THE ASSOCIATION BETWEEN RATINGS ON SPECIFIC MANEUVERS AND SUCCESS OR FAILURE IN FLIGHT TRAINING OF RAF CADETS

by

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A preliminary report on research conducted by the National Research Council Committee on Selection and Training of Aircraft Pilots through the cooperation of the RAF and the British Flying Training Schools, with funds provided by the Civil Aeronautics Administration.

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Committee on Selection and Training of Aircraft Pilots

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LETTER OF TRANSMITTAL

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October 13, 1944

Dr. Dean R. Brimhall, Director
Airman Development Division
Civil Aeronautics Administration
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Dear Dr. Brimhall:

Attached is a report entitled The Association Between Ratings on Specific Maneuvers and Success or Failure in Flight Training of RAF Cadets, by Morris S. Viteles, Raymond Franzen, and Robert C. Rogers. This report 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 issued by the Airman Development Division, Civil Aeronautics Administration.

The study represents an exploratory investigation of the importance attached to specific maneuvers in the evaluation of flight performance. In spite of the limitations of the study, referred to in the Editorial Foreword, it is nevertheless of significance in indicating a fruitful method for the study of rating systems as a basis for arriving at uniform grading standards in which individual maneuvers may be rated in proportion to their contributions to over-all flight proficiency.

Cordially yours,

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

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EDITORIAL FOREWORD

One problem which arises frequently in grading or evaluating flight performance is that of the emphasis which should be given to each maneuver in arriving at the final grade on a cadet's performance.

The practice of evaluating only the over-all flight performance allows for wide variation in the choice of maneuvers emphasized in determining whether the trainee passes or fails. Where, for example, one instructor or inspector "thinks" performance of spins is the most important determinant of flight proficiency, another places his emphasis on performance of straight and level flight. In arriving at uniform standards of grading it may prove desirable to weight each maneuver in proportion to its contribution to over-all flight proficiency.

A first step in arriving at such weights is the determination of the emphasis now placed by instructors and inspectors on individual maneuvers in arriving at over-all grades or ratings. The system of flight evaluation used by the RAF training schools permits such an analysis.

Presented in this report are the results of a preliminary investigation of the emphasis placed on maneuvers in the elimination of student pilots made at British Flying Training Schools operating in the United States. The results of this investigation are exploratory only and are presented primarily to indicate the nature of the problem and possible approaches to its solution.

Three specific limitations in the present study must be noted: First, the various maneuvers are not each represented by a constant number of ratings. It is probable that the ratios based on the largest number of ratings are the most reliably determined and that these maneuvers are the ones which appear to have received the greatest emphasis. Second, detailed information is not available on the factors leading to elimination of specific cadets or on the procedure for determining elimination in the British Flying Training Schools. Third, the records of those trainees who were failed in the early stages of primary flight training were not available for this investigation. As quite a large percentage of washouts do occur during the early stages of flight training, it is possible that the relations of the maneuvers to failure demonstrated in this report do not represent the actual relations. Because certain maneuvers occur late in training, and some candidates were washed out before their appearance, it was necessary to exclude them from the analysis.

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THE ASSOCIATION BETWEEN RATINGS ON SPECIFIC MANEUVERS AND SUCCESS OR FAILURE IN FLIGHT TRAINING OF RAF CADETS

INTRODUCTION

In evaluating the over-all flight performance of a cadet the emphasis that is given to each maneuver in arriving at a final grade represents an important problem. In giving a cadet a final rating one instructor may regard satisfactory performance on the maneuver of straight and level flight as indicative of flight proficiency, while another instructor bases his judgment on the performance of take-offs and landings. Since uniform standards of rating are desirable it would appear advisable to weight each maneuver according to the contribution each makes to over-all flight proficiency.

The method of evaluating flight proficiency employed by the RAF at British Flying Training Schools in the United States makes it possible to conduct a preliminary analysis on the problem of emphasis of particular maneuvers in flight failure. As each maneuver, under the RAF system is evaluated as "satisfactory" or "unsatisfactory" at the time it is practiced, it is possible to show the proportion of unsatisfactory ratings on each maneuver practiced during flight training. In this investigation[1] the proportion of unsatisfactory ratings on each maneuver is analyzed in relation to washout data.[2]

THE MATERIALS

The materials for this study were secured from microfilm flight records filled out by the instructor for each training flight made by RAF cadets. These materials were available for four classes of trainees at each of four RAF training centers in this country (located at Ponca City, Oklahoma; Miami, Oklahoma; Terrell, Texas; and Lancaster, California). A total of 759 cadets was studied, although the number of cases available for each maneuver varied. The N's for retained cadets and washouts utilized in the statistical treatment of each maneuver are presented in the accompanying tables.

