36	8.50	155.0	5.1	0.0	2.4	0.0	D
37	9.00	526.0	0.0	0.0	0.0	0.0	B

A DENOTES MULTIENGINE LICENSE
B DENOTES GLIDER PILOT
C DENOTES HELICOPTER PILOT
D DENOTES NOT CURRENT
E DENOTES INSTRUMENT LICENSE
F DENOTES INSTRUCTOR LICENSE
G DENOTES WORLD WAR II PILOT
H DENOTES REISSUE OF LICENSE
I DENOTES AIR NATIONAL GUARD MEMBER

TABLE II
DISTRIBUTION OF PILOTS WITH TIME SINCE LICENSE

E.T.S.L.	Desired Distribution	Actual Commercial	Actual Private
0.5	3	4	3
1.0	3	5	2
1.25		2	1
1.5	3	3	3
2.0	3	6	6
2.25			2
2.5		3	1
3.0	3		1
3.25		1	1
3.5		1	2
4.0	3	2	1
5.0	3		2
5.5			2
6.0	3		3
7.0	3	2	2
7.25		1	
7.5			1
8.0	3		1
8.5			2
9.0	3	3	1

3. PROFICIENCY EVALUATION

To assure that any one participant's proficiency would be evaluated under the same conditions as those of the others, instrument flight checklists (see Figures 1 and 2) were derived from the Instrument Flight requirements for certification of both the private and commercial pilot.

Grading for the flight checklists was set up on the following scale:

PERFORMANCE	GRADE
Excellent	1
Above Average	2
Average	3
Below Average	4
Unsatisfactory	5

In some cases, separate grades were given for both right and left turns to provide a more accurate indication of the pilot's ability to perform a given maneuver. The numerically higher grade was used in determining the pilot's overall test score.

If a participant received a proficiency grade of (4) or (5), "Instruction Needed" was marked in the appropriate space. A grade of (4) in any area on the checklist indicates a level of proficiency that is minimal for performance and only marginal for certification. A grade of (5) in any area automatically fails the subject. The Instructor worked with subjects both in the air and on the ground.

The Instructor used the next four columns to record the grades during instrument training. During each session, the Instructor worked the student as long as he felt necessary to strengthen the areas of weakness indicated on the checklist. During flight instruction, he logged the time for each segment of instruction. At the end of each session the time spent on the maneuvers in each area was totaled, with a grand total entered after the final check ride.

After the completion of instruction a final check ride was given during which the Examiner again graded the participant's performance on the 5 point grading scale. In order to insure uniformity, all initial and final check rides were given by the Chief Pilot (Examiner). All instruction was handled by the same flight instructor.

The Instrument Flight Checklist was the primary source for determining when the private or commercial pilot begins to lose his instrument proficiency. Furthermore, areas of major proficiency

COMMERCIAL PHASE — INSTRUMENT FLIGHT CHECK — NAME _____

	GRADE CHECK FLIGHT	INSTRUCTION NEEDED	TIME 1ST FLIGHT	TIME 2ND FLIGHT	TIME 3RD FLIGHT	TIME 4TH FLIGHT	FINAL CHECK FLIGHT
1. STRAIGHT & LEVEL FLIGHT							
Altitude Control (100')							
Directional Control (10°)							
Airspeed Control (10k)							
Cross Check							
Coordination							
Trim Control							
Power Control							
2. POWER DESCENT							
Power Control							
Pitch Control							
Bank Control							
90° Turn to Heading (10°)							
Directional Control (10°)							
Timing							
Trim Control							
Cross Check							
Coordination							
3. CLIMB							
Power Control							
Pitch Control							
Bank Control							
180° Turn to Heading(10°)							
Constant Heading (10°)							
Speed Control							
Trim Control							
Cross Check							
Coordination							

Figure 1

Figure 1 (continued)

	GRADE CHECK FLIGHT	INSTRUCTION NEEDED	TIME 1ST FLIGHT	TIME 2ND FLIGHT	TIME 3RD FLIGHT	TIME 4TH FLIGHT	FINAL CHECK FLIGHT
4. STANDARD RATE TURNS (180° - 360°)							
Altitude Control (150')							
Power Control							
Pitch Control							
180° Roll Out (10°)							
360° Roll Out (20°)							
Cross Check							
Coordination							
Trim Control							
5. SPIRAL RECOVERY							
Attitude Recognition							
Power Control							
Bank Control							
Pitch Control							
Speed Control During Recovery							
6. APPROACH TO TURNING STALL							
Attitude Recognition							
Power Control							
Pitch Control							
Bank Control							
Speed Control During Recovery							

Figure 1

PRIVATE PHASE

INSTRUMENT FLIGHT CHECK

NAME _____

	GRADE CHECK FLIGHT	INSTRUCTION NEEDED	TIME 1ST FLIGHT	TIME 2ND FLIGHT	TIME 3RD FLIGHT	TIME 4TH FLIGHT	FINAL CHECK FLIGHT
1. STRAIGHT & LEVEL FLIGHT							
Altitude Control							
Directional Control							
Power Control							
Cross Check							
Coordination							
Trim Control							
2. LEVEL TURNS, LEFT & RIGHT							
Altitude Control							
Bank Control							
Power Control							
Recovery on Heading							
Airspeed Control							
Cross Check							
Coordination							
Trim Control							
3. DESCENDING TURNS TO PRE-DETERMINED ALTITUDE							
Power Control							
Airspeed Control							
Pitch Control							
Bank Control							
Recovery to Cruise							
Cross Check							
Coordination							
Trim Control							

Figure 2

Figure 2 (continued)

	GRADE CHECK FLIGHT	INSTRUCTION NEEDED	TIME 1ST FLIGHT	TIME 2ND FLIGHT	TIME 3RD FLIGHT	TIME 4TH FLIGHT	FINAL CHECK FLIGHT
4. CLIMBING TURNS TO PRE-DETERMINED ALTITUDE							
Power Control							
Pitch Control							
Bank Control							
Airspeed Control							
Level Off to Cruise							
Cross Check							
Coordination							
Trim Control							
STALL & SPIRAL RECOVERY							
Attitude Recognition							
Power Control							
Pitch Control							
Bank Control							
Coordination							
Recovery							
Cross Check							
Trim Control							

Figure 2

deterioration were readily apparent.

Briefly, the check rides, both initial and final, were conducted as follows. The participant went through the normal pre-flight under the observation of the Examiner. When the participant cleared the traffic pattern, the Examiner directed him to the practice area and observed him carefully as he flew under VFR conditions. This permitted the pilot to become familiar with the aircraft. Upon reaching the practice area, the participant put on the instrument hood and flew as instructed. Most of the flying was done at an altitude of 3,000 feet. Stalls and spiral recoveries were conducted at an altitude of 7,000 feet. For standardization, maneuvers were performed in the order listed on the checklist. During the flight test, the subject was in control of the aircraft most of the time. Periodically the Examiner took control to create an unusual attitude such as a spiral or an approach to a stall and then returned the controls to the participant (under the hood) and let him recover.

Afterwards the participant was asked for his impressions of the program. The check rides averaged from 30-40 minutes in length. Where necessary, the participant was re-scheduled as soon as possible for additional instruction.

The Instructor worked the participants at a pace which he felt the pilots were capable of handing. Some pilots improved more readily than others; therefore, instruction for each pilot was varied to meet individual needs. There was no fixed pattern to the amount or degree of instruction. Each instruction period increased the pilot's ability to perform the maneuvers. In practicing unusual attitudes, the Instructor created situations such as spirals or stalls, then let the participant correct. The Instructor increased the difficulty of the stall or spiral as the pilot became more familiar with correcting procedures. If the participant could not handle the maneuver the Instructor showed him how to regain straight and level flight. The average length of the instruction ride was 52 minutes. Afterwards, the participant was re-scheduled for additional instruction or for his final check ride. Following instruction, a question-answer period was conducted on the day's lesson.

An important part of the pilot's proficiency upgrading was the time devoted to classroom instruction on basic instruments. It was apparent that the pilot's ability to handle the aircraft in flight depended not only on skill but also on his individual knowledge of how the instruments operate and what they indicate.

In the classroom the Instructor explained how such instruments as altimeters, directional gyros, airspeed indicators,

vertical climb indicators, turn and bank indicators and artificial horizons operate and what they indicate. Using models he could create typical situations encountered in flight and have the student verbally explain proper procedures to correct the given situation.

After their final check ride, the participants were given their initial and final scores. Letters of appreciation (Appendix A-5) were sent to all participants who completed the program, thanking them for their cooperation.

A majority of the participants expressed a feeling that after completing this program they would have more confidence if inadvertently exposed to IFR conditions than they might have had previously.

4. EVALUATION RESULTS AND DISCUSSION

The results of the proficiency evaluation are presented in two parts. Section 4.1. presents the results of the commercial pilot evaluation while Section 4.2. presents the data for the private pilot participants.

In interpreting the scores of the various pilots, it is helpful to relate their score to some base or norm. Recall that the grading scale was from 1 to 5, going from excellent to unsatisfactory, with the "average" pilot (as judged by the examining instructor) scoring 3 on each area. Since there were thirty-eight (38) and forty-three (43) areas of evaluation for the private and commercial pilots respectively, the "average" private pilot would score one hundred fourteen (114) points and the "average" commercial pilot would score one hundred twenty-nine (129) points. This "average" pilot score was used as one base score. A second useful base score is the arithmetic mean of all scores achieved by the pilots in each category, i.e., private or commercial certification.

Table III presents the tabulated data obtained from this study. The pilot identification numbers are the same as those used in Table I. It should be noted that those pilots who did not receive a final check ride did so on their own due to personal reasons.

4.1. Commercial Pilot Results - Figure 3 presents the distribution of the initial check ride scores P(1) with elapsed time since license (ETSL). Of the thirty-three commercial pilots twenty, or 61%, achieved scores equal to or better (i.e., numerically less) than the "average" pilot score of 129. Fifteen pilots, or 45%, scored equal to or better than the arithmetic mean score of 121.3. A natural breaking point, for the selection

TABLE IIIa EVALUATION RESULTS

COMMERCIAL PILOTS

PILOT NO.	INITIAL SCORE	GROUND INSTRUCTION TIME	FLIGHT INSTRUCTION TIME	FINAL SCORE
1	97.	10.	58.	93.
2	124.	15.	48.	106.
3	104.	15.	29.	86.
4	88.	0.	0.	NO FINAL CHECKRIDE
5	144.	30.	148.	101.
6	130.	15.	96.	102.
7	134.	90.	164.	102.
8	88.	0.	0.	NO FINAL CHECKRIDE
9	122.	20.	101.	105.
10	135.	45.	171.	104.
11	141.	30.	110.	102.
12	109.	10.	44.	95.
13	116.	10.	47.	90.
14	98.	15.	0.	97.
15	133.	30.	101.	93.
16	89.	0.	0.	NO FINAL CHECKRIDE
17	113.	10.	49.	89.
18	106.	30.	35.	95.
19	123.	15.	68.	94.
20	103.	0.	24.	95.
21	136.	90.	175.	97.
22	124.	10.	40.	94.
23	154.	60.	213.	105.
24	177.	90.	225.	115.
25	103.	30.	31.	95.
26	156.	60.	256.	116.
27	115.	10.	60.	101.
28	118.	10.	62.	97.
29	127.	10.	56.	100.
30	143.	60.	154.	106.
31	89.	0.	14.	86.
32	130.	20.	50.	98.
33	133.	20.	120.	106.

TABLE IIIb EVALUATION RESULTS

PRIVATE PILOTS

PILOT NO.	INITIAL SCORE	GROUND INSTRUCTION TIME	FLIGHT INSTRUCTION TIME	FINAL SCORE
1	139.	40.	113.	92.
2	114.	20.	54.	106.
3	116.	60.	112.	97.
4	121.	30.	100.	91.
5	125.	90.	223.	104.
6	128.	60.	207.	101.
7	126.	60.	150.	93.
8	111.	20.	57.	90.
9	123.	60.	134.	109.
10	117.	25.	111.	86.
11	129.	90.	237.	97.
12	119.	30.	195.	84.
13	129.	60.	191.	90.
14	127.	0.	204.	88.
15	136.	120.	215.	110.
16	137.	60.	219.	100.
17	129.	25.	105.	96.
18	119.	40.	95.	80.
19	120.	90.	132.	79.
20	132.	90.	235.	87.
21	110.	0.	70.	99.
22	104.	60.	85.	84.
23	128.	45.	121.	95.
24	114.	15.	81.	90.
25	97.	0.	0.	NO FINAL CHECKRIDE
26	92.	0.	0.	NO FINAL CHECKRIDE
27	131.	45.	172.	88.
28	116.	20.	127.	91.
29	104.	0.	0.	NO FINAL CHECKRIDE
30	119.	0.	0.	NO FINAL CHECKRIDE
31	131.	90.	226.	93.
32	97.	20.	43.	95.
33	151.	90.	279.	109.
34	153.	90.	216.	104.
35	131.	60.	215.	94.
36	111.	20.	53.	92.
37	128.	30.	161.	100.

