Not for publication

THE EFFECTIVENESS OF "PATTER" AND OF "FUNDAMENTALS OF BASIC FLIGHT MANEUVERS" AS TRAINING AIDS

BY

E. LOWELL KELLY

AND

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A Report on research conducted at Purdue University, Lafayette, Indiana, by means of a grant-in-aid from the National Research Council Committee on Selection and Training of Aircraft Pilots from funds provided by the Civil Aeronautics Administration.

December 1942

CIVIL AERONAUTICS ADMINISTRATION

DIVISION OF RESEARCH

REPORT NO. 6

WASHINGTON, D. C.

LETTER OF TRANSMITTAL

NATIONAL RESEARCH COUNCIL
2101 Constitution Avenue
Washington, D. C.

Division of Anthropology and Psychology

Committee on Selection and Training of Aircraft Pilots

December 16, 1942.

Dr. Dean R. Brimhall,
Director of Research,
Civil Aeronautics Administration,
Washington, D. C.

Dear Dr. Brimhall:

The attached report on The Effectiveness of Patter and of Fundamentals of Basic Flight Maneuvers as Training Aids, by E. Lowell Kelly and E. Ewart, is submitted by the Committee on Selection and Training of Aircraft Pilots with the recommendation that it be included in the series of technical reports published by the Division of Research, Civil Aeronautics Administration.

This report covers one of a series of investigations in the field of pilot training undertaken by the Committee. These studies reflect the conviction, which you have so frequently stated, that the improvement of training methods is an essential step in the most effective use of manpower in aviation. Such emphasis upon training in the Committee research program represents a particularly important advance upon earlier research in the field of aviation psychology which, both during World War I and throughout the period immediately following, was primarily concerned with problems of selection.

In considering the attached report, it is well to recall that the work with the Patter and Fundamentals of Basic Flight Maneuvers was originally conceived as an "action" program designed to bring to bear upon pilot training the experience of education and industry. As an "action" program this work has been eminently successful. The letters received from flight instructors and flight operators, as well as the reception accorded to these training aids by the Navy, furnish evidence of the extent to which this material has found useful application in the field. In view of such wide acceptance, a research study to test the usefulness of these training aids might well have been considered unnecessary. However, it is the fixed opinion of the Committee, which I am certain you share, that it is still necessary to determine objectively how well such training aids function and what they contribute to training.

Unfortunately, the present investigation does not present definitive evidence with respect to these questions. The investigation, which was con-

ceived as an exploratory study, does give a clear indication of the difficulties to be experienced and of the controls which must be applied in such further studies as may be undertaken in exploring the value of training aids and of improved training methods. From this point of view, the study represents an important contribution to the application of psychology in aviation.

In presenting this report, it is probably important to note that the criteria to which Dr. Kelly refers are undergoing very complete and detailed analysis and that reports will be submitted on the Ohio State Flight Inventory and on other criteria considered in the study. These, it is anticipated, will throw further light on the usefulness of these criteria both for field use and as research aids.

Very truly yours,

Morris S. Viteles, Chairman,
Committee on Selection and
Training of Aircraft Pilots,
National Research Council.

MSV-cs

THE EFFECTIVENESS OF "PATTER" AND OF "FUNDAMENTALS OF BASIC FLIGHT MANEUVERS" AS TRAINING AIDS*

Summary

A group of forty primary Civilian Pilot Training Students was divided into two sub-groups matched on the basis of six variables known or thought to be related to success in learning to fly. One group was called "experimental" and taught with the aid of specially prepared study sheets for students and standerdized vocabulary or "patter" for instructors. The other group was called "control" and taught as previous groups of Civilian Pilot Training students had been taught at the same institution.

Several criteria were used to compare the rate and degree of learning in the two groups. These included performance records on four special check flights, instructor's rating at solo and at end of the course, and Civil Aeronautics Administration Inspector's grade on the flight test.

Limitations of the experimental design were: availability of study sheets and patter for the pre-solo maneuvers only, the impossibility of matching instructors, the small number of cases in each group, and the inadequacy of criteria of student success.

Analysis of the resulting data showed no significant differences in the performance in the two groups on any of the criteria. On the average, the experimental students were considered "ready for solo" before those in the control group; this finding could however have resulted from a difference in standards of the instructors of the two groups.

These negative findings could be interpreted to mean that the instructional aids studied were of no value, but they could equally well have resulted from the inadequacy of the criteria and other limitations of experimental design. Evidence is presented to show that the criteria of flight competency were not suitable for revealing differences between matched groups trained by only slightly differing methods.

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*This study was made during the spring of 1942 at Purdue University with the cooperation of the local Civilian Pilot Training staff. It was financed by a grant from the National Research Council Committee on Selection and Training of Aircraft Pilots from funds provided by the Civil Aeronautics Administration.

THE PROBLEM

In the course of research on training methods conducted at Purdue University with funds provided by the Civil Aeronautics Administration through the National Research Council Committee on Selection and Training of Aircraft Pilots there were developed early in 1942 two training aids, viz.:

1. A manual known as Fundamentals of Basic Flight Maneuvers[1] containing a detailed description of each of the maneuvers in the primary Civilian Pilot Training Course for study by the student on the ground prior to flight instruction in the maneuver.

2. A small booklet known as Patter[2] embodying a simple, straightforward, and standardized description of each maneuver to be used by the instructor while demonstrating the maneuver to students during flight.

This material was developed on the basis of a careful study of more than 100 hours of actual conversations between instructors and students as recorded by means of specially designed radio air-to-ground recording equipment. The description of each flight maneuver as used both in the Fundamentals and in the Patter was carefully reviewed by many flight operators, inspectors, and students before receiving final approval. Finally, the material was flight-tested before being turned over to Civilian Pilot Training instructors and, in modified form, to Navy instructors for use in training pilots at the primary level.[3]

Although both the Fundamentals and the Patter were well received by instructors and students, it seemed desirable to conduct a training experiment which might yield objective evidence of their effectiveness as instructional aids. Such an experiment was carried out during the spring of 1942 at Purdue University. Briefly, the experiment consisted of dividing the 40 available primary C.P.T. students into two matched groups, providing one of the groups with the instructional aids,

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[1] A sample page is presented as Exhibit A. See:
Fundamentals of Basic Flight Maneuvers for Civilian Pilot Training, (Supplementary Student Material). (1st ed.) Washington, D. C.: Civil Aeronautics Administration, 1942. (Prepared by E. L. Kelly and staff at Purdue University.)

[2] A sample page is presented as Exhibit B. See:
Patter: Basic Flight Maneuvers for Civilian Pilot Training. (1st ed.) Washington, D. C.: Civil Aeronautics Administration, 1942. (Prepared by E. L. Kelly and staff at Purdue University.)

[3] A general statement of the need for these aids and the research leading up to their preparation is given in The Story Behind the Patter which appears in the Appendix.