A record was kept of each flight made by the student pilot through preliminary, basic, and advanced flight training including, in all, 200 hours of flight training. The record contained the grades (satisfactory and unsatisfactory) assigned by the instructor to each maneuver after it was practiced, and whatever comments or recommendations the instructor saw fit to make. Differently colored slips were used for "satisfactory" or "unsatisfactory" grades. As a rule, the number of grade slips for each pilot approached a

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[1] The study is based upon data gathered during the course of an investigation involving RAF pilots training in this country. See Bridgman, Dean P. and Fransen, Raymond. A preliminary study of physical standards in relation to success in flight training. Washington, D.C.: Civil Aeronautics Administration Division of Research, Report No. 7, February 1944.

[2] The current Midwest City training program is so designed that it will be possible to investigate this problem on a much larger scale.

hundred, except for elimination of "carbon" cases. In the latter instance, there were fewer, the number depending upon the stage at which the pilot was dropped from the course.

As mentioned, the number of "satisfactory" and "unsatisfactory" grades for each cadet on each maneuver[3] was obtained for the analysis. The maneuvers and the stages of flight training at which they appeared in the training of the RAF cadets are listed below:[4]

A. Preliminary
   (1) Cockpit familiarization
   (2) Controls
   (3) Air familiarization

B. Basic
   (1) Taxiing
   (2) Straight and level flight
   (3) Turns
      (a) Medium
      (b) Rectangular course
      (c) Stalled turns
      (d) Steep turns
   (4) Climbs and climbing turns
   (5) Glides and gliding turns
   (6) Take-off and landing
      (a) Into wind
      (b) Cross-wind
      (c) Out-of-wind
      (d) Gliding approach
      (e) Side-slip approach
      (f) Power approach
   (7) Slips
   (8) Stalls and spins
   (9) Spirals
   (10) First solo
   (11) Forced, precautionary, accidental landing
   (12) Coordination (S and 8's)

C. Advanced
   (1) Coordination (chandelles, lazy 8's, 180° side and overhead, 360° overhead)
   (2) Navigation and unusual position rectified
   (3) Instruments
   (4) Compass
   (5) Spotting pin points
   (6) Use of time-scale
   (7) Formation flying

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[3] A number of ratings were made on aspects of flight performance which are not specific maneuvers; for example "progress" and "first solo." All such ratings are referred to in this report as ratings of maneuvers, for ease of discussion.

[4] The period of training covered a total of 200 hours divided as follows: Preliminary 91 hours, Basic 54 hours, Advanced 55 hours.

(9) [illegible]
(10) Low flying
(11) Abandoning aircraft
(12) Action in event of fire
(13) Restarting engine in flight

METHODS OF ANALYSIS

Three methods of analysis of these data have been employed in this investigation. The first method involved the calculation of the relation existing between ratings in each maneuver and a criterion of washout versus retained cadets.[5] Since the rigor of the rating differed somewhat from class to class, it was necessary either (1) to calculate separate relations for each of the 16 classes studied, or (2) to develop some method of rendering these ratings comparable so that the classes could be combined. The first alternative was discarded for the reason that there would have been too few cases involved in any one calculation to justify the analysis. Combining all classes in all schools appeared to be undesirable because successive classes were at different levels of training. It was therefore decided to combine corresponding classes from the four schools.

The method chosen to render the materials comparable in corresponding classes in the four schools was to divide each class as nearly as possible into equal thirds on the basis of the percentage of unsuccessful performances of a given maneuver. Corresponding classes could then be combined by considering the top third in one school to be as good as the top third in another, regardless of the absolute values in percentage of grades which were unsatisfactory.