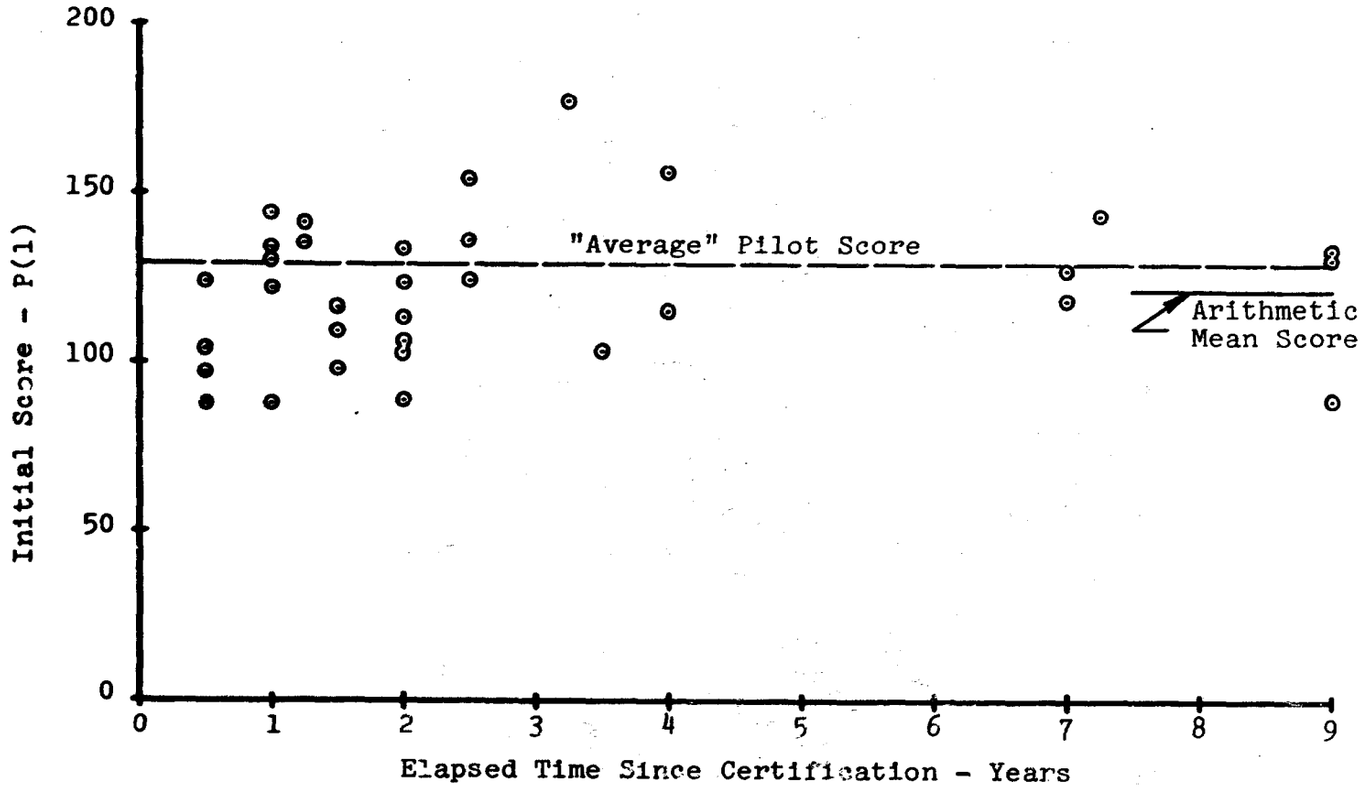

Figure 3 - VARIATION OF INITIAL EVALUATION SCORE WITH TIME SINCE CERTIFICATION - COMMERCIAL PILOTS

of pilots occurred at four years E.T.S.L.. 63% of those pilots having four or less years E.T.S.L. scored better than "average", while only 50% of them with seven years or more ETSL scored better than "average". Relative to the arithmetic mean, 48% having 4 years or less E.T.S.L. scored at or better, while only 33% having 7 years or more E.T.S.L. scored at or better. The actual number of pilots in each category is given in Table IV.

The variation of initial score, P(1), with total flight time (T.T.) in hours is shown on Figure 4. Of those pilots having 550 hours or less T.T., approximately 71% scored at or better than the "average", while 58% scored at or better than the arithmetic mean. The comparative scores for those pilots having over 550 hours T.T. are 33% and 11% respectively.

The influence of total instrument time, T.I.T., on the initial score is illustrated by Figure 5. Figure 6 presents the influence of total instrument time since receipt of license (T.I.T.S.L.) on initial score. It is of interest to note that, although the pilots involved had licenses spanning upwards to nine years since issuance less than 58%, had more than 0.5 hours of instrument time logged since they received their certification. Of those pilots having more than 20 hours T.I.T., 69% scored at or better than the mean, while 77% scored at or better than the "average" pilot. Of the 16 pilots having 60 hours T.I.T. or less, but having more than 1.3 hours T.I.T.S.L., 10, or over 62%, scored better than both the mean and the "average". Of the 11 pilots in this T.I.T. category with less than 0.3 hours T.I.T.S.L. only 5, or 45%, scored better than the mean, while 7, or 64%, scored at or better than the "average" pilot.

From the approximate data envelope given on Figure 6, it is seen that the more I.I.T.S.L. a pilot has, the more proficient he will be, a logical and anticipated conclusion.

Figure 7 illustrates the variation of the initial score with the average number of instrument hours since license per year since license (T.I.T.S.L./E.T.S.L.). Only 10 pilots, or 30% of the sample, had flown more than 1.5 hours per year on the average. Of these ten, seven or 70% were better than the arithmetic mean and all had scores of 134 (3.9% worse than the "average" pilot) or less. Of the twenty-three pilots with 1.5 hours per year or less, only one-third were better than the mean and one-half were "average" or better.

A similar plot is given as Figure 8, where the independent variable is now T.I.T./E.T.S.L.. The anticipated result is illustrated, i.e., the more hours per year instrument experience a pilot has, the better instrument pilot he will be.

The previous discussion has been concerned solely with the results of the initial check ride.

TABLE IV - STATISTICAL DATA

Case	Break Point	A No. at or better/ No. to break	A%	B No. at or better/ No. above break	B%
CA	Overall	20/33	60.6	---	---
CM		15/33	45.4	---	---
CA	4 Yrs. ETSL	17/27	63.0	3/6	50.0
CM		13/27	48.1	2/6	33.3
CA	550 Hrs TT	17/24	70.8	3/9	33.3
CM		14/24	58.3	1/9	11.1
CA	60 Hrs TIT	19/30	63.3	1/3	33.3
CM		15/30	50.0	0/3	0
CA	6+ Hrs TITSL	16/28	57.1	4/5	80.0
CM		11/28	39.3	4/5	80.0
PA	Overall	10/37	27.0	---	---
PM		18/37	48.6	---	---
PA	4 Yrs. ETSL	4/23	17.4	6/14	42.9
PM		10/23	43.5	8/14	57.1
PA	199 Hrs TT	6/24	25.0	4/13	30.8
PM		11/24	45.8	7/13	53.8
PA	9.5 Hrs TIT	6/28	21.4	4/9	44.4
PM		14/28	50.0	4/9	44.4
PA	6 Hrs TITSL	8/28	28.6	2/9	22.2
PM		14/28	50.0	4/9	44.4

CA = Commercial "average" pilot (129.)
CM = Commercial pilot mean score (121.3)

PA = Private "average" pilot (114.)
PM = Private pilot mean score (122.)