FUNDAMENTALS OF BASIC FLIGHT MANEUVERS

10. CLIMBING TURNS

A CLIMBING TURN IS SIMPLY A SHALLOW TURN MADE WHILE THE SHIP IS CLIMBING. Thus, in making a climbing turn, combine the principles you learned when you practiced normal climbs and normal turns.

AS IN ALL TURNS, COORDINATION OF YOUR CONTROLS IS IMPORTANT. You will find it necessary to hold more back pressure in a climbing turn than in a normal turn, since the nose is already held in a climbing position.

REMEMBER: In a climb, the air speed of the plane decreases. In a turn your minimum safe flying speed becomes greater.

Thus, in a climbing turn, your margin of safety above this minimum flying speed is less than during either a normal climb or a normal turn.

THEREFORE: WITH THE SAME AMOUNT OF POWER, THE SAME DEGREE OF CLIMB CANNOT BE MAINTAINED in a climbing turn as in a straight climb.

DECREASE THE ANGLE OF CLIMB BEFORE STARTING THE TURN.

MAKE A SHALLOW BANKED TURN.

COORDINATE YOUR CONTROLS. If you don't use enough rudder for your angle of bank you will climb with one wing low and "slip". Too much rudder for your angle of bank results in a skid, and a resultant loss of air speed.

A SKID IN A CLIMBING TURN IS DANGEROUS. IT MAY DEVELOP INTO A SPIN.

TO RECOVER FROM A CLIMBING TURN, coordinate opposite rudder and aileron. At the same time ease off your additional back pressure so that, by the time the ship is flying straight, you are back in a normal climb.

A MAXIMUM CLIMBING TURN is executed similarly to a shallow climbing turn, except that it is done at full throttle so that your angle of climb can be slightly steeper. In maximum climbing turns, your bank should be less than in a shallow climbing turn. In general, the steeper the climb, the shallower should be your bank in a turn.

THE RECOVERY is the same as from a normal climbing turn, except that when you come out of the turn you should be back in a maximum climb.

CPT MANUAL: 153

EXHIBIT A

Sample page from

Fundamentals of Basic Flight Maneuvers

10. CLIMBING TURNS

Talk over while gaining altitude

Turns may be executed in the normal and the maximum climb. In both of these, the turn is made with a shallow bank. The only difference is that the normal climb is accomplished with a hundred RPM above cruising speed, while the maximum climb is accomplished at full throttle, so a slightly greater angle of climb is possible.

Left climbing turn Point to left wing

We will first do a gentle, 90-degree left climbing turn. First, after making sure that there will be no other ships in the way, open the throttle until the engine speed is approximately 100 RPM above cruising. Then, assume a normal climb as we have done before. Now, since we know that additional back pressure is needed in a turn, we decrease this angle of climb by approximately one-third. This will provide for the additional lift needed when we are turning. Now we coordinate our controls until our left wing tip is in this relation to the horizon. You can see that it is the same as in an ordinary shallow-banked turn. Remember, too, that we must keep the nose in its usual position during the turn. As in our previous turns, we release our rudder and aileron pressure as soon as the turn is established, then apply slight opposite aileron. When we wish to recover from the turn, we coordinate our controls so as to stop the turn and the bank. At the same time we adjust the back pressure so that by the time we are flying straight, we are back in a normal climb. O.K., now you take over and execute a climbing turn to the left.

Recover

EXHIBIT B - Sample page from Patter

teaching the other group by the traditional methods, and then comparing the success of the two groups in learning to fly.[4]

Difficulties in research on training. It was recognized in advance that research on training offers many difficulties. Research on selection may be clean-cut in design and impressive in outcome. Very large populations may be used, so that the results have high reliability. Differences between groups may be both large and significant. The use of a valid test battery may produce easily recognizable changes in practical operations.

Research on training, on the contrary, is characterized by difficulties in experimental design which frequently lead to results that are at best inconclusive. Studies of training must ordinarily be done with small numbers. There are generally extreme difficulties in matching two samples of student populations. To obtain adequate matching of two instructional situations presents an equally troublesome problem. Research on educational aids, therefore, rarely yields significant results clearly and unequivocally attributable to the use of such aids. As a result, most of the training devices now used in education and in industry have been introduced because their employment appeared sound and not because of experimental evidence proving their effectiveness.

It was realized at the outset of this investigation that any study of such aids in aeronautics was particularly subject to all these difficulties. The Fundamentals and Patter had already received an enthusiastic welcome by operators and instructors. In other words, they had passed a practical "acceptance" test. Nevertheless, it was thought worth while to undertake at least an exploratory experiment with the hope of securing objective evidence as to their effectiveness as training aids. It was the opinion of the Committee that the prospect of an indeterminate outcome should not prevent an investigation in which a positive outcome could have great practical significance.

DESIGN OF THE EXPERIMENT

Experimental and control groups. Since only 40 students were available for use in the study, it was essential that the experimental group (those using the training aids) and the control group be as much alike as possible at the beginning of the flight training program.

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[4] More specifically the study was concerned with the effectiveness of the new materials for pre-solo maneuvers, since only these materials were available at the time of the experiment. As post-solo maneuvers are essentially combinations of the fundamentals taught before solo, any initial superiority due to the new materials should be evident throughout the training period.

Otherwise, with such small numbers, either group might be found superior at the completion of the training as the result of a chance initial superiority in flying aptitude. In order to avoid such accidental inequality, the groups were matched on several variables known or thought to be related to success in flight training. Available measures on which the groups were matched included:

1. Score on American Council Psychological Examination.
2. Score on the Iowa Mathematics Placement Test.
3. University grade-point index.
4. Median rating by three interviewers after a 20-minute interview.
5. Total score on An Inventory of Personal Data for Prospective Pilots.[5]
6. Score on Section A of An Inventory of Personal Data for Prospective Pilots.
7. Previous flight training.

Because the 40 students were to be taught by four flight instructors, the group was first divided into four sub-groups of 10 students each. Although perfect matching on all seven variables was not possible with such small groups, there were no statistically significant differences among the four groups on any of the variables listed above. (A test for significance of differences was not applied in the case of previous flight training. There was one student with previous training in Group I; there were two such students in each of the other groups.)

Two of the four groups (I and II) were chosen at random and assigned to the two "experimental" flight instructors who used the training aids. The other two groups (III and IV) were assigned to the two "control" flight instructors who taught without the training aids.

Instructors. In a perfectly designed experiment the experimental and control groups should have received flight instruction from perfectly matched (i.e., "identical") instructors. Because the experiment was conducted in conjunction with a regular university C.P.T. program and by reason of other factors, this ideal was not even approachable. It was necessary to proceed with the instructors whom the operator had hired for the program or to drop the experiment entirely.

Both instructors of the experimental group were under 25 years of age; both had only recently completed the C.A.A. instructor training course; neither had instructed in a C.P.T. program before. Their instructional experience was limited to a few hours, but both had assisted in the preparation of the Patter and Fundamentals.