If the rating distributions in all classes could have been divided evenly into thirds, it would not have been necessary to qualify this solution. However, in some instances, more than one-third of the class had no unsatisfactory ratings whatsoever. In such an instance the zero score was counted as one category and the remainder of the cases were divided equally so that three classes were developed, two of which had the same frequency and one of which had more than one-third. As a result of the differences in type of division, it was not always possible to combine all four classes of one grade for a given maneuver. Only classes having the same type of division were combined. The classes involved will be designated for each analysis undertaken.

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[5] Details in the procedure for determining the elimination of a cadet are not presented in this report. Elimination was not determined solely by the instructor making the ratings. Furthermore, ratings on individual maneuvers were not specifically "scored" or totaled in arriving at the decision to "pass" or "fail" a cadet. However, the records were available to instructors and to the Administrative Staff of the British Flying Training Schools and it can be safely assumed that the occurrence of unsatisfactory grades in specific maneuvers influenced the final decision on washouts. In view of the fact that four schools and many instructors were involved in the study, it is obvious that the findings here reported represent uniformities emerging from the rating practices and elimination standards of a rather large number of individuals.

Table 1 indicates the way the material looked before combinations were made for climbs and glides. In this case, Lancaster, Miami, and Ponca City were combined because it was possible to make the same type of division for these large schools. The interval 20% to 100% in Lancaster was then considered comparable to the interval 3% to 100% in Miami, and to the interval 20% to 100% in Ponca City because this would divide off the top third in all these schools. Similarly, 0 to 10%, 0, and 0 to 6% were considered comparable. Of course, scale points applying to the retained cadets in a school also applied to washouts.

Another illustration is provided in Table 2 for grades in navigation.

TABLE 1

CLIMBS AND GLIDES
(Most Advanced Class)

% of Grades which are Unsatisfactory	Retained Cadets	Washouts	% of Grades which are Unsatisfactory	Retained Cadets	Washouts
Lancaster			**Miami**		
20-100	10	5	3-100	11	8
11-19	11	0	1-2	11	2
0-10	12	1	0	12	2
Total	33	6	Total	34	12
Ponca City			**Terrell**		
20-100	9	14	10-100	8	8
7-19	10	3	1-9	8	1
0-6	13	3	0	20	2
Total	32	20	Total	36	11

TABLE 2

NAVIGATION
(Most Advanced Class)

% of Grades which are Unsatisfactory	Retained Cadets	Washouts	% of Grades which are Unsatisfactory	Retained Cadets	Washouts
Lancaster			**Miami**		
27-100	12	2	14-100	3	1
9-26	10	1	1-13	4	2
0-8	11	3	0	28	8
Total	33	6	Total	35	11
Ponca City					
20-100		4			
1-19		1			
0		4			
Total	32	9			

[illegible]

[illegible] of the foregoing [illegible] the analysis. The most [illegible] of these is the fact that when schools were combined, the same [illegible] points applied to retained (successful) cases [illegible] within each school but were different between schools, [illegible] each the point used was the one which separated a given proportion of retained cases from the [illegible]. As a result of the differences in type of division it was not always [illegible] combine all four classes of one grade for a particular maneuver. Only classes having the same type of division were combined.

These considerations gave rise to an alternative form of treatment. In addition to the combinations possible in the first method, this procedure allows the analysis of single classes not included in those combinations. This alternative treatment involves the computation of a chi with one degree of freedom for each combination and for each separate class not included in the combinations.[6] These individual chis are then combined.

Chis with one degree of freedom are used in all cases because they are necessary in some. A chi computed on a combination of three classes is then divided by three so as to assign one-third of the chi value to each class. Similarly, a chi computed by a combination of two classes is divided by two so that half of the value is assigned to each constituent class. When a chi is computed on one class only, then this class takes the value of the chi. These constituent classes are then added and divided by the number of classes in order to give the average chi value to each maneuver. The reason for dividing the chi-value by the number of classes included is because the size of the chi is a function of the number of cases used. Table 3 presents a sample work sheet illustrating this process.