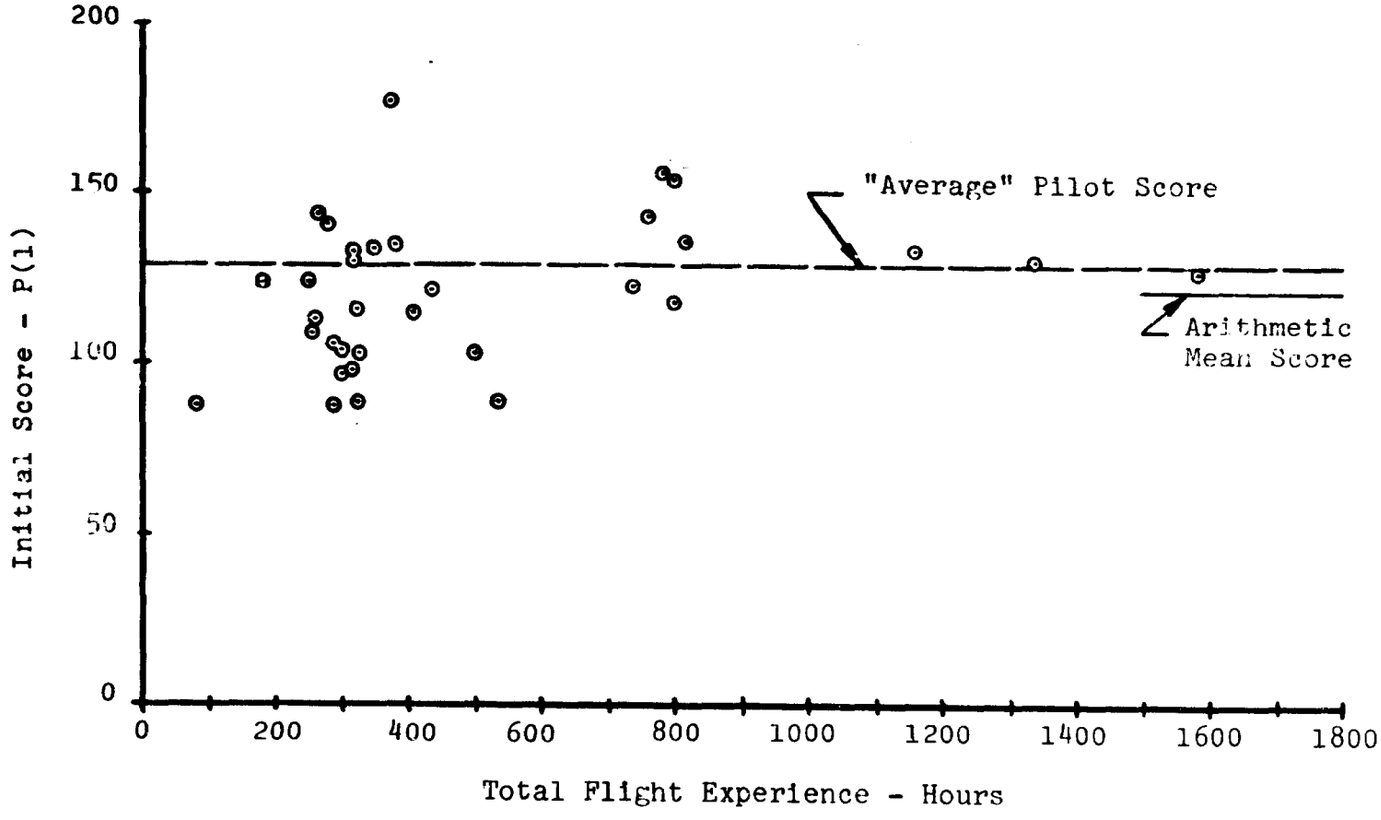

Figure 4 - INITIAL EVALUATION SCORE VARIATION WITH TOTAL FLIGHT EXPERIENCE - COMMERCIAL PILOTS

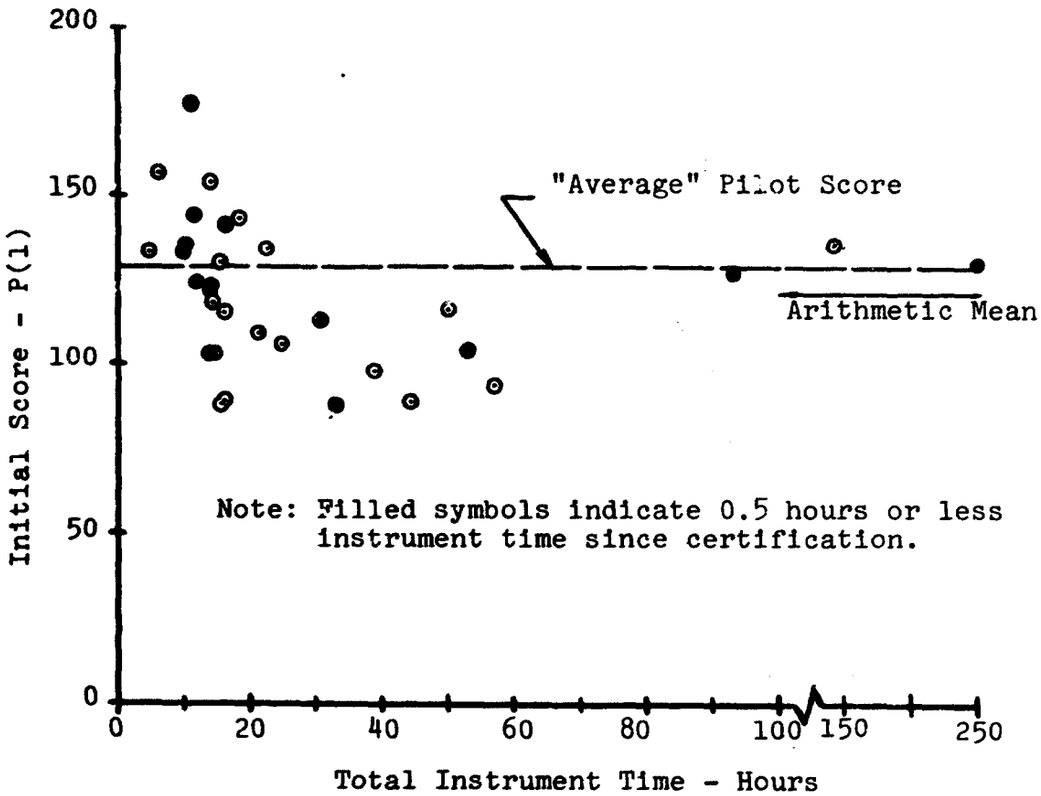

Figure 5 - VARIATION OF INITIAL EVALUATION SCORE WITH TOTAL INSTRUMENT TIME - COMMERCIAL PILOTS

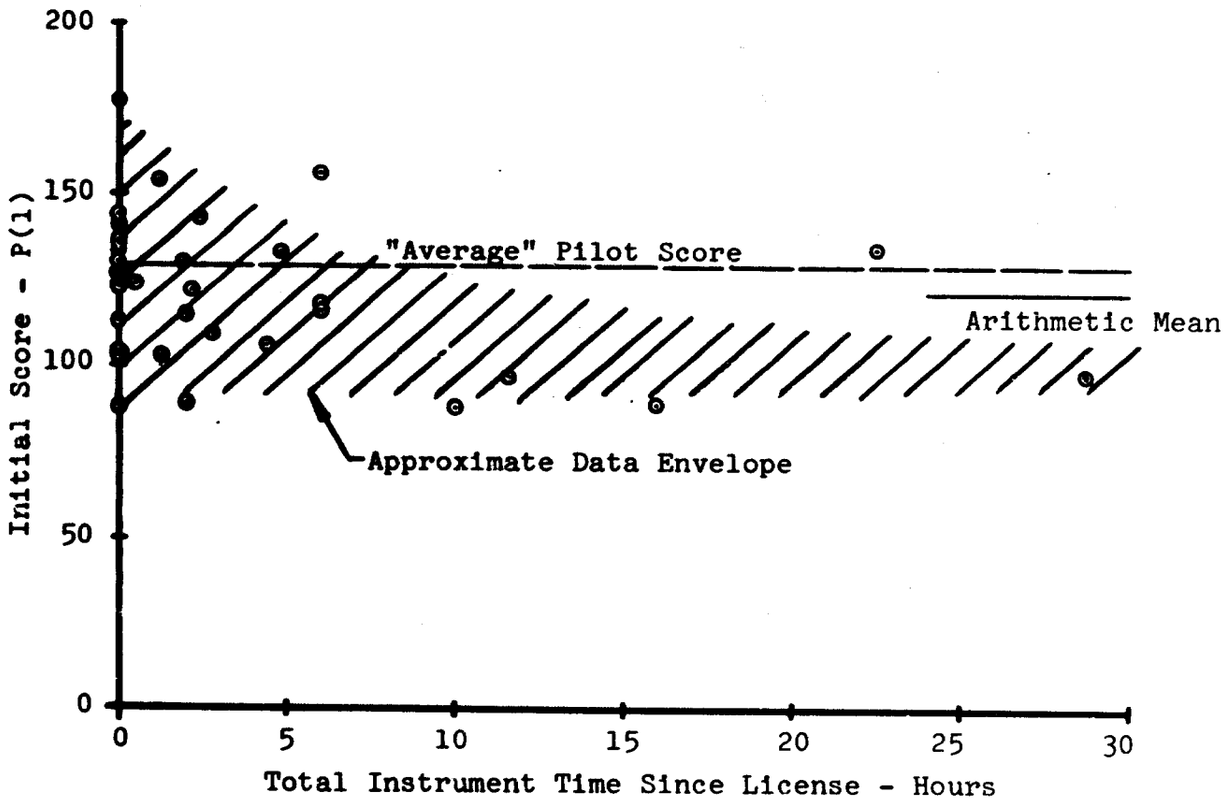

Figure 6 - INITIAL SCORE VERSUS TOTAL INSTRUMENT TIME SINCE LICENSE - COMMERCIAL PILOTS

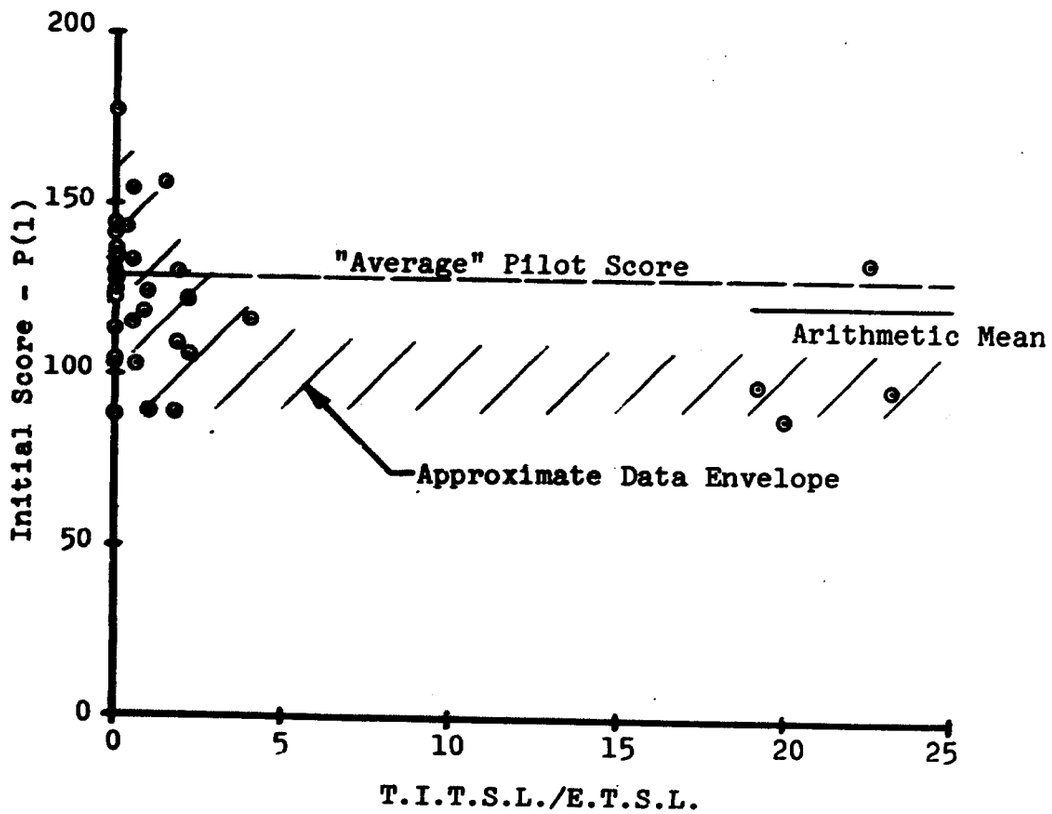

Figure 7 - INITIAL SCORE VARIATION WITH AVERAGE NUMBER OF INSTRUMENT HOURS PER YEAR SINCE LICENSE - COMMERCIAL PILOTS

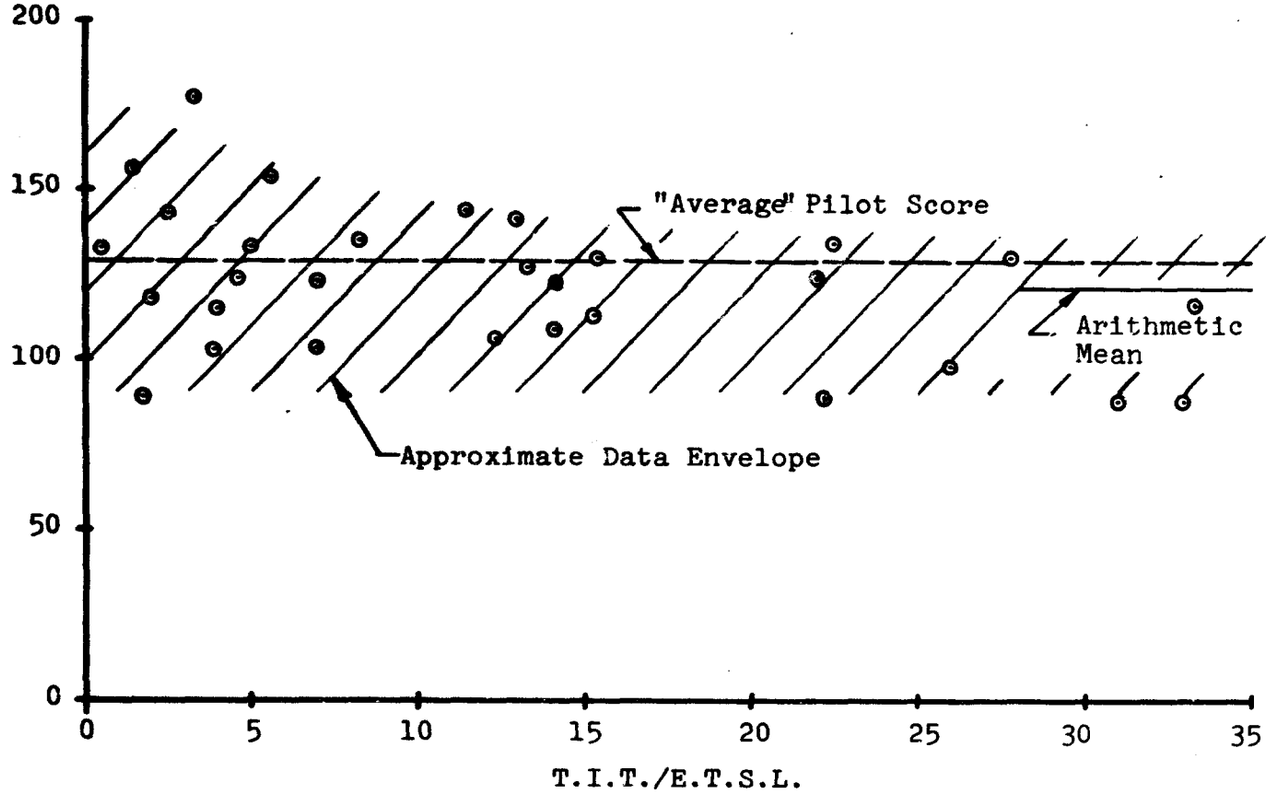

Figure 8 - INITIAL SCORE AS A FUNCTION OF THE RATIO OF TOTAL INSTRUMENT TIME AND THE NUMBER OF YEARS SINCE CERTIFICATION - COMMERCIAL PILOTS

Figure 9 represents a correlation between the initial and final check ride scores with the instruction time given to the pilot to improve his proficiency. The numerical data for this plot were obtained from Table III. A second degree least-squares polynomial fit of these data is also given on Figure 9. One way of using this plot is as follows: 1) Grade a pilot on an initial check ride to obtain P(1); 2) take the difference between this score and the "average" pilot score to obtain the independent variable for the abscissa of Figure 9; 3) for that value of the independent variable determine, from the curve fit, that statistical value of the dependent variable - the required instruction time - which the pilot would need to attain the skill of the "average" pilot.