One of the instructors in the control group was very similar to the two "experimental" instructors with respect to age, training, and lack

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[5] An Inventory of Personal Data for Prospective Pilots, Form 2c. Washington, D. C.: Civil Aeronautics Administration, 1941. See:

Kelly, E. L. The Relationship of Background and Personality Factors to Pilot Competency. (Purdue Research Foundation, Project No. 3: Progress Report, September, 1940.) Washington, D. C.: National Research Council Committee on Selection and Training of Aircraft Pilots, 1940.

of instructional experience. He had not, however, worked on the Patter or Fundamentals. The second "control" instructor was a veteran pilot about 50 years of age, who had been flying for 15 years and had taught in several previous C.P.T. programs.

Procedure. Groups I and II were taught to fly by the "experimental" instructors using both the Fundamentals and the Patter. At the end of each period of flight instruction, the instructor gave the student those sheets from the Fundamentals descriptive of the maneuvers to be covered in the next period. Before taking off for a lesson, the instructor quizzed the student on the material which he should have studied.

Groups III and IV were taught by the "control" instructors, who did not use either Fundamentals or Patter. Both groups followed the regular C.P.T. syllabus outlining the sequence of maneuvers. An attempt was made to keep the Fundamentals and Patter out of the hands of the control group of students and instructors, and while it was not possible to ascertain the success of this control, it is believed to have been reasonably adequate.

Criteria of success in flight training. Because of the difficulty of securing a satisfactory measure of student pilot competency, it seemed advisable to secure as many and as varied criteria as possible. Six different criteria were used:

1. Instructor's estimate of when student was ready to solo.[6]
2. Instructor's rating of pilot competency at actual time of solo.[7]
3. Instructor's rating of pilot competency at completion of course.[7]
4. Scores on Ohio State Flight Inventory completed during a standard check flight at the end of each of the four stages of the course.[8]

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[6]Criterion No. 1 needs some explanation. It is a fixed rule of the controlled C.P.T. course that a student must have eight hours of dual instruction before soloing, even though he may seem qualified earlier. If a student was ready to solo at the end of eight hours, the instructor estimated at that time how many hours the student would have needed if the rule had not existed. If a student was not ready to solo at eight hours, the time when the instructor allowed the student to solo was taken as his estimate.

[7]Criteria Nos. 2, 3, and 5 were derived from Item 14 of A Scale for Rating Pilot Competency. This scale, frequently referred to as the Purdue Rating Scale, was prepared by E. L. Kelly and is printed by the Purdue Research Foundation. See:

Kelly, E. L. Development of a Scale for Rating Pilot Competence. (Purdue Research Foundation, Project No. 2: Progress Report, September 1, 1940.) Washington, D. C.: National Research Council Committee on Selection and Training of Aircraft Pilots, 1940.

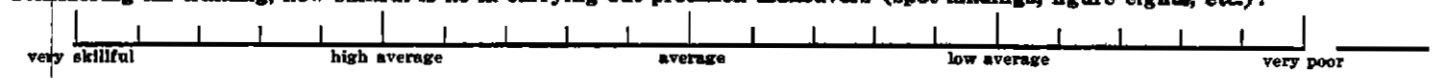
[8]The controlled C.P.T. flight course is divided into four stages: A, B, C, and D. Stage A ends when the student solos, usually between the eighth and the tenth hours. Stage B covers five additional hours, through the thirteenth hour. Stage C ends at approximately 25 hours, and Stage D at 35. Provision is made for additional hours in each stage in cases where the student needs further practice on certain maneuvers.

Student Pilot's Name_____

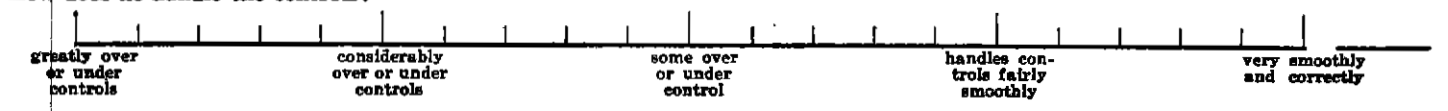
A SCALE FOR RATING PILOT COMPETENCY

Considering his training, how skillful is he in carrying out precision maneuvers (spot-landings, figure eights, etc.)?

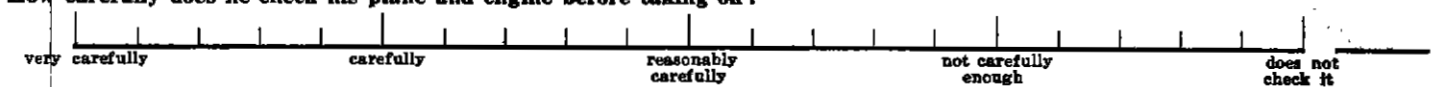
No opportunity to observe



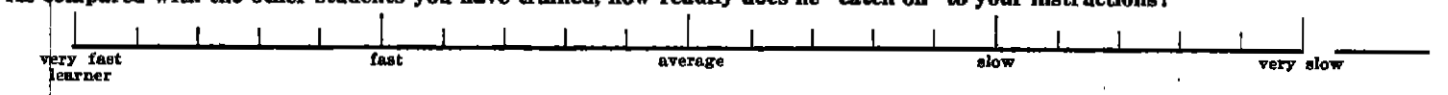
How does he handle the controls?



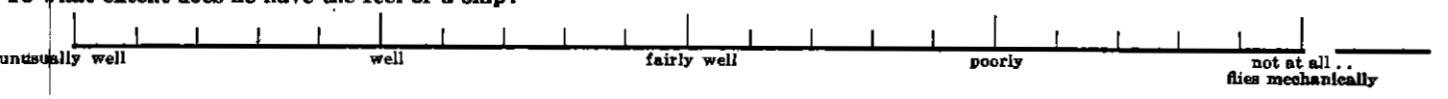
How carefully does he check his plane and engine before taking off?



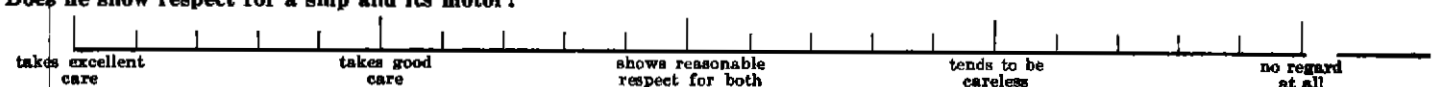
As compared with the other students you have trained, how readily does he "catch on" to your instructions?



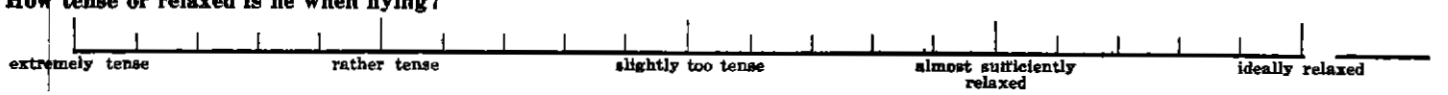
To what extent does he have the feel of a ship?