TABLE 3

SAMPLE WORK SHEET
(Alternative method)

[illegible]

Maneuver	Lancaster	Miami	Ponca City	[illegible]	Average
[illegible] Approach		6.2	a	.4	[illegible]
	(3.2 plus 3.2 plus .4 divided by 3)				
[illegible] Wind	4.3	b	6	[illegible]	[illegible]
	([illegible] divided by 4)				
[illegible]	3.1	c	4.8	d	[illegible]
	([illegible] plus 4.8 divided by 4)				

a. Ponca City combined with Miami
b. All four schools in one combination
c. Miami combined with Lancaster
d. [illegible] combined with Ponca City

[6] In [illegible] the chis for [illegible] schools, only those cases were [illegible] and [illegible], respectively, [illegible]

It will be noted that over this method of analysis excluded certain of the maneuvers because of the inadequacies of the data. Among those excluded were the Immelmann, Progress, and Rectangular Course. The analyses of these maneuvers are presented in Appendix A.

In order to meet some of the criticisms which might be directed at the first two methods of treatment, the materials were reanalyzed by means of the Coefficient of Mean Square Contingency. It is interesting to note that this method of treatment, which is more acceptable from the standpoint of the assumptions involved, yields practically the same results as the other two methods.

The Mean Square Contingency Coefficient, $\sqrt{\chi^2 / \chi^2 + N}$, was calculated from χ^2's based on three-by-two contingency tables where the two-place ordinate was the retained cadets versus the washouts and the three-place ordinate was the three-part division of percent of unsatisfactory grades assigned to a given maneuver.[7]

This measure of correlation is particularly suited to the analysis of materials which do not lend themselves to arrangement into categories that can be satisfactorily said to be quantitatively ordered and where the distances between the intervals are not susceptible to definitive quantification. These, obviously, are the conditions which prevail in this study. It may be said also that this formula (C) removes from the chi-squared calculations any difference between maneuvers which are due to varying populations, i.e., the coefficient of contingency evaluates a maneuver in terms of how important it is when populations occurring for all maneuvers are rendered constant.

It will be recalled that the alternative (second) method also made some, though not complete, allowance for populations by using average chi. If chi-squared alone is employed, as in the first method of analysis, it must be assumed that both the occasion of the ranking and the "division" employed are being evaluated since the population of a maneuver affects its evaluation.

RESULTS OF FIRST METHOD OF ANALYSIS

Presented in Table 4 are the results for the chi-squared calculation for combinations of four classes (the schools and class number being indicated at the top of the table). In every case, they are the chi-squared calculations of the relation existing between washouts and retained cadets in three-place distributions of the proportion of grades which were unsatisfactory. Each of these chi-squared calculations has two degrees of freedom.

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[7] This 3-place division of grades is the same as the division used in the first method of analysis. The method of obtaining this division is fully explained earlier in the report.

These chi-squareds are then ranked in order of magnitude for each of the four classes. The highest chi-squared is given a rank of 1, indicating the greatest certainty that some relationship exists. Those maneuvers which have low ranks in three out of the four schools are the ones that are judged as receiving greatest emphasis in determining elimination. (These maneuvers are indicated in the tables as being the "better" elements. No implication is intended that these are really "better" elements of training or that they are better performed. They are better only in the sense that ratings on these maneuvers receive more emphasis in determining elimination.) Maneuvers with 3 out of 4 high ranks are judged as receiving least emphasis in determining elimination.

It should be pointed out that the percentage of grades which are unsatisfactory is almost certainly more reliably determined for those maneuvers which were rated a large number of times during flight training. Other things being equal, the more reliable measures might be expected to show the more significant chi-squareds. This difficulty would not be completely solved even if equal numbers of ratings were available on all cadets for all maneuvers, inasmuch as reliability would be determined not only by the number of measures but also by the consistency of performance of the pilots and the accuracy of ratings by the individual instructors. It may be argued, indeed, that the more frequent repetition of certain maneuvers probably in itself reflects an evaluation of their importance. In any event the probable differences in reliability of these measures must be kept in mind in the interpretation of all results presented in this paper.

Reading across under the headings "Rank Order" in Table 4, factors may be found which have consistent rankings throughout the four classes. Whenever a relation is in the unexpected direction, i.e., more likelihood of unsatisfactory grades in the retained cadets, the symbol (a) is attached. This does not occur in any significant relation.

The details of the computations summarized in Table 4 are presented in Tables 5, 6, 7, and 8 which show which combinations were involved for each of the four classes. Presented in Tables 5, 6, 7, and 8 are two separate chi calculations: (1) First, the chi-squared described above which uses a three-place relation, and (2) second, a chi (χ), calculated from a two-place relationship of the same materials.[8] In the latter case (chi) the larger tail of the distribution on the retained cases was compared with the remainder of the cases.