It would be more appropriate, however, if one could obtain, on a statistical basis, the initial score, P(1), for a given pilot, solely from information readily obtainable from his log book. This information was obtained from the questionnaires supplied by the pilots and tabulated in Table I. Although the sample is biased, as the sample is restricted to include approximately three pilots in each time slot, it is believed that a multiple regression analysis can be performed with a minimal risk of obtaining erroneous results. A multiple regression analysis was conducted with these independent data and (1) is that regression equation which yields a maximum index of determination and minimum standard error of estimate.

$$P(1)\ \text{(calculated)} = 114. + 5.108\,X(1) + 0.045\,X(2) - 0.697\,X(3) - 0.285\,X(4) + 0.0026\,X(5) - 0.943\,X(6) \qquad (1)$$

where:

X(1) = elapsed time since license (E.T.S.L.)
X(2) = total flight time (T.T.)
X(3) = total instrument time (T.I.T.)
X(4) = total instrument time since license (T.I.T.S.L.)
X(5) = X(3)·X(3)
X(6) = X(1)·X(1)

Figure 10 presents the result of this multiple regression analysis, plotted as P(1) (actual) versus P(1) (predicted). Also included on this figure are regions representing scores better than the arithmetic mean (crosshatched) and scores better than the "average" pilot (gray). Examination of this figure shows that (1) predicts scores higher than "average" for four pilots who actually scored better, while it predicts scores better than "average" for seven pilots who tested lower than the "average" pilot. Recall Figure 7, which illustrated actual score versus the average number of instrument hours flown per year since re-

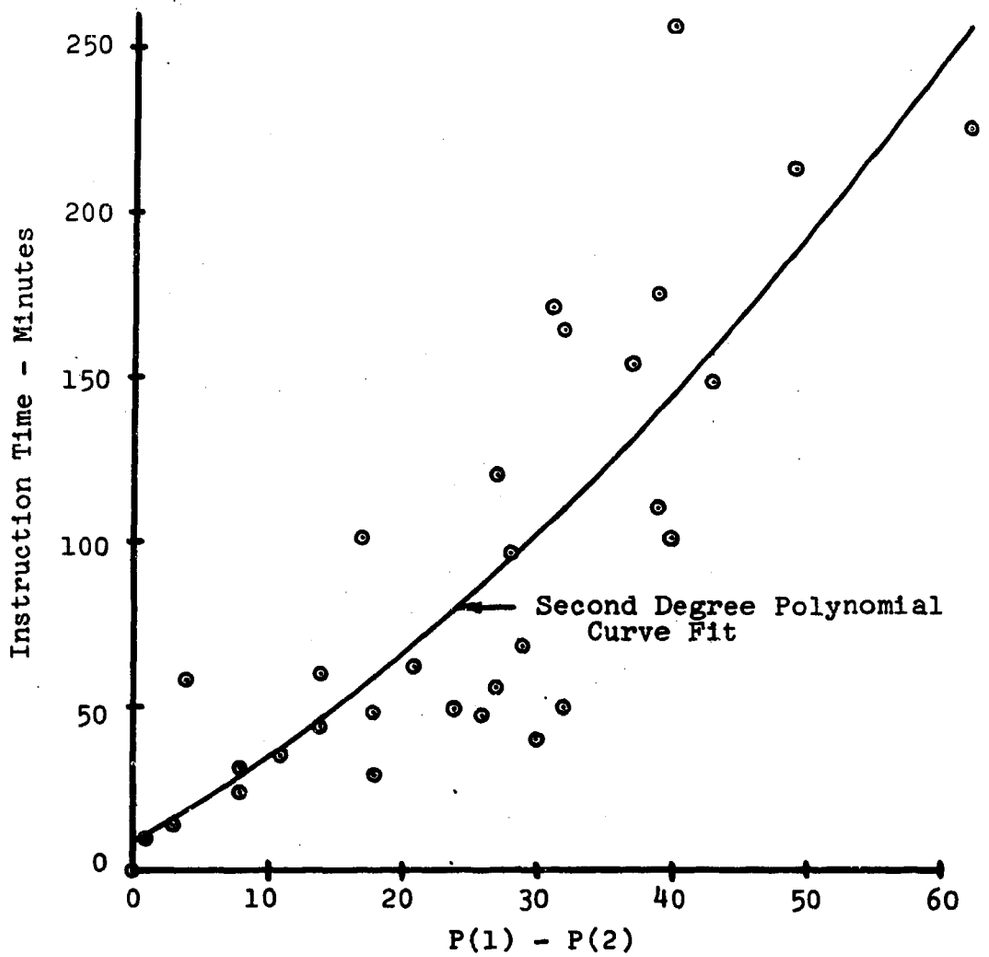

Figure 9 - REQUIRED INSTRUCTION TIME VERSUS SCORE DEFICIENCY - COMMERCIAL PILOTS

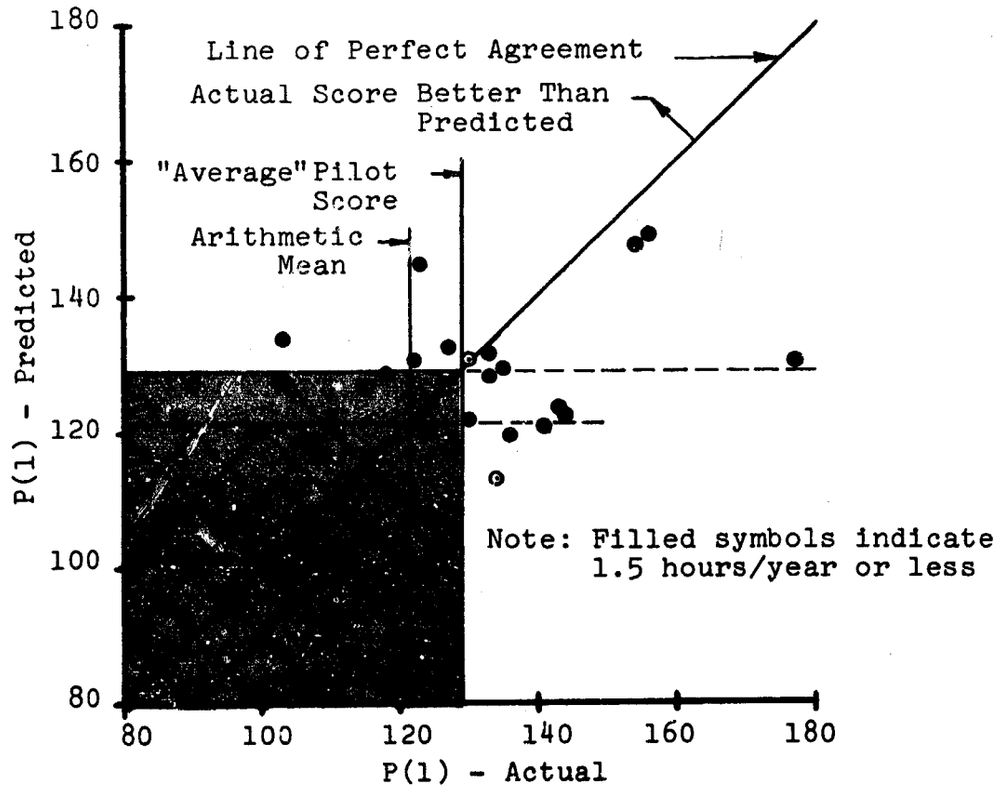

Figure 10 - CORRELATION BETWEEN ACTUAL AND PREDICTED INITIAL SCORES - COMMERCIAL PILOTS

ceipt of license. One conclusion which may be drawn from this figure is that, on a statistical basis, the "average" pilot will have at least 1.5 hours per year. If one imposes this restriction, which can be taken directly from the pilot's log book, together with the predicted score from (1) in order to determine those pilots requiring additional proficiency instruction, it can be seen that all but one pilot who actually tested poorer than the "average" pilot will be so indicated, and only four pilots who actually tested better than "average" would be required to take a check ride. Of those four, only one pilot was significantly better than "average" (26 points), while the other pilots were within seven points (5.4%) of the "average" pilot.

The conclusion of this analysis, based on the data sample used, is that by using two criteria, 1) that the commercial pilot shall log at least 1.5 hours of instrument time per year after receipt of certification, and 2) that the predicted proficiency score shall be equal to or less than the "average" pilot score of 129, all but one of the pilots whose demonstrated proficiency was poorer than the "average" pilot are so indicated and they would be required to take a proficiency check ride. Using the result of this check ride, together with the curve fit of Figure 9, an estimate can be made of the instruction time required to return the pilot to a proficiency level equal to that of an "average" pilot.

One would like to determine, from the initial flight check data, those areas in which the commercial pilots tested worse than the "average" pilot. The arithmetic means and standard deviations for each of the forty-three areas of evaluation are presented in Table V. As the assumption is that the "average" pilot would receive a grade of 3 in any area, it is of interest to determine which areas have a mean score above 3. From Table V we see that the mean for questions 14, 23, 24, 35, 38 and 40 exceed 3. Using a one-sided t-test (a statistical test used when the standard deviation of the population is not known); a null hypothesis of H_0: $\mu \leq 3$; alternate hypothesis H_1: $\mu > 3$; α (type I error) equal to 0.05, the following table can be obtained:

TABLE V -

STATISTICAL DATA FROM INITIAL FLIGHT CHECK RIDE - COMMERCIAL PILOTS

		Arith. mean-μ	Std.Dev.-s
	STRAIGHT & LEVEL FLIGHT		
1.	Altitude Control (100')	2.484	.667
2.	Directional Control(10°)	2.636	.699
3.	Airspeed Control (10k)	2.666	.540
4.	Cross Check	2.878	.545
5.	Coordination	2.878	.415
6.	Trim Control	2.484	.507
7.	Power Control	2.757	.435
	POWER DESCENT		
8.	Power Control	2.757	.867
9.	Pitch Control	2.909	.842
10.	Bank Control	2.969	.809
11.	90° Turn to Heading(10°)	2.606	.788
12.	Directional Control(10°)	2.818	.726
13.	Timing	2.484	.795
14.	Trim Control	3.515	.795
15.	Cross Check	2.909	.722
16.	Coordination	2.666	.540
	CLIMB		
17.	Power Control	2.939	.933
18.	Pitch Control	2.757	.708
19.	Bank Control	2.909	.804
20.	180° Turn to Heading(10°)	2.727	.839
21.	Constant Heading (10°)	2.818	.846
22.	Speed Control	2.818	.635
23.	Trim Control	3.515	.712
24.	Cross Check	3.030	.769
25.	Coordination	2.787	.599
	STANDARD RATE TURNS (180° - 360°)		
26.	Altitude Control (150')	2.696	.847
27.	Power Control	2.727	.516
28.	Pitch Control	2.696	.809
29.	180° Roll Out (10°)	2.636	.895
30.	360° Roll Out (20°)	2.454	.564
31.	Cross Check	2.848	.712
32.	Coordination	2.727	.626
33.	Trim Control	2.848	.441
	SPIRAL RECOVERY		
34.	Attitude Recognition	2.636	.603
35.	Power Control	3.090	1.011
36.	Bank Control	2.909	.913
37.	Pitch Control	2.939	.704
38.	Speed Control During Recovery	3.212	.857
	APPROACH TO TURNING STALL		
39.	Attitude Recognition	2.727	.516
40.	Power Control	3.181	.917
41.	Pitch Control	2.696	.529
42.	Bank Control	2.757	.501
43.	Speed Control During Recovery	2.757	.501

TABLE VI - t-TEST, COMMERCIAL PILOTS

Question	Arithmetic Mean-μ	Critical Value-X_c	Accept H_0
14	3.515	3.234	No
23	3.515	3.210	No
24	3.030	3.227	Yes
35	3.090	3.298	Yes
38	3.212	3.253	Yes
40	3.181	3.270	Yes

Because the subpopulation corresponding to each time slot is normal, the population formed by combining all subpopulations will be normal. Therefore, the t-test should give valid results.

$$X = 3 + 1.693 \frac{s}{\sqrt{33}}$$

where s is the sample standard deviation, the constant 1.693 is the confidence coefficient, which depends on the level of confidence desired and the sample size, and the constant 33 is the sample of size N, the number of commercial pilots.