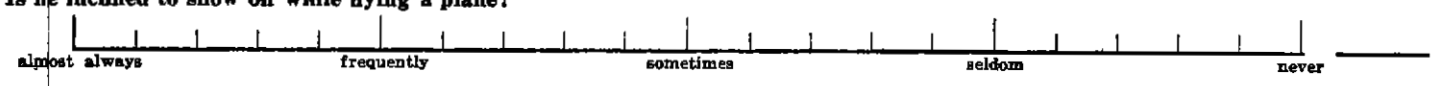
Does he show respect for a ship and its motor?



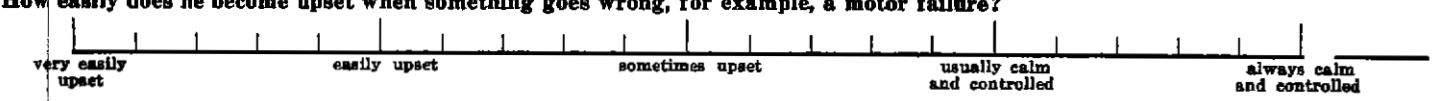
How tense or relaxed is he when flying?



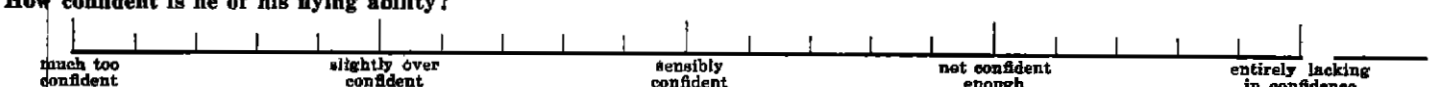
Is he inclined to show off while flying a plane?



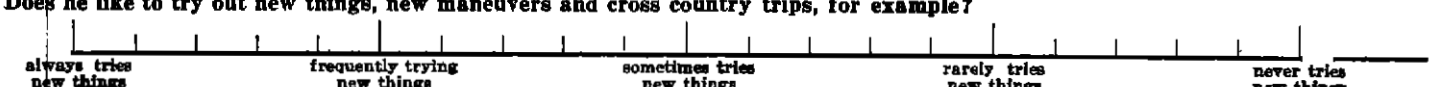
How easily does he become upset when something goes wrong, for example, a motor failure?



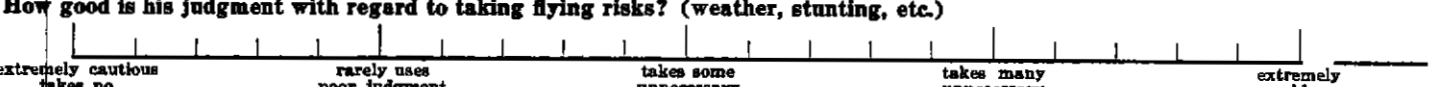
How confident is he of his flying ability?



Does he like to try out new things, new maneuvers and cross country trips, for example?

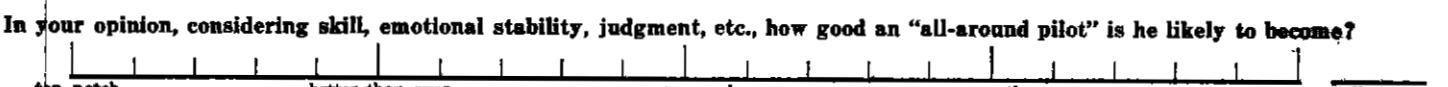


How good is his judgment with regard to taking flying risks? (weather, stunting, etc.)



How well is he satisfied with his flying ability?

In your opinion, considering skill, emotional stability, judgment, etc., how good an "all-around pilot" is he likely to become?



Rated by_____ Instructor

5. Check pilot's rating of pilot competency at completion of the course. (See Footnote 7.)

6. C.A.A. Flight Inspector's grade on flight test made in terms of a percentage scale, 70% being the lowest passing grade.

Because criteria Nos. 1, 2, and 3 all involved subjective estimates by an instructor of his own students, and especially because of the differences between instructors noted above, it seemed desirable to secure other more objective criteria (No. 4). To this end, a qualified instructor was hired to give each student a standard check flight at the completion of each of the four stages of primary training. He used the Ohio State Flight Inventory which yields objective scores presumably indicative of the quality of performance on each of several flight maneuvers.[9] The check pilot did not know until the completion of the experiment whether a student was in the experimental or the control group. This check pilot was also asked to rate each student as to over-all competency at the end of the last check flight (No. 5 above).

Flight test grades as assigned by the C.A.A. Flight Inspector constituted criterion No. 6.

Experimental and control groups were compared on each of the six criteria.

RESULTS

The Ohio State Flight Inventory. According to the original design, the principle criterion of pilot competency was to have been the scores on the Ohio State Flight Inventory obtained during standard check flights[10] administered by an instructor who devoted full time to the giving of check flights to each student at the completion of each of the four stages of flight training. Presumably, the check flight was to give objective scores indicative of the student's excellence in performing each of the maneuvers required in the primary training program. The scores supposedly were objective in that they indicated the student's excellence on a fixed scale, and not in terms of the check pilot's estimate of this excellence judged against the number of hours of flight training the student had logged.

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[9] A sample page is presented as Exhibit C. See:

Walker, R. Y., Lipman, E., & Wantman, M. J. Manual for the Administration of the Ohio State Flight Inventory. (Progress Report, December 20, 1941.) Washington, D. C.: National Research Council Committee on Selection and Training of Aircraft Pilots, 1941.

[10] Developed with the cooperation of M. S. Viteles and A. S. Thompson, University of Pennsylvania. See:

Installation of Photographic Recording Equipment and Check Flights for the Boston Project. (University of Pennsylvania Research Project: Progress Report, November 7, 1941.) Washington, D. C.: National Research Council Committee on Selection and Training of Aircraft Pilots, 1941.

Standard Check Flight Procedures. Washington, D. C.: Department of Commerce, Civil Aeronautics Administration, Bulletin No. 1.

Exhibit C

Sample page from

Preliminary Inventory

A criterion of this sort to be valid and reliable should meet two conditions:

1. In general the mean and median scores for individual maneuvers should increase significantly from stage to stage. In other words, it could be reasonably expected that the students, as a whole, would be more expert in performing given maneuvers at the end of their flight training than they were at the end of the period of dual instruction, after eight hours of instruction. Thus the mean or median scores on the given maneuvers should be higher for the check flight given at the end of the training, than for the check flight given after eight hours, and the mean or median scores after each stage of training should progressively increase.

2. For individual maneuvers, the correlation between check flight scores from stage to stage should be positive, just as one would expect to find a positive correlation between college grades at intervals during a semester.