It is clear from Tables 5 to 8, inclusive, that the error which may be ascribed to a choice of divisions is small, since conclusions reached from the chi-squared computation (three-place relationship) and those reached from the chi computation (two-place relationship) are so nearly alike.

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[8]The probability of a chi (when grouping reduces the degrees of freedom to 1) is interpreted like the probability of a standard score. A chi of 1.0 indicates a probability of .3 that the difference was the result of chance; for a chi of 1.9, the P-value is .05 (.025 at each end of the distribution), etc.

TABLE 4

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY

Maneuver	Consistent & Better (+) Poorer (#)	Lancaster 7, Miami 7, Ponca City 5, Terrell 7		Lancaster 8, Miami 8, Ponca City 6, Terrell 8		Lancaster 9, Miami 9, Ponca City 7, Terrell 9		Lancaster 10, Miami 10, Ponca City 8, Terrell 10	
		X^2	Rank Order	X^2	Rank Order	X^2	Rank Order	X^2	Rank Order
Power Approach		41.4	1	-	-	3.5(a)	15	-	-
Take-off into Wind	+	34.0	2	70.3	1	65.8 (4.9)*	1 (13)*	29.0	6
Climbs and Glides	+	30.4	3	64.8	2	29.8	7	34.5	4
Formation Flying		28.0	4	6.5	19	.5	19	-	-
Straight and Level	+	24.9 (10.5)*	5 (13)*	24.3	6	63.6	2	59.7	1
Taxiing		23.0 (8.0)*	6 (17)*	17.5 (14.5)*	9 (14)*	33.8	5	39.4	3
Gliding Approach	+	21.7	7	36.2	4	44.1	3	31.8	5
Air Familiarity		21.1	8	-	-	-	-	-	-
Medium Turns	+	19.4	9	30.9	5	12.6	8	44.6	2
Stalls and Spins	#	19.1	10	53.3	3	4.7	14	5.0	10
Forced Landings	#	17.4	11	15.2	12	11.1	11	6.9	9
Night Flying	#	15.1 (4.6)*	12 (18)*	8.8 (4.9)*	17 (21)*	-	-	-	-
Loops	#	10.2	14	12.0	15	-	-	-	-
S's and 8's	+	10.1	15	18.0	8	20.4	6	27.2	7
Advanced Coordination	#	8.6	16	7.4 (2.8)*	18 (22)*	2.7(a)	16	-	-
Steep Turns	#	3.6	19	14.8	13	7.2	12	-	-
Navigation		3.1	20	16.2	11	12.1 (11.6)*	9 (10)*	-	-
Rolls	#	1.9	21	1.4	23	2.7(a)	17	-	-
Instruments		1.5	22	23.7	7	.1	20	-	-
First Solo	#	1.5	23	6.3	20	.2	18	-	-
Cockpit Familiarity	#	.1(a)	24	10.5	16	-	-	4.2(a)	11
Judgment	#	-	-	17.7	10	-	-	15.7	8
Controls	#	-	-	-	-	34.0	4	-	-
Progress		-	-	-	-	-	-	-	-

(a) Washouts are less likely to have unsatisfactory grades.

*Second combination where two combinations were possible.

TABLE 5

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY

(Lancaster 7, Miami 7, Ponca City 5, Terrell 7)