If the arithmetic mean is greater than the critical value we have a 95% probability ($\alpha = 0.05$) that we are sampling from a population whose population mean is greater than 3.0. From Table VI one can conclude that areas 14 and 23 are indeed areas in which, statistically, the commercial pilot performed at levels inferior to that of the "average" pilot. These areas are:

Power descent - trim control

and Climb - trim control.

It is apparent, therefore, that commercial pilot skill deteriorates more rapidly in the area of trim control than in the other skill areas, and it is an area in which further instruction and/or periodic skill evaluation must be made.

4.2 Private Pilot Results - Data results for private pilots are presented in this section similar to those included in Section 4.1. for the commercial pilot group. Figure 11 presents the variation of the initial check ride evaluation with E.T.S.L. A reverse trend is noted in comparing the private pilot to the commercial pilot. For the commercial pilot the arithmetic mean score was lower than the "average" pilot score, indicating a higher overall proficiency. For the private pilot, however, the arithmetic mean score is higher (worse) than the "average" pilot score, implying that the "average" private pilot in this sample group is less proficient in his instrument skills than the Examiner's concept of the "average" pilot. Of the thirty-seven private pilots evaluated, ten, or 27% (Table IV), equaled or bettered the "average" pilot score of 114. Eighteen, or 49%, equaled or bettered the mean score of 122.

Again taking the breaking point for E.T.S.L. at four years, it is seen that only 17% of the pilots having fewer than 4 years had proficiencies equal to or better than "average", while for those with more than 4 years, almost 43% demonstrated proficiencies at least equivalent to the "average" pilot.

The distribution of total flight experience, T.T., and initial evaluation scores is shown on Figure 12. The private pilots evaluated had between 50 and 1800 hours total time; however, the majority had only between 90 and 210 hours (59.5%). Of these private pilots with fewer than 210 hours T.T., only 23% demonstrated proficiency at least equivalent to the "average" pilot, while for those having over 210 hours T.T., 36% were at least "average" pilots. If one considers the arithmetic mean score, 42% of those with fewer than 210 hours were at least average while for those having more than 210 hours, almost 64% were at least average.

Figure 13 illustrates the effect of total instrument time on initial score. Taking 9.5 T.I.T. as a breaking point, 21% of those pilots with less time were at least "average", while 44% of those with more than 9.5 hours were at least as proficient as the "average" pilot.

Initial score versus T.I.T.S.L. is illustrated on Figure 14. Due to the extreme data scatter on this figure, no conclusions or definite trends are indicated.

The variation of initial score with the average number of instrument hours per year since license is shown on Figure 15. Again, definite conclusions, which were reasonably apparent for the commercial pilot population, are not so evident for the private pilot. As anticipated, the more hours per year flown on the average, the better pilot one should be, and this is indicated on this figure. However, from the data envelope indicated on this figure, a leveling off of improvement is apparent beyond two or three hours per year and, from the available data, one