The scores from the Ohio State Flight Inventory satisfied neither of these two conditions, as is apparent below:

Scores for students on the various maneuvers in the check flight were plotted by group, and by stage. Examples of these plots appear in Tables I to V. Inspection of these figures indicates that the medians and ranges for scores from stage to stage, and from group to group, show no consistent trend.

For seven of the maneuvers which from inspection showed the greatest increase in score from stage to stage, the four sub-groups were merged into a single distribution, and the scores were plotted by stages. An "epsilon squared"[11] was computed for each of these distributions with

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[11]The statistic "epsilon", developed by T. L. Kelley is an unbiased expression of the correlation ratio which is not subject to distortion resulting from size of the sample, as is the conventional "eta." Like eta, the size of this coefficient is a function of the relationship between the standard deviations of the scores in the Y arrays, and the standard deviation of scores in the entire distribution. If no law were operating affecting the distributions of scores of a number of groups, the standard deviations of individual groups would differ only by chance from the standard deviation of all scores combined. Since epsilon is dependent on the relationship between the standard deviations of individual arrays (or groups) and the standard deviation of the entire distribution, and is independent of the number of cases, it offers a convenient way of testing the null hypothesis.

Peters and Van Voorhis give the distribution of epsilon squared when the true correlation is zero. Application of epsilon squared gives results comparable to the "F" test in analysis of variance, and gives an indication of the strength of whatever law is operating, in addition to indicating significance of differences between groups. See:

Peters, C., & Van Voorhis, W. R. Statistical Procedures and their Mathematical Bases. (1st ed., 2nd imp.) New York: McGraw-Hill, 1940. (Pp. 319-330, 494-497.)

TABLE I

DISTRIBUTION OF SCORES ON OHIO STATE FLIGHT INVENTORY
BY EXPERIMENTAL GROUPS AND BY STAGES A, B, C, AND D.

MANEUVER - TAXIING

Group	I				II				III				IV			
Stage	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Score																
14			/	/////			/	//		/		//		//	/	/
13																
12						/	//	///		/	///			/	/	///
11																
10	//		////	/	/	//	/	//		//	/	//			////	
9																
8		////	//		/	////	//	//	//		//	/	/	//	/	/
7																
6	/	/		/	//	/	//			/	/	/	//	/	/	/
5																
4	/	/			//		/		/	/		/	/	//		
3																
2	/	/		/					/				/	/	/	
1																
0			/		/				/				//			
-1																
-2					/	/					/	/				
-3																
-4						/										
-5										/						
-6									/	/						
-7																
-8																
-9																
-10																
-11																
-12													/			
Mdn.	5	7	8	8	8	10	9	9	6	8	8	8	8	9	9	7
	6	8	10	14	5	8	8	12	3	8	9	9	3	8	10	12

TABLE II

DISTRIBUTION OF SCORES ON OHIO STATE FLIGHT INVENTORY
BY EXPERIMENTAL GROUPS AND BY STAGES A, B, C, AND D.

MANEUVER - STRAIGHT GLIDE

Group	I				II				III				IV			
Stage	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Score																
9			//				/				/					
8		/		/			/									
7				/				//	/	/		/				/
6	/	/				/	/	//	//		//		/			/
5			//		/	/		/								
4	/	/	/	//		/			/	///	///	/		/	///	/
3		/	///		/		/			///	/	/	/	/	///	
2	//	//	/			/	///						/	///		
1			/	//	//	//	/	//		/		/				/
0													////	////		/
-1				/	/	/	/	/			/	/				
-2						/	/	/				/	/	/	/	
-3	/						/		/			/				//
-4					//	/										
-5		/														
-6										/						
-7												/				
-8						/			/							
-9					/					●						
Man.	5	7	8	8	3	10	9	9	6	8	8	8	3	9	9	7
	2	3	3	4.5	0	-	2	5	5	3	4	0	0	0	3	1

TABLE III

DISTRIBUTION OF SCORES ON OHIO STATE FLIGHT INVENTORY
BY EXPERIMENTAL GROUPS AND BY STAGES A, B, C, AND D.

MANEUVER - LEFT TURN

Group	I				II				III				IV			
Stage	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Score																
18	/	/	/	/	//	/	///	////	/	/	//	/	///	//	//	/
17																
16	//	/			///	///	//				//	//	//	/		
15										/						
14	/		//	/////	/	/////	/	///	//	/	//	///	/	////	///	///
13																
12	/	//		/		/			/	///				/	/	//
11										//			/			
10		/	//		/											
9																
8			///		/			/			/				/	/
7																
6		/					/								/	
5																
4							/		//		/	//			/	
3																
2							/									
1																
0																
-1		/														
-2													/			
-3																
-4																
N	5	7	8	8	8	10	9	9	6	8	8	3	8	9	9	[illegible]
Mdn.	16	12	10	14	16	14	16	14	13	12	15	14	[illegible]	14	[illegible]	[illegible]

TABLE IV

DISTRIBUTION OF SCORES ON OHIO STATE FLIGHT INVENTORY
BY EXPERIMENTAL GROUPS AND BY STAGES A, B, C, AND D.