Schools*	Maneuver	Retained Cadets	Washouts	X^2	Chi
M, P	Power Approach	67	28	41.4	6.4
L, M, P, T	Take-off into Wind	136	47	34.0	5.8
L, M, P	Climbs and Glides	99	38	30.4	5.5
M, P, T	Formation Flying	102	22	28.0	5.2
P, T	Straight and Level	67	30	24.9	4.8
(L, M)**	Straight and Level	(68)	(18)	(10.5)	(3.1)
L, M	Taxiing	68	18	23.0	4.7
(P, T)**	Taxiing	(67)	(31)	(8.0)	(.8)
L, M, P	Gliding Approach	96	32	21.7	4.7
M, P	Air Familiarity	64	31	21.1	1.8
L, M, P	Medium Turns	100	38	19.4	3.9
L, M, P	Stalls and Spins	100	37	19.1	4.1
L, M, P, T	Forced Landings	136	42	17.4	4.2
L, P	Night Flying	65	14	15.1	3.9
(M, T)**	Night Flying	(70)	(17)	(4.6)	(.5)
M, P, T	Loops	97	15	10.2	1.0
L, M, P	S's and 8's	99	36	10.1	3.2
L, M, P	Advanced Coordination	100	29	8.6	2.8
M, P, T	Steep Turns	102	33	3.6	.3
L, P	Navigation	65	15	3.1	1.1
P, T	Rolls	48	8	1.9	.5
L, P, T	Instruments	101	29	1.5	.4
M, P	First Solo	67	24	1.5	0
L, T	Cockpit Familiarity	56	10	.1(a)	0

(a) The relationship is in the unexpected direction, that is, washouts are less likely to have unsatisfactory grades.

*L is Lancaster, M is Miami, P is Ponca City, and T is Terrell.

**Computation made separately for each pair of schools, because their distribution of ratings made this advisable.

TABLE 6

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY

(Lancaster 8, Miami 8, Ponca City 6, Terrell 8)

Schools*	Maneuver	Retained Cadets	Wash-outs	X^2	Chi
L, M, P, T	Take-off into Wind	69	70	70.3	8.3
L, M, P, T	Climbs and Glides	69	71	64.8	8.0
P, T	Stalls and Spins	30	39	53.3	7.2
L, M, T	Gliding Approach	54	49	36.2	6.0
L, M, T	Medium Turns	55	49	30.9	5.4
L, M, T	Straight and Level	55	51	24.3	4.9
L, M, P, T	Instruments	69	38	23.7	4.8
L, P	S's and 8's	41	34	18.0	4.2
P, T	Taxiing	30	39	17.5	3.3
(L, M)**	Taxiing	(39)	(33)	(14.5)	(3.7)
L, T	Judgment	40	21	17.2	4.1
M, T	Navigation	28	15	16.2	1.1
L, M, P, T	Forced Landings	69	47	15.2	3.9
M, P	Steep Turns	26	13	14.8	3.8
M, P, T	Loops	41	18	12.0	1.9
L, T	Cockpit Familiarity	30	14	10.5	3.2
M, T	Night Flying	28	15	8.8	1.2
(L, P)**	Night Flying	(41)	(18)	(4.9)	(2.1)
L, P	Advanced Coordination	41	20	7.4	2.7
(M, T)**	Advanced Coordination	(28)	(14)	(2.8)	(1.3)
M, P, T	Formation Flying	42	22	6.5	.4
M, P	First Solo	25	18	6.3	.8
M, P	Rolls	19	8	1.4	.4

*L is Lancaster, M is Miami, P is Ponca City, and T is Terrell.

**Computation made separately for each pair of schools, because their distribution of ratings made this advisable.

TABLE 7

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY

(Lancaster 9, Miami 9, Ponca City 7, Terrell 9 and 11)

Schools*	Maneuver	Retained Cadets	Wash-outs	X^2	Chi
M, T	Take-off into Wind	75	33	65.8	6.1
(L, P)**	Take-off into Wind	(65)	(30)	(4.9)	(2.0)
M, T	Straight and Level	75	34	63.6	8.0
L, P, T	Gliding Approach	102	51	44.1	3.4
M, P	Controls	68	28	34.0	4.6
M, P	Taxiing	69	28	33.8	3.3
L, P	S's and 8's	65	29	20.4	2.8
L, M, P	Climbs and Glides	102	41	19.8	2.7
L, P	Medium Turns	65	31	12.6	3.5
M, T	Navigation	75	17	12.1	1.4
(L, P)**	Navigation	(63)	(13)	(11.6)	(1.3)
L, M, P, T	Forced Landings	140	51	11.1	.2
M, T	Steep Turns	71	19	7.2	2.6
L, P	Stalls and Spins	65	28	4.7	.2
M, P	Power Approach	66	13	3.5(a)	1.7(a)
L, P	Advanced Coordination	65	18	2.7(a)	.6(a)
P, T	Rolls	69	14	2.7(a)	1.3(a)
M, T	First Solo	72	24	1.2	1.1
M, P, T	Formation Flying	106	18	.5	0
L, P, T	Instruments	102	34	.1	.1

(a) The relationship is in the unexpected direction, that is, washouts are less likely to have unsatisfactory grades.