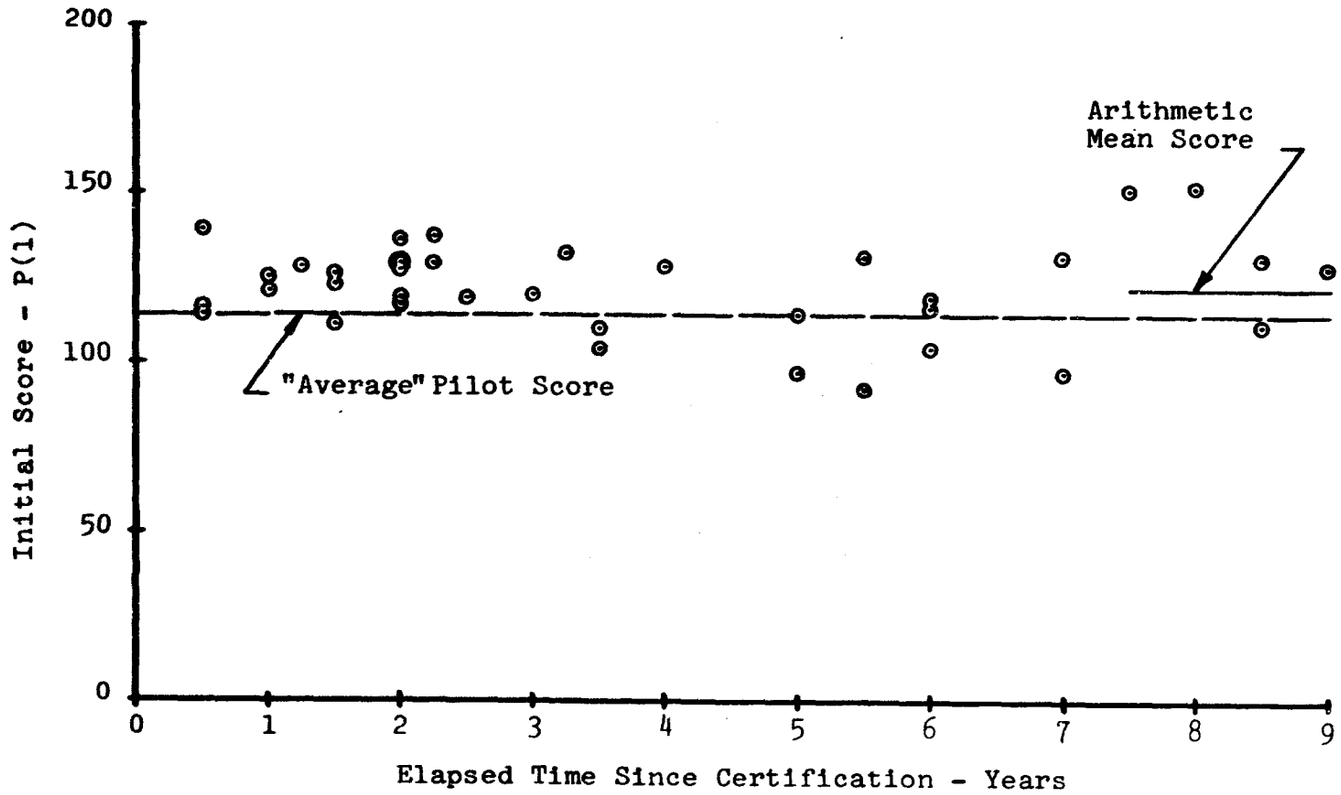

Figure 11 - VARIATION OF INITIAL EVALUATION SCORE WITH TIME SINCE CERTIFICATION - PRIVATE PILOTS

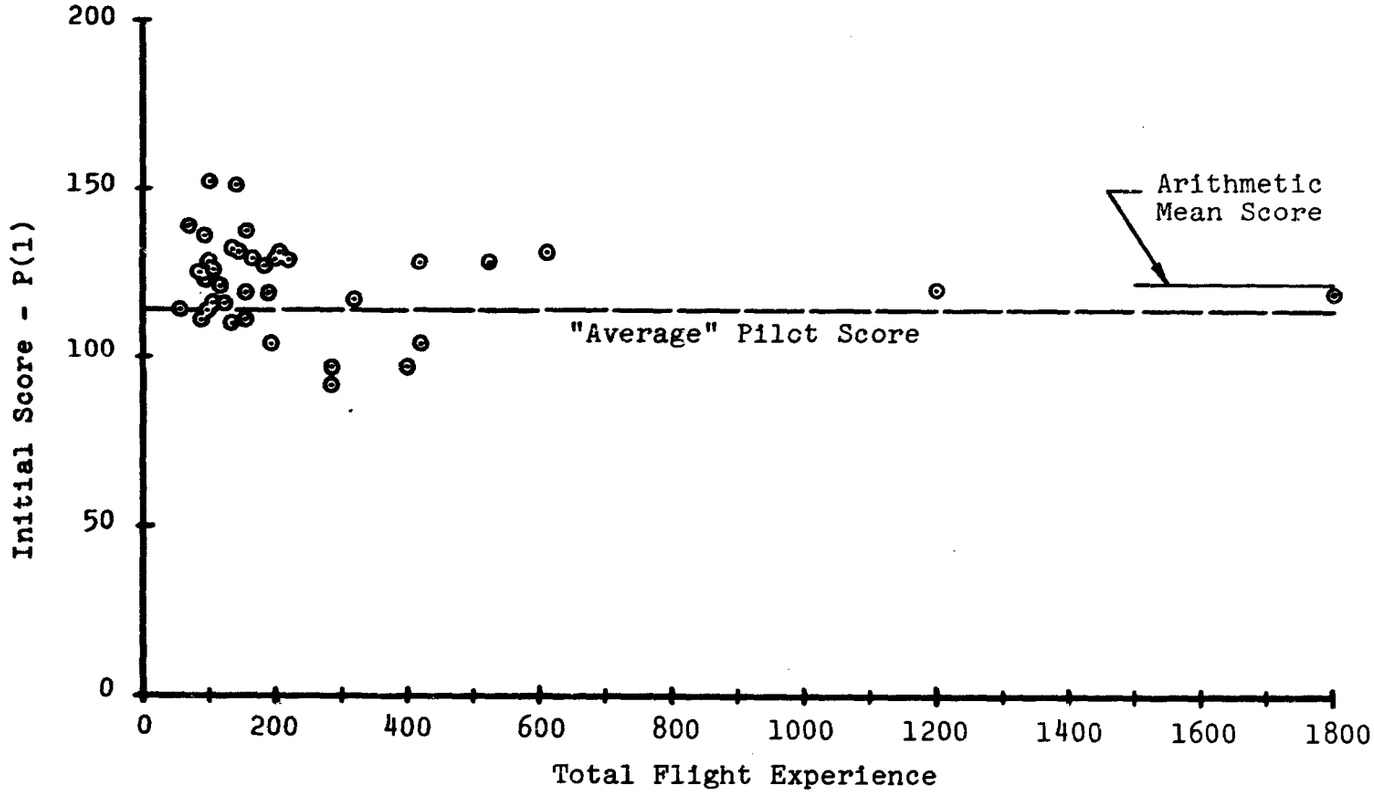

Figure 12 - INITIAL EVALUATION SCORE VARIATION WITH TOTAL FLIGHT EXPERIENCE - PRIVATE PILOTS

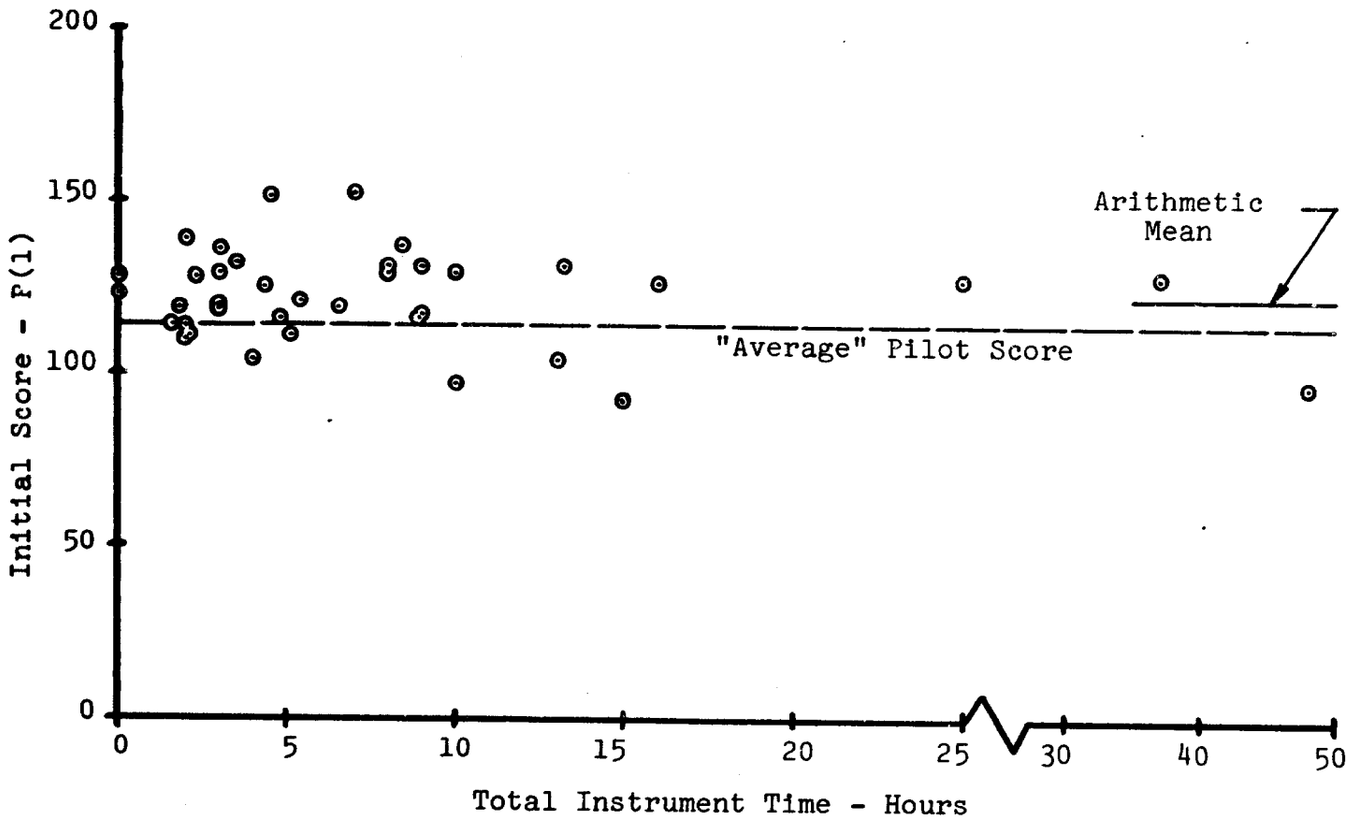

Figure 13 - VARIATION OF INITIAL EVALUATION SCORE WITH TOTAL INSTRUMENT TIME - PRIVATE PILOTS

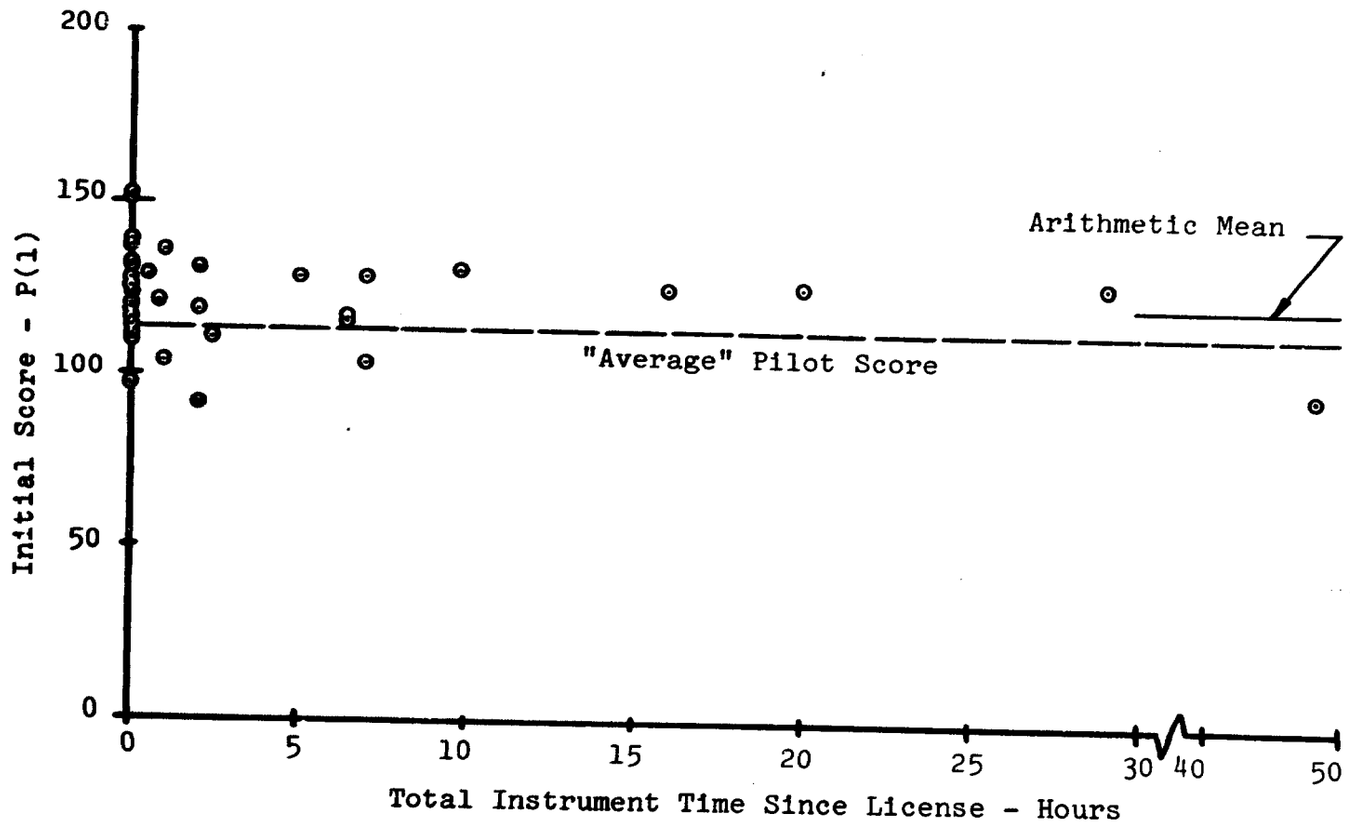

Figure 14 - INITIAL SCORE VERSUS TOTAL INSTRUMENT TIME SINCE LICENSE - PRIVATE PILOTS

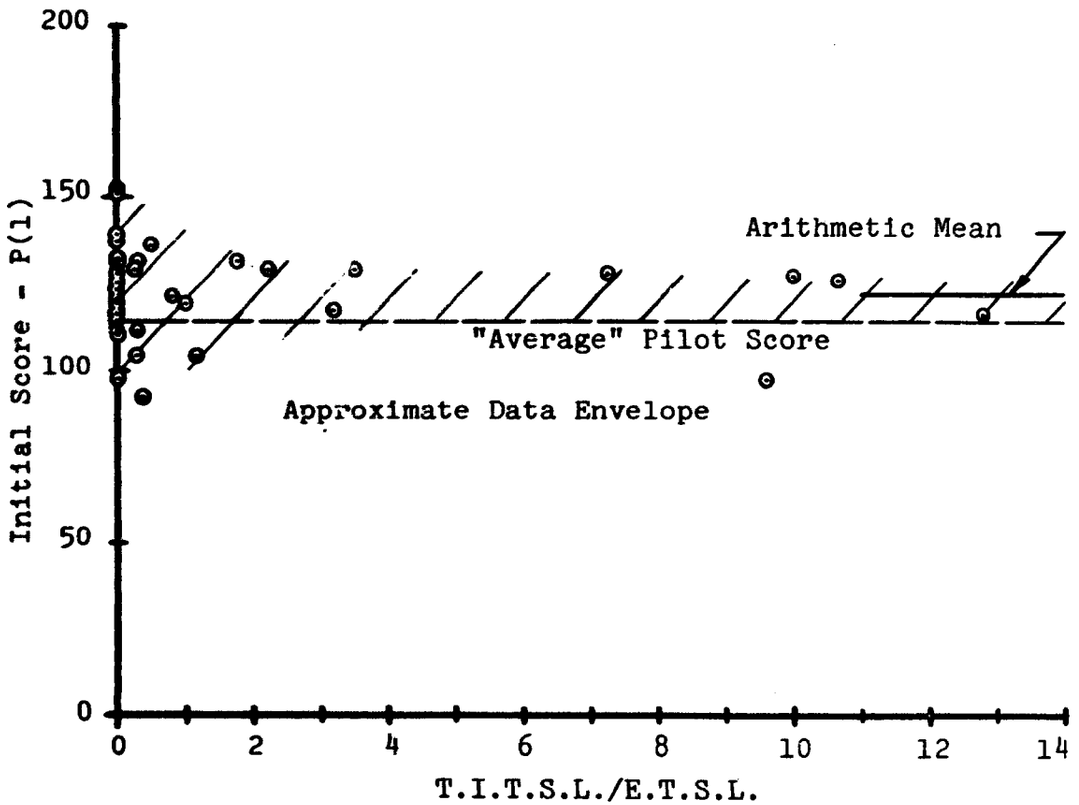

Figure 15 - INITIAL SCORE VARIATION WITH AVERAGE NUMBER OF INSTRUMENT HOURS PER YEAR SINCE LICENSE - PRIVATE PILOTS

could draw the conclusion that no matter how many hours per year one flies, some pilots may never have a skill level equivalent to the "average" pilot. If one conjectures as to possible reasons for this conclusion, he might make one of the following statements. Private pilots, flying solely for pleasure, obtain their training usually whenever financially convenient rather than when they feel the need for additional training, therefore often 1) putting additional training off; 2) seeking out non-professional flight instructors due to their reduced fees (over a full-time professional instructor); and/or 3) obtaining hood time in the presence of another private pilot, usually in a straight and level attitude. Another very possible reason for the apparent lack of proficiency is that some private pilots really never learn the fundamentals of instrument flying during their training. They often obtain their training in a very haphazard way, a few hours this year at this airport, a few hours with a friend here and there, a few more hours at another airport and finally, a check-ride with an FAA examiner; an examiner who walks away from the check ride with knowledge that the newly certified private pilot is just barely a qualified pilot. If this new pilot were graded on the system employed in this investigation, no doubt many fours would appear on his evaluation sheet, instead of the twos and threes he would have if he had obtained his training at a professional flight training school. It may well be that the haphazard flight training a private pilot often receives, at least in comparison with that the commercial pilot receives, may account for the "shotgun" appearance of many of the private pilot data curves, and the apparent conclusions drawn from these figures. Figure 16 may somewhat substantiate the above hypothesis. On this figure the initial check ride score is presented versus the number of total instrument hours flown divided by time since certification (T.I.T./E.T.S.L.). It appears that the proficiency may indeed continue to improve with increasing instrument hours per year. The difference between this figure and Figure 15 is that this figure reflects the training the pilot received prior to certification.

The difference between initial and final check ride scores is presented in Figure 17 versus the instruction time utilized in preparation for the final check ride evaluation. A second degree least-squares polynomial is fitted to the data to permit a statistical basis for using this plot for instruction time prediction purposes.

The results of the multiple regression analysis for the private pilot is shown on Figure 18. (2) is that regression equation which yielded the maximum index of determination and a minimum standard error of estimate.