MANEUVER - STRAIGHT CLIMB

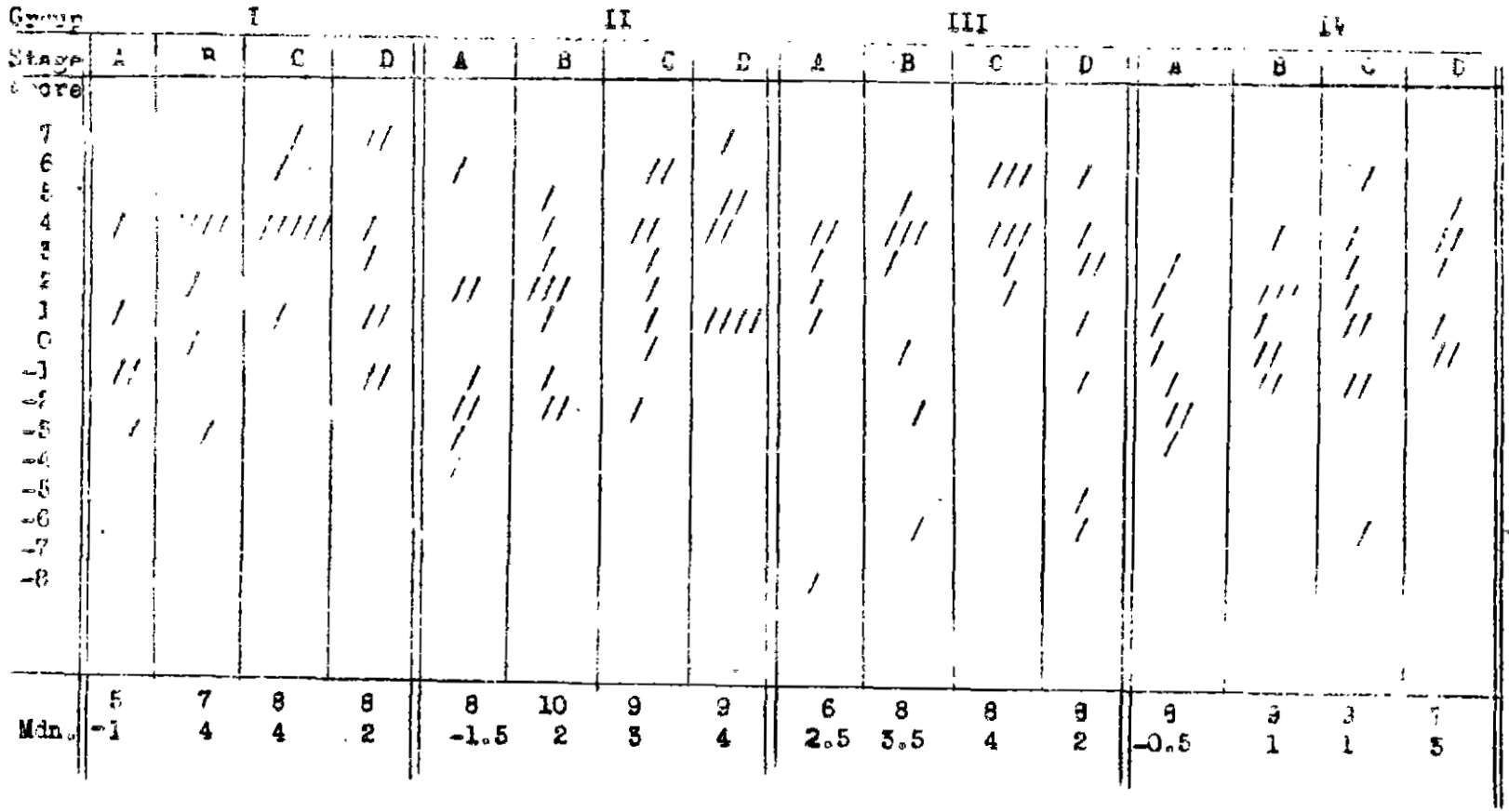
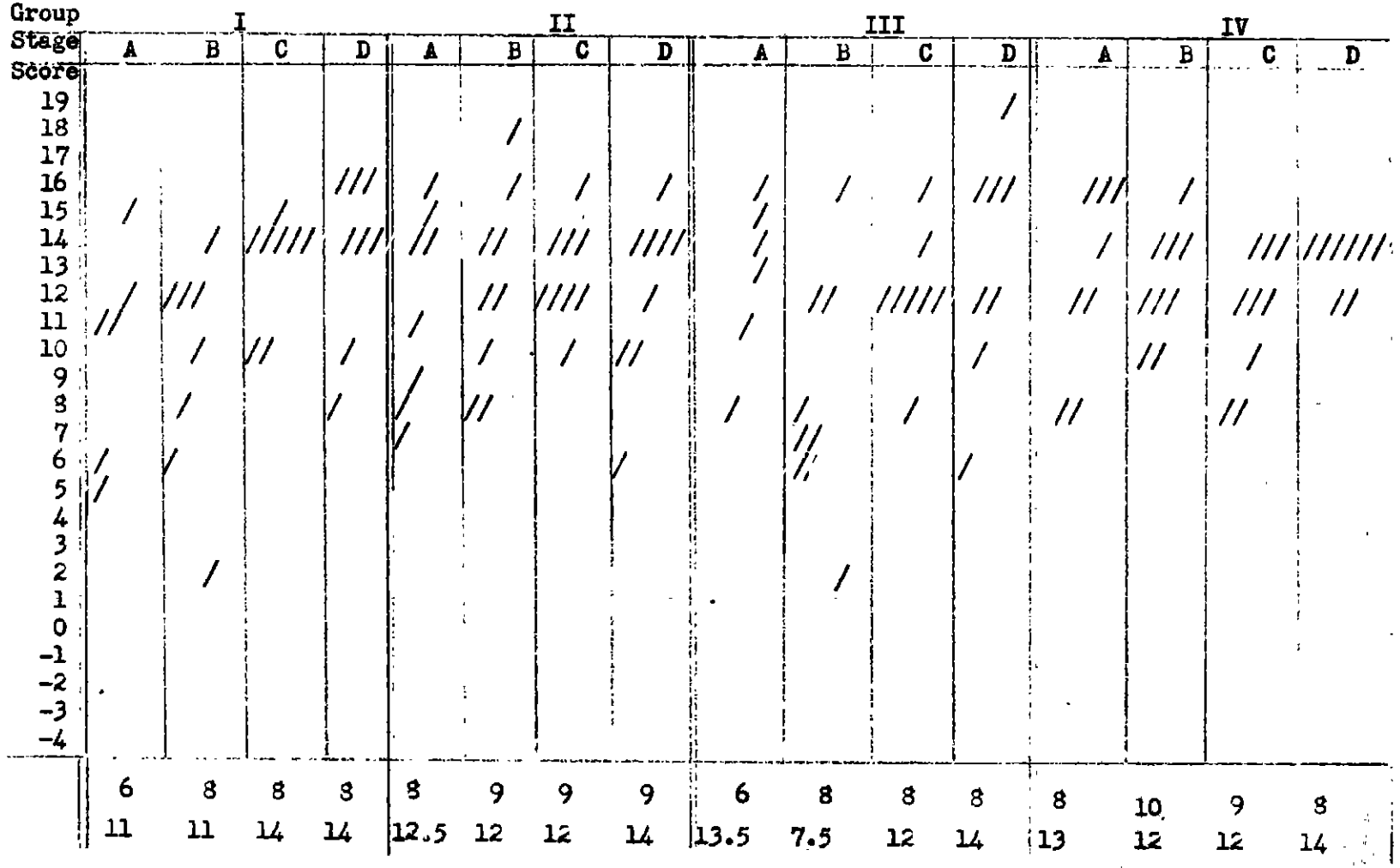


TABLE V

DISTRIBUTION OF SCORES ON OHIO STATE FLIGHT INVENTORY
BY EXPERIMENTAL GROUPS AND BY STAGES A, B, C, AND D.

MANEUVER - CLIMBING TURN



the results seen in Table VI. An examination of the table shows that two of the epsilons squared, those applying to taxiing and to take-off, are statistically significant at the one percent level (in the sense that such values would occur by chance in only one percent of samples drawn at random from a homogeneous population). Two additional epsilons squared, those for landing and climbing turn, are statistically significant at approximately the five percent level. However, there is an appreciable increase in median score from stage to stage only in the case of taxiing.

To check the second condition mentioned above for a satisfactory criterion, correlations were plotted between scores at Stage A and scores at Stage B for 17 of the 23 maneuvers. In no case was a positive correlation of over .15 evident, and a number of low negative correlations appeared. Correlations between Stage C and Stage D yielded coefficients of the same order. Even correlations between Stages A and D for the seven most promising measures (shown in Table VI) with one exception, were below the level of .30. Such low correlations could result from lack of consistency of performance from one check flight to another, or from unreliability of the flight inventory scores.