*L is Lancaster, M is Miami, P is Ponca City, and T is Terrell.

**Computation made separately for each pair of schools because their distribution of ratings made this advisable.

TABLE 8

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY

(Lancaster 10, Miami 10, Ponca City 8, Terrell 10)

Schools*	Maneuver	Retained Cadets	Washouts	X^2	Chi
M, P	Straight and Level	76	26	59.7	7.7
L, M, P	Medium Turns	108	41	44.6	6.7
L, M, P	Taxiing	108	41	39.4	6.2
M, P	Climbs and Glides	76	26	34.5	5.7
L, M, P	Gliding Approach	106	40	31.8	5.5
L, M, P	Take-off into Wind	108	41	29.0	5.3
L, P	S's and 8's	69	27	27.2	5.1
L, T	Judgment	57	29	15.7	3.8
L, M, P	Forced Landings	99	25	6.9	2.3
L, M	Stalls and Spins	69	23	5.0	2.2
M, P	Cockpit Familiarity	72	24	4.2(a)	1.1
M, P	Air Familiarity	72	25	**	4.8

(a) The relationship is in the unexpected direction, that is, washouts are less likely to have unsatisfactory grades.

*L is Lancaster, M is Miami, P is Ponca City, and T is Terrell.

**Three-place distribution impossible.

RESULTS OF SECOND METHOD OF ANALYSIS

Presented in Table 9 is a summary of the second (alternative) method of analysis. The average chi (X) of each maneuver for each set of classes and the rank order are given. The maneuvers are arranged in order of high to low average chi in the most advanced set of classes. The first column after the list of maneuvers (consistent and: better+, poorer #) is the authors' interpretation of whether the maneuver is consistently better than average or poorer than average, the "better" and "poorer" referring, respectively to "more" or "less" emphasis toward elimination. Where the rank orders for different sets of classes are inconsistent, neither (+) nor (#) appears in the column.

This table indicates the importance (emphasis) of a maneuver in washing out a cadet by a method of treatment which salvages as much of the available material as is possible. It will be noted that the rank orders in Table 9 are for the most part the same as those appearing in the first method of treatment (Table 4).

Tables 10, 11, 12, and 13 present the detailed analysis using the alternative method of analysis. Each of these tables presents the average chi (X) for each maneuver for one set of flight classes. The N's (for both washouts and retained cadets) presented in these Tables represent the sum of the population used in the calculation of the individual chis from which the average chi was computed. The maneuvers are arranged in rank order according to their average chi value. As such, these tables are directly comparable to Tables 5, 6, 7, and 8, resulting from the first method of analysis, except that in the alternative method all single and uncombined materials are included. It must be remembered, however, that although these tables represent a more complete treatment of the data, they run the risk of including unreliable samples.

Comparisons of the rank order of the maneuvers obtained in this analysis with the rank order obtained by means of the first method and contingency method are presented in Tables 19, 20, 21, and 22 of this report.

TABLE 9

SUMMARY OF DEGREES OF RELATION OF BEING WASHED OUT TO RATINGS IN THE VARIOUS MANEUVERS
(Alternative Method)