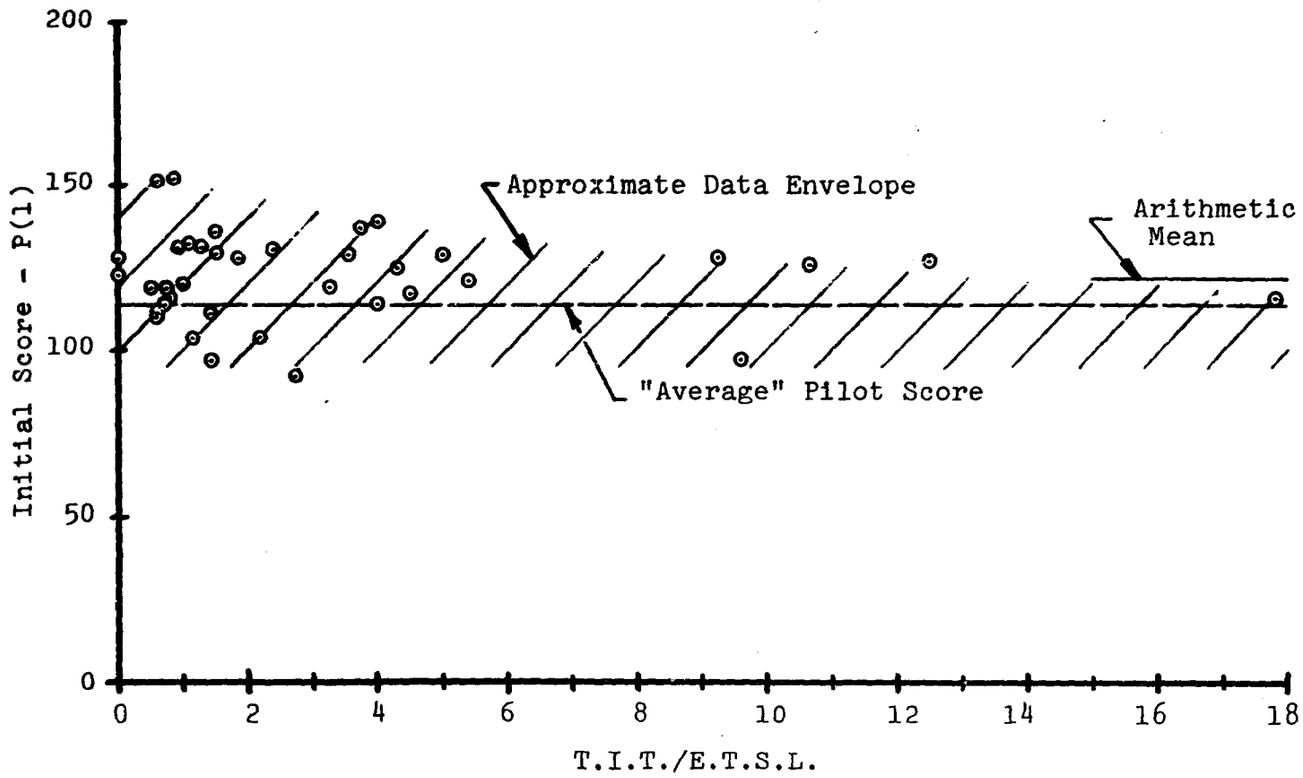

Figure 16 - INITIAL SCORE AS A FUNCTION OF THE RATIO OF TOTAL INSTRUMENT TIME AND THE NUMBER OF YEARS SINCE CERTIFICATION - PRIVATE PILOTS

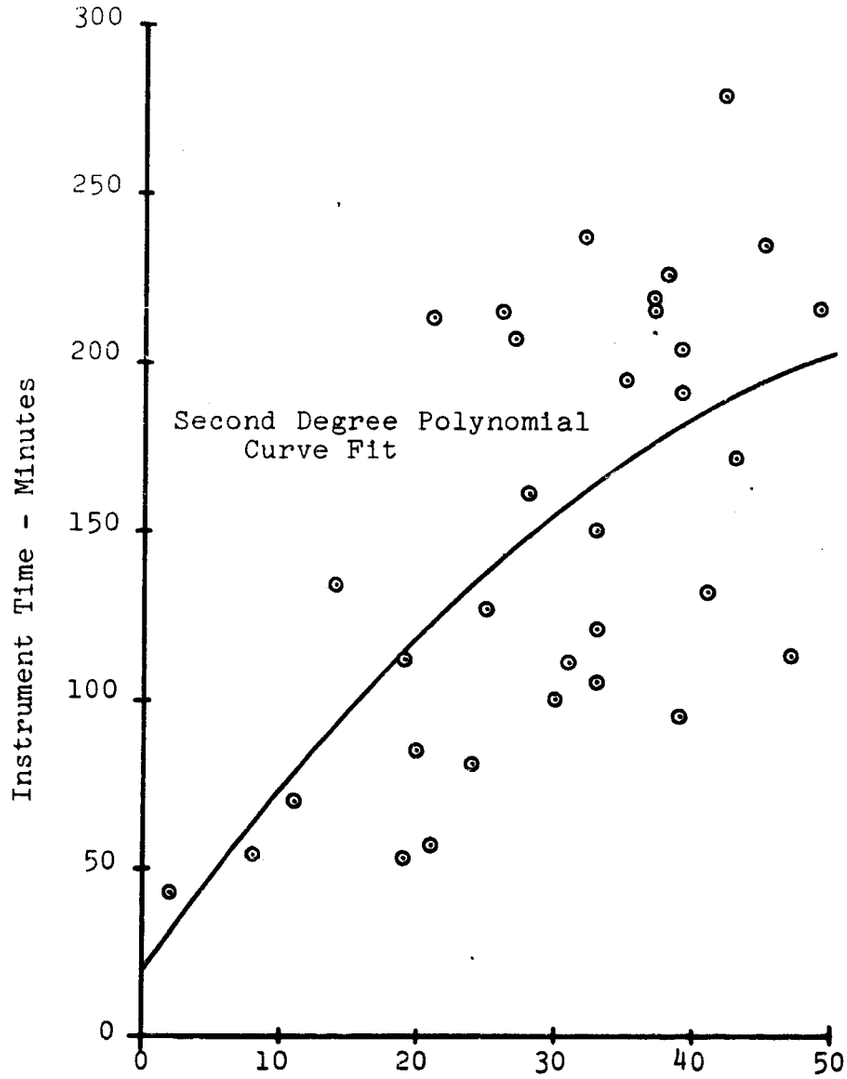

Figure 17 - REQUIRED INSTRUCTION TIME VERSUS SCORE DEFICIENCY - PRIVATE PILOTS

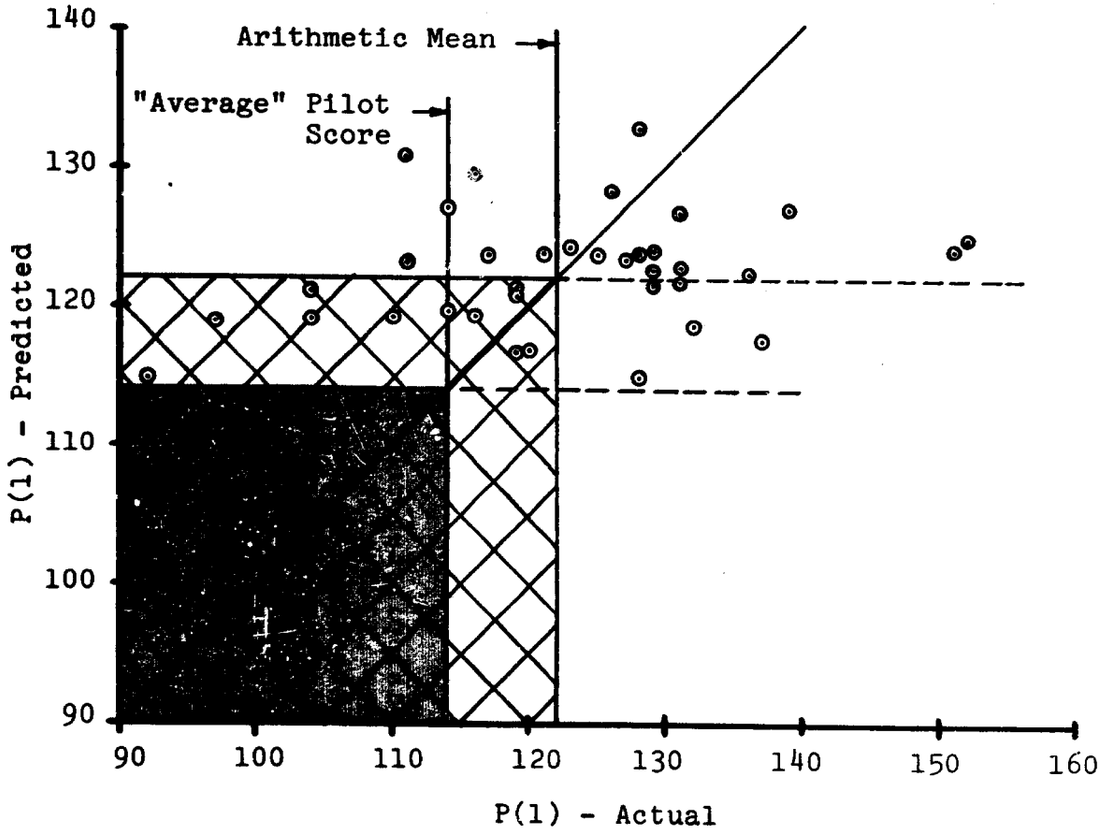

Figure 18 - CORRELATION BETWEEN ACTUAL AND PREDICTED INITIAL SCORES - PRIVATE PILOTS

$$P(1)(\text{calculated}) = 130.564 - 4.937\,X(1) - 0.0021\,X(2) - 0.539\,X(3) + 1.098\,X(4) - 0.0194\,X(5) + 0.591\,X(6) \quad (2)$$

where again:

$X(1)$ = E.T.S.L.
$X(2)$ = T.T.
$X(3)$ = T.I.T.
$X(4)$ = T.I.T.S.L.
$X(6) = X(1) \cdot X(1)$

but $X(5) = X(4) \cdot X(4)$

This correlation predicted seven pilots to have initial evaluation scores worse than "average" who actually scored better than the "average" pilot.

Because none of the seven had more than 1.2 hours per year, it is anticipated that a prediction technique would imply they would need additional proficiency instruction. It will be noted that in no case did the prediction anticipate a better than "average" score for a pilot actually scoring worse than average. From Figure 15 one could conclude that a private pilot should have <u>at least</u> two hours of instrument time per year.

As for the commercial pilots, one would like to determine in which areas the private pilot will score worse than the "average" private pilot on a statistical basis. The means and standard deviations for the thirty-eight areas are presented in Table VII. Again, using the one-sided t-test for evaluation of the twenty-nine areas in which the arithmetic mean exceeded 3.0 (ref. Table VII), Table VIII is obtained with the critical values determined by

$$X = 3 + 1.689 \frac{s}{\sqrt{37}}$$

The result of this test is that in twenty-three, or over 60%, of the skill areas evaluated, the private pilot performed with less proficiency than is required for the "average" private pilot! If the level of "average" pilot proficiency is desired it is obvious that the private pilot should be required to have periodic check rides and, where necessary, instrument refresher training.

TABLE VII -

STATISTICAL DATA FROM INITIAL FLIGHT CHECK RIDE - PRIVATE PILOTS

		Arith. Mean-μ	Std.Dev.-s
	STRAIGHT & LEVEL FLIGHT		
1.	Altitude Control	2.837	.687
2.	Directional Control	2.972	.725
3.	Power Control	2.891	.314
4.	Cross Check	3.162	.500
5.	Coordination	2.864	.419
6.	Trim Control	2.729	.450
	LEVEL TURNS, LEFT&RIGHT		
7.	Altitude Control	3.135	.673
8.	Bank Control	3.297	.661
9.	Power Control	3.027	.164
10.	Recovery on Heading	3.108	.737
11.	Airspeed Control	3.000	.527
12.	Cross Check	3.243	.434
13.	Coordination	3.000	.527
14.	Trim Control	2.972	.287
	DESCENDING TURNS TO PRE-DETERMINED ALTITUDE		
15.	Power Control	3.270	.732
16.	Airspeed Control	3.432	.647
17.	Pitch Control	3.324	.668
18.	Bank Control	3.378	.758
19.	Recovery to Cruise	3.243	.683
20.	Cross Check	3.378	.545
21.	Coordination	2.972	.644
22.	Trim Control	3.756	.596
	CLIMBING TURNS TO PRE-DETERMINED ALTITUDE		
23.	Power Control	3.270	.902
24.	Pitch Control	3.324	.668
25.	Bank Control	3.432	.647
26.	Airspeed Control	3.405	.643
27.	Level Off to Cruise	3.297	.701
28.	Cross Check	3.486	.558
29.	Coordination	3.027	.644
30.	Trim Control	3.810	.518
	STALL & SPIRAL RECOVERY		
31.	Attitude Recognition	3.081	.546
32.	Power Control	3.648	.789
33.	Pitch Control	3.270	.732
34.	Bank Control	3.405	.724
35.	Coordination	3.135	.480
36.	Recovery	3.270	.732
37.	Cross Check	3.054	.524
38.	Trim Control	3.135	.346

TABLE VIII

t-TEST, PRIVATE PILOTS

Question	Arithmetic Mean - μ	Critical Value - X_c	Accept H_0
4	3.162	3.139	No
7	3.135	3.187	Yes
8	3.297	3.184	No
9	3.027	3.046	Yes
10	3.108	3.205	Yes
12	3.243	3.121	No
15	3.270	3.203	No
16	3.432	3.180	No
17	3.324	3.185	No
18	3.378	3.210	No
19	3.243	3.190	No
20	3.378	3.151	No
22	3.756	3.165	No
23	3.270	3.250	No
24	3.324	3.185	No
25	3.432	3.80	No
26	3.405	3.179	No
27	3.297	3.195	No
28	3.486	3.155	No
29	3.027	3.179	Yes
30	3.810	3.144	No
31	3.081	3.152	Yes
32	3.648	3.219	No
33	3.270	3.203	No
34	3.405	3.201	No
35	3.135	3.133	No
36	3.270	3.203	No
37	3.054	3.145	Yes
38	3.135	3.096	No

5. CONCLUSIONS

Based on the preceding results there appears to be a definite trend towards a loss of instrument proficiency with time. For the commercial pilots evaluated almost 61% tested at or better than the hypothetical "average" pilot score of 129. Of these pilots, 63% of those having 4 or less years since receipt of certification were at least "average" in proficiency, while only 50% of those having been certificated for more than 4 years were at least "average" in instrument skills. For the private pilot population only 27% were at least as good as the "average" pilot score of 114. Only 17% of the private pilots having their certification for 4 years or less were "average" in their instrument skills, while almost 43% of those with more years experience had at least "average" proficiency.