The above facts led the investigators to refrain from accepting scores on the Ohio State Flight Inventory as an acceptable criterion of performance during flight. Further difficulty with the inventory lies in the fact that no total score is available on the inventory as a whole, that is, there is no method for combining the scores on individual maneuvers in order to arrive at an over-all index of pilot efficiency.

Secondary criteria. Since the principal criterion was found to be inadequate, it was necessary to use the five secondary criteria in evaluating the training materials in spite of their known limitations.

Since the groups were matched, the following null hypothesis was assumed: "There are no significant differences between experimental and control groups in the scores on the five criteria of pilot competency."

Epsilon squared was computed for criteria Nos. 2, 3, and 5 respectively and the null hypothesis was substantiated insofar as the distributions on these criteria were concerned, since none of the epsilons squared approached the five percent level of significance. (Criteria Nos. 2, 3, and 5 are instructor's rating at solo, instructor's final rating, and check pilot's final rating.) Inspection gave clear evidence that the null hypothesis was also substantiated insofar as criterion No. 4, Flight Inspector's rating, was concerned.

The distribution of scores on criterion No. 1 (estimated hours to solo) yielded an epsilon squared of .450, which is very significant. The mean estimated times to solo for the two experimental groups were 7.55 and 6.31 hours respectively, and 7.31 and 8.12 hours for the two control groups. The differences between the means of the second and third groups, and the second and fourth groups, were significant at the six percent and the three percent levels respectively.

TABLE VI

COMPARISON OF SCORES ON OHIO STATE FLIGHT INVENTORY FOR REPRESENTATIVE MANEUVERS AT END OF STAGES A, B, C, & D.

Median Scores for all 40 students

Maneuver	Stage A	Stage B	Stage C	Stage D	E^2*	r_{A-D}**
Taxi	4.5	8	10	12	.200	.230
Take-off	2.5	4	5	7	.125	-.012
Climbing turn	12.1	10.8	12.4	13.1	.057	.130
Landing	1.5	5	5	7	.037	-.014
S-turn	3	7	7	9	.026	.269
Left turn	13.8	13.3	12.7	13.7	.025	.424
Straight glide	1.5	2	3	3	.021	.021
N =	28	35	34	33		

Level of significance for E^2 (N = 130)

5% = .038

1% = .064

*Epsilon squared was computed for the distribution of scores on the check flights given after each stage. If a definite improvement from stage to stage were present, epsilon squared should be large.

**r_{A-D} denotes the correlation between scores at the end of Stage A and scores at the end of Stage D.

This item of evidence in favor of the experimental groups is, however, far from conclusive. The size of the epsilon squared is increased, and the size of the standard error of the difference is decreased by the fact that the variances of the scores on Groups III and IV on criterion No. 1 are extremely small. The fact that students in the experimental groups received a wider range of ratings than those in the control groups cannot unequivocally be interpreted as resulting from differences in the methods of instruction. Since each instructor rated only one group, the large epsilon squared may just as well reflect differences between instructors in methods of rating, in standards of judgment, and in attitude towards the students, rather than differences among the students themselves or in the type of training which they received. It must not be overlooked, however, that since the effects of the Fundamentals and the Patter were probably most pronounced during the first eight hours, this difference may to some extent be real. Nevertheless the obtained significance of the difference is probably spuriously high. It is regrettable that more directly comparable estimates were not available.

One other item should be considered in reviewing the evidence, namely the fact that none of the criteria revealed a superiority of those students taught by the highly experienced instructor of one of the control groups. In fact, students in both experimental groups were better than or as good as those taught by the highly experienced instructor. However, the significance of this finding is confused by the inadequacy of the criteria and by the limitations of the experimental design referred to elsewhere in this report.

DISCUSSION AND CONCLUSIONS

The negative findings obtained in this experiment, that is, the absence of significant differences in proficiency between experimental and control groups, could easily have resulted from the conditions under which the experiment was conducted. The small number of cases; the inadequacy of the criteria; the differences between instructors employed in teaching the experimental and control groups; the fact that study sheets were available only for pre-solo maneuvers; all tend to confuse the picture and to make impossible a definitive interpretation of the findings. On the one hand, therefore, there is wholehearted acceptance of the Patter and Fundamentals by both instructors and students; on the other hand, there are negative objective findings (of doubtful significance) as to the value of these training aids. In general it can be concluded that the experiment has served its function as an exploratory attack upon the problem but has produced no definitive results. A repetition of the experiment with a larger number of cases and with improved criteria and conditions would be necessary in order to procure acceptable objective evidence on the contributions made by the training aids in improving instruction. It should be noted that such validation of textbooks, work manuals, and similar instructional aids is not ordinarily attempted in academic education. A question of broad policy is involved in deciding whether an elaborate and costly experiment along these lines is at present desirable in the field of pilot training.

APPENDIX

THE STORY BEHIND THE PATTER*

A short time ago the Division of Research of the Civil Aeronautics Authority published two aids to flight instruction. One, entitled simply "Patter," is a small booklet containing carefully prepared descriptions of each of the maneuvers in the primary C.P.T. course. The patter is intended for the use of instructors and is written in the style which instructors would use while actually instructing in the plane. The other entitled "Fundamentals of Basic Flight Maneuvers" consists of some sixty 8½ x 11 sheets bound in loose leaf form. It contains more detailed descriptions of the maneuvers for study by the students on the ground before each period of flight instruction. Both of these publications have been enthusiastically received by C.P.T. operators and flight instructors.

Because the story behind these publications is such an interesting one, we have asked the man responsible for their development to tell us the story. The author, Dr. E. Lowell Kelly, is Associate Professor of Psychology at Purdue University and himself an experienced private pilot. During the past three years he has been a project director for various studies on the selection and training of aircraft pilots being carried on at Purdue under the guidance of the National Research Council Committee on the Selection and Training of Aircraft Pilots. Funds for these studies have been provided by the Division of Research of the Civil Aeronautics Authority.

Although small and apparently very simple, both the "Patter" book and the study sheets for the student have a long and complicated history. A great many people have helped to write them and many of them don't even know it. Here is the story.

Three years ago the Civil Aeronautics Authority, realizing the need for research on the human side of flying, wisely set aside a portion of the C.P.T. appropriations for fundamental research on the selection and training of aircraft pilots. Rather than attempt to assemble its own research staff and laboratories, the C.A.A. contracted with the National Research Council to carry out its researches on pilot selection and training. The National Research Council immediately organized a Committee on Selection and Training of Aircraft Pilots, which in turn con-

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*An article prepared for publication in Aero Digest.

(September 1942)

tracted with various universities and colleges to conduct specific research projects. One such project, "A Study of Flight Training Methods," was assigned to the Purdue Research Foundation and the writer was asked to assume direction of the project. That was nearly two years ago.