It must be noted that, while the number of years since certification is indeed an important parameter in determining instrument skills, other independent variables must also be taken into account. These variables are:

1. The total number of instrument hours logged;
2. The total number of instrument hours logged since receipt of license; and
3. The total number of hours of all types logged.

Of the commercial pilots evaluated, only 58%had more than 0.5 hours of instrument time since license and 55% of them had logged 0.5 hours/year or less since receipt of their license.

The picture was not much different for the private pilots included in this study. Fifty-four percent (54%) of the private pilots had logged no more than 0.5 hours of instrument time since receipt of license, while almost 68% had flown only 0.5 hours/year or less in the time period since they were certificated.

The performance of a pilot can be divided into two categories:

1. Motor Skills - Actual maneuvering of the aircraft; and
2. Knowledge, the use, functioning, and interpretation of the instruments.

Loss of proficiency is attributed partly to the motor skills of the individual pilot and also to his lack of knowledge.

A majority of pilots did not seem to have a thorough understanding of the primary instrument indications experienced in straight and level flight, climbing and descending turns. Explaining and demonstrating the proper sequence to follow in

transition from one maneuver to another immediately improves the situation. A majority of pilots demonstrated a lack of understanding of proper procedures for recovery from unusual attitudes. Again, instruction on the proper procedure for recovery brought good results, which in turn, improved the confidence level of the subject.

The time required to regain the instrument proficiency in any case, varied with the pilot. Some were quick to correct their mistakes, while others took more time to grasp the fundamentals. For the private pilots, the average time to regain proficiency was 2-1/2 hours of flight instruction and 50 minutes of ground instruction; for the commercial pilot, it was 1-1/2 hours of flight instruction and 25 minutes ground instruction.

Several possible factors contribute to deterioration:

1. The primary instruction received during the original private and commercial phase of flight instruction was inadequate and accounts for a lack of understanding of procedures and basic flying techniques.

   a. Some schools or instructors do not give a sufficient amount of ground school with their flight instruction. Consequently, the student may have less than enough knowledge of the "why's and how's" of flying.

   b. There are flight programs which do not follow a set curriculum or syllabus for teaching the basic fundamentals of flying and there may be omissions or "soft spots".

2. As a result of the interviews with the subjects, it was found that over 59% of the private pilots and 50% of the commercial pilots do not go back for additional instruction, nor do they have any simulated instrument time to keep proficient on instruments. Unless knowledge is reviewed and actual manipulation of the aircraft under simulated conditions is practiced, a pilot's proficiency will decrease over a relatively short period of time after certification. Several reasons for failure to do so are that:

   a. Financial resources may be inadequate to allow the pilot to fly as often as he would like or is able to.

   b. There may be a loss of interest in flying for a given period of time due to personal reasons.

   c. Pilots may develop a closed mind to instruction due to an earlier experience or merely fail to recognize the value of sound procedures.

3. Again, through the interviews of the subjects, it was found that many pilots, once passing the written exam for their license do not keep up on current regulations. As a result, they not only lose some of their knowledge of the regulations, but also may operate in violation of currently accepted practices.

As it may not be practical to require all pilots to take periodic check rides, a statistical analysis was carried out using the existing data. Equations were developed, utilizing data obtainable from the pilot's log book, which permit a prediction of the pilot's instrument proficiency. This predicted proficiency can be used in conjunction with curve-fitted data to yield the approximate (statistical) amount of instruction time which will be required to return the pilot to the level of proficiency of the "average" pilot.

6. ACKNOWLEDGEMENTS

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William L. Conley, Jr.
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Charles Gaedig
Chief Pilot and Examiner

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Chairman, Department of
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Director, Aeronautical Studies Group

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Research Associate

James Kvarda
Instrument Instructor

James E. Marsh, Jr.
Research Associate

W. Dennis Wacker, D.Sc.
Associate Professor - Mathematics

William F. Whealen
Chairman, Department of
Humanities and Social Sciences

A P P E N D I C E S

APPENDIX A-1

INTRODUCTORY LETTER TO PRIVATE PILOTS

Dear Sir:

Now you have the opportunity to renew your instrument flying proficiency "at no cost to you" by cooperating with the Federal Aviation Administration and Parks College of Aeronautical Technology of Saint Louis University.

Parks College, under a contract with the FAA, is presently conducting an intensive study program to test, evaluate and renew (if necessary) the instrument flying proficiency of private and commercial pilots.

You, as a private pilot, will be tested only on your instrument skill as required by the FAA for a private license. All information compiled during this research study is confidential and will not in any way affect your license.

Each pilot will receive a one-hour check ride and evaluation by a certified FAA Examiner. Instruction will then be given, as necessary, to renew the pilot's instrument proficiency to that initially required for his particular rating. Therefore, the testing program will probably vary with each person. It will be operated weekdays and week-ends in order to accommodate the participants.

The College fleet of modern, fully instrumented Cessna 172's will be used for the tests and instruction. All instructors will be qualified, FAA certified, personnel from the Parks College Flight Department.

Pilots who do not live within the immediate St. Louis metropolitan area and need overnight accommodations can contact the Aeronautical Studies Group of Parks College and we will be happy to make a reservation for you at the nearby Holiday Inn. All expenses incurred, other than the above designated flying time, are the responsibility of the individual pilot.

If you wish to be considered for this instrument flight refresher, please complete and return the enclosed questionnaire to A.S.G., Parks College, Cahokia, Illinois 62206, or call (314) 436-1695 [MISSOURI] or (618) 397-7100 [ILLINOIS], Extension 57.

Sincerely yours,

APPENDIX A-2

INTRODUCTORY LETTER TO COMMERCIAL PILOTS

Dear Sir:

Now you have the opportunity to renew your instrument flying proficiency "at no cost to you" by cooperating with the Federal Aviation Administration and Parks College of Aeronautical Technology of Saint Louis University.

Parks College, under a contract with the FAA, is presently conducting an intensive study program to test, evaluate and renew (if necessary) the instrument flying proficiency of private and commercial pilots.

You, as a commercial pilot, will be tested only on your instrument skill as required by the FAA for a commercial license. All information compiled during this research study is confidential and will not in any way affect your license.

Each pilot will receive a one-hour check ride and evaluation by a certified FAA Examiner. Instruction will then be given, as necessary, to renew the pilot's instrument proficiency to that initially required for his particular rating. Therefore, the testing program will probably vary with each person. It will be operated weekdays and week-ends in order to accommodate the participants.

The College fleet of modern, fully instrumented Cessna 172's will be used for the tests and instruction. All instructors will be qualified, FAA certified, personnel from the Parks College Flight Department.

Pilots who do not live within the immediate St. Louis metropolitan area and need overnight accommodations can contact the Aeronautical Studies Group of Parks College and we will be happy to make a reservation for you at the nearby Holiday Inn. All expenses incurred, other than the above designated flying time, are the responsibility of the individual pilot.

If you wish to be considered for this instrument flight refresher, please complete and return the enclosed questionnaire to A.S.G., Parks College, Cahokia, Illinois 62206, or call (314) 436-1695 [MISSOURI] or (618) 397-7100 [ILLINOIS], Extension 57.

Sincerely yours,

APPENDIX A-3

LETTER OF REGRET

Dear Sir:

We would like to extend our appreciation to you for your interest in the instrument proficiency testing program being conducted here at Parks College under a contract with the Federal Aviation Administration. The prompt response of the enthusiastic pilots of the greater metropolitan area has instilled an even greater spirit into this significant project.

Regretfully, because of the tremendous response from qualified pilots interested in renewing their instrument proficiency, and because of limiting specifications outlined in the contract, you and many other "top notch" pilots will not be able to participate. It is most unfortunate that everyone cannot be accommodated, but just as when flying VFR, there are definite restrictions which must be followed in this program.

I am sure you will understand these circumstances. If we can be of service to you in the future, please do not hesitate to call on us.

Best of flying to you in the years ahead!

Sincerely,

APPENDIX A-4

LETTER OF NOTIFICATION

Dear Sir:

We are pleased to inform you that you have been selected to participate in the Federal Aviation Administration instrument flight study program being conducted at Parks College of Aeronautical Technology of Saint Louis University.

According to the questionnaire which you completed and returned to us, you indicated that you were available to fly on _____ _____ around _____. Therefore, unless otherwise notified, we have scheduled you for your check-ride on _____ at _____.

If you are unable to fly at this particular time, please comtact A.S.G., Parks College, Cahokia, Illinois 62206, or call Mr. Charles Snyder, Operations Clerk, at (314)436-1695 or (618) 397-7100, Extension 67, immediately, so that we may reschedule your flight as soon as possible. Mr. Snyder is available Monday through Friday from 8:00 a.m. to 4:00 p.m.

Please report to the Parks College hangar at Bi-State Parks Airport, 1454 Upper Cahokia Road, Cahokia, Illinois, about 15 to 20 minutes before the scheduled check ride for a brief orientation and familiarization with the equipment. Please bring your log book, license(s), and current physical with you for verification.

We are looking forward to meeting you.

Sincerely yours,

APPENDIX A-5

LETTER OF APPRECIATION

Dear Sir:

On behalf of Parks College, I would like to take this opportunity to extend to you our sincere appreciation for your cooperation on the FAA instrument proficiency testing program. It has only been through the cooperation of devoted pilots, such as yourself, that this program has developed into the success that we know it to be today.

Though the outcome of this research project is not yet completely known, we foresee that in the future, there will be new requirements placed upon the private and commercial pilot, in regard to their instrument proficiency, which will make flying safer for everyone.

I hope that you have found this evaluation not only informative but also interesting. With the evaluation you received in this project, we hope that you will continue to maintain the proficiency on instruments, and set an example for others, therefore making the skies safer for all persons involved in general aviation, business, or commercial airlines.

Best of flying to you in the years ahead!

Sincerely,

APPENDIX A-6

QUESTIONNAIRE

PARKS COLLEGE OF AERONAUTICAL TECHNOLOGY
FAA CONTRACT NO. DOT FA69WA-2202

( ) I am interested in participating.
( ) I am not interested in participating.

QUESTIONNAIRE
(Please Print)

NAME: _____
ADDRESS: _____
PHONE: _____ DATE OF BIRTH: _____ AGE: _____

LICENSES HELD:	DATE ISSUED	office use only ELAPSED TIME
( ) Private	_____	_____
( ) Commercial	_____	_____
( ) Instrument	_____	_____
( ) Multi-Engine	_____	_____
( ) Instructor	_____	_____
( ) Other (Specify)_____	_____	_____

TOTAL HOURS: _____ Dual _____ Solo _____
TOTAL INSTRUMENT INSTRUCTION: Aircraft _____ Simulator _____
INSTRUMENT TIME SINCE PRIVATE OR COMMERCIAL CERTIFICATE:
Aircraft _____ Simulator _____

TYPE OF AIRCRAFT CURRENTLY QUALIFIED: (Specify under category)

Cessna Model	Piper Model	Beech Model	Mooney Model	Other Model
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

DATE OF LAST PHYSICAL: _____ CLASS: _____
DATE OF LAST FLIGHT AS PILOT IN COMMAND: _____
TIME AVAILABLE: (days of the week) _____
HOUR OF DAY: _____

REMARKS: _____
_____
_____

SIGNATURE: _____

RETURN TO: A.S.G., Parks College, Cahokia, Illinois 62206