Our first job was that of finding out how flight instructors actually went about their work. Patter has been written before, and has, in fact, been used for many years by the British in instructing pilots. However, no effort had been made to find out exactly what goes on during instruction in the air as a basis for preparing patter that would be completely realistic in character.

Discussion with both flight instructors and students, revealed wide variation in instructional practices, but such discussions failed to reveal very much about the actual methods which the instructors used. As a group they are not inclined to talk about their art. It became obvious that some method had to be devised for observing flight instruction itself, if we were to learn how it actually took place.

After considerable experimentation, a technique was developed which permitted us to make sound recordings of all conversations between an instructor and student during an instructional flight. Briefly, the apparatus consisted of a two-way electrical interphone which also served as a modulator for a light weight, high-frequency transmitter. Thus, we could "listen in" and make recordings on the ground of the conversations taking place in the air. Over one hundred hours of actual flight instruction, by many different instructors and in different types of aircraft, were recorded, typed, and then studied in detail.

Our analysis of these typed records of actual flight instruction revealed a great many interesting things. Perhaps the most significant finding was the great variation from instructor to instructor -- variation not only in the actual type of explanation accompanying a demonstration of maneuvers, but variation as well in the amount said, in the vocabulary or terminology used by the instructor, in goodness of grammar, and even in correctness of the explanation itself from an aerodynamic point of view. For instance, in one analysis of ten hours of instruction by each of four instructors, we found a total of 500 technical terms or phrases used by the four instructors. There were many other terms unique with each of them. In other words, each instructor seemed to have a sort of a private instructional vocabulary.

In no instance, in all of the instruction recorded, did we find a single description accompanying a maneuver which might be said to be both complete and correct. Many obviously incorrect instructions were given, such as, "you steer this thing just like a sled." In other instances, the student was given a "bawling out" for holding left rudder on the climb after take-off when he was actually not holding any rudder pressure; he simply had not been instructed to hold right rudder to counteract for torque!

Of perhaps even greater importance was the discovery that much of the instruction now being given in the air could much better have been given to the student on the ground. In many instances, the instructor would go into a relatively comprehensive explanation of the aerodynamics of a maneuver for the first time while flying through the maneuver -- at a time when the student was obviously not ready to listen and when conditions of communication were poor.

These and other findings led to the recognition of two very real needs: (1) a set of short and simple descriptive study sheets describing each maneuver to be studied by the student before being given instruction in that particular maneuver and, (2) a standardized patter for use by instructors, both in actual flight instruction and in the training of new instructors.

The study sheets for the students were prepared first and are known as "Fundamentals of Basic Flight Maneuvers." In these sheets, an attempt has been made to provide the student, in the simplest and most straight-forward fashion, the minimum essentials of knowledge and information concerning each of the maneuvers in the primary C.P.T. program. These descriptions are not as comprehensive as those found in the Civilian Pilot Training Manual (Bulletin 23) to which the student is referred for more detailed discussion of the maneuver. They do, however, contain what we believe are the minimum essentials which a student needs to know before having a maneuver demonstrated to him, or before he attempts to practice it himself.

Every effort has been made to describe the maneuvers in non-technical terms and with no assumption regarding the student's previous knowledge of aerodynamics or other technical subjects related to flying. In a sense the sheets might be said to contain the type of information which instructors used to give their students under the wing of the plane in the days when instructors had lots of time. These sheets have been bound in loose-leaf fashion to permit an instructor to hand out study sheets for the particular maneuvers which the student will take up in the next lesson. Because the study sheets are both brief and interestingly written, it is likely that a student will read them when he would not go to the trouble to look up an assignment in a text. Parenthetically, it might be added that this procedure also has the virtue of requiring an instructor to think of each individual student and his needs to the extent of making the appropriate assignment for the next lesson. From our recordings, we found it a not uncommon practice for an instructor to get in a plane and ask the student "Let's see, what did we do last time?" Apparently, he was thinking for the first time about the particular student and his needs for that instructional period.

Behind the preparation of the "Patter" was the very strong feeling that a student deserved at least one simple and complete description of each maneuver while in the air, preferably during the first time it was demonstrated to him. As indicated above, our analysis of actual recordings of flight instruction convinced us that such descriptions were not available in the spontaneous instructions given by instructors in the

air. It was at this point we decided to prepare appropriate "patter" for each of the maneuvers. Using the recorded "patter" of actual flight instruction as a beginning, we then revised it for each maneuver in line with the following standards:

(a) it had to be aerodynamically correct;
(b) it had to be simple and clear to the student, using no words or terms not already explained to the student in the study sheet for each maneuver;
(c) it had to be suitable for actual use in the air;
(d) it had to have the same meaning for all who read it.

These standards were not easily met. In fact, we ourselves were surprised at how very difficult it is to write a description of a maneuver which even reasonably nearly approximates the standards listed above. As is the case with many of the activities in which we engage in everyday life, it is considerably easier to fly a maneuver than it is to tell someone else how to do it. Let anyone who doubts this statement try to write out a detailed and correct set of instructions for putting on a coat or, if he is a flight instructor, let him try to write out the detailed steps in making a gentle banked 90-degree turn in an airplane and then have it read over by two or three other flight instructors. Either of these tasks will be found to be amazingly difficult.

On first glancing at the "Patter" booklet, the average instructor is inclined to say, "Yes, that's all right, but I don't see any reason why I should use it. I explain the maneuver in the same way." Our recording of various instructors' actual spontaneous patter in the air followed by a critical analysis of it, however, has in every instance convinced each instructor that he was not able to say on the spur of the moment just what he had intended to say.

Not obvious to the casual reader of the "Patter" are two facts: (1) that it is based upon an analysis of actual instruction in the air obtained through the use of air-to-ground recording, and (2) that each of the sheets in it has literally been written, revised and rewritten dozens of times. The success with which we were able to meet the standards noted above was possible only because so many different persons operated in the preparation of the "Patter." After each set of "patter" had been revised to the point where the several persons cooperating in the project agreed that it was correct and sufficiently clear, it was then "flight tested;" that is, we tried it out in the air in the instructional situation. This was necessary to assure that sufficient time would be available during the maneuver for the particular patter which had been written. In these flight tryouts, new recordings were made of the "patter" and both the instructor and persons listening in on the ground noted places where it needed revising. After being again rewritten, it was again flight tested and this procedure continued until all persons associated with the project were satisfied with the product.

At this point, the "patter" was prepared in a mimeographed form and submitted to a larger group of flight instructors for their criticism and suggestions for improvement. The "Patter" as published by the C.A.A. is thus the result of the cooperative effort of a great many persons, and the acceptance which it has had by operators and flight instructors is largely the result of the cooperative nature of the project. Certainly neither the "Patter" nor the "Fundamentals" could have been prepared by any single individual and, for that matter, not even by the group responsible for it, without the help and cooperation of both the N.R.C. Committee on Selection and Training of Aircraft Pilots and the Division of Research of the C.A.A.