Maneuver	Consistent &: Better (+) Poorer (#)	Lancaster 7 Miami 7 Ponca City 5 Terrell 7		Lancaster 8 Miami 8 Ponca City 6 Terrell 8		Lancaster 9 Miami 9 Ponca City 7 Terrell 9-11		Lancaster 10 Miami 9 Ponca City 8 Terrell 10	
		Average Chi	Rank Order	Average Chi	Rank Order	Average Chi	Rank Order	Average Chi	Rank Order
Power Approach		2.3	1	-	-	.7*	20	-	-
Climbs and Glides	+	2.0	2.5	2.0	7.5	1.1	10	4.2	2
Straight and Level	+	2.0	2.5	2.9	1	2.2	4	4.3	1
Controls	+	1.9	4	1.8	9.5	1.9	7	-	-
Formation Flying	#	1.7	5.5	.1	21	.6	13.5	-	-
Medium Turns	+	1.7	5.5	2.5	2.5	2.5	2.5	2.8	3
Take-off into Wind	+	1.5	7.5	2.1	5.5	2.0	5.5	2.7	4
Gliding Approach	+	1.5	7.5	2.4	4	1.6	8	2.3	7
Taxiing	+	1.4	9.5	1.8	9.5	2.0	5.5	2.4	5.5
Stalls and Spins		1.4	9.5	2.5	2.5	.9	11	1.3	11
Forced Landing	#	1.1	11.5	1.0	13.5	.1	17	1.5	10
Night Flying	#	1.1	11.5	.8	15.5	.6	13.5	-	-
Air Familiarity	+	.9	13	-	-	4.4	1	2.4	5.5
S's and 8's		.8	14	2.0	7.5	2.5	2.5	1.8	9
Navigation	#	.6	15.5	0	22	.7	12	-	-
Instruments	#	.6	15.5	1.2	12	.2	16	-	-
Advanced Coordination	#	.5	17.5	1.0	13.5	0	19	-	-
Rolls	#	.5	17.5	.4	19	0	18	-	-
Loops	#	.4	19	.6	17	-	-	-	-
Steep Turns	#	.1	20	1.7	11	1.2	9	1.1	12
First Solo	#	0	21	.4	19	.5	15	-	-
Cockpit Familiarity	#	.2*	22	.4	19	-	-	.6	13
Judgment	+	-	-	2.1	5.5	-	-	1.9	8
90° Accuracy		-	-	.8	15.5	-	-	-	-

*The relationship is in the unexpected direction, that is, the washouts are less likely to receive unsatisfactory ratings.

TABLE 10

THE DEGREE OF RELATION OF BEING WASHED OUT TO RATINGS IN THE VARIOUS MANEUVERS
(Alternative Method)

Advanced Classes

(Lancaster 7, Miami 7, Ponca City 5, Terrell 7)

Maneuver	Retained Cadets	Wash-outs	Average Chi
Power Approach	103	35	2.3
Climbs and Glides	135	49	2.0
Straight and Level	135	48	2.0
Controls	96	36	1.9
Formation Flying	135	28	1.7
Medium Turns	135	49	1.7
Take-off into Wind	136	47	1.5
Gliding Approach	132	43	1.5
Taxiing	135	49	1.4
Stalls and Spins	136	48	1.4
Forced Landing	136	42	1.1
Night Flying	137	31	1.1
Air Familiarity	64	31	.9
S's and 8's	134	46	.8
Navigation	135	32	.6
Instruments	136	40	.6
Advanced Coordination	136	35	.5
Rolls	81	14	.5
Loops	131	20	.4
Steep Turns	135	39	.1
First Solo	102	30	0
Cockpit Familiarity	123	41	.2*

*The relationship is in the unexpected direction, that is, the washouts are less likely to receive unsatisfactory ratings.

TABLE 11

THE DEGREE OF RELATION OF BEING WASHED OUT TO RATINGS IN THE VARIOUS MANEUVERS
(Alternative Method)

(Lancaster 8, Miami 8, Ponca City 6, Terrell 8)

Maneuver	Retained Cadets	Wash-outs	Average Chi
Straight and Level	69	71	2.9
Stalls and Spins	69	71	2.5
Medium Turns	69	70	2.5
Gliding Approach	65	64	2.4
Take-off into Wind	69	70	2.1
Judgment	40	21	2.1
Climbs and Glides	69	71	2.0
S's and 8's	69	66	2.0
Taxiing	69	69	1.8
Controls	49	50	1.8
Steep Turns	53	26	1.7
Instruments	69	38	1.2
Forced Landings	69	47	1.0
Advanced Coordination	69	34	1.0
Night Flying	69	33	.8
90° Accuracy	34	23	.8
Loops	68	26	.6
Cockpit Familiarity	56	50	.4
First Solo	25	18	.4
Rolls	46	18	.4
Formation Flying	69	30	.1
Navigation	69	33	0

TABLE 12

THE DEGREE OF RELATION OF BEING WASHED OUT TO RATINGS IN THE VARIOUS MANEUVERS
(Alternative Method)

(Lancaster 9, Miami 9, Ponca City 7, Terrell 9 & 11)

Maneuver	Retained Cadets	Wash-outs	Average Chi
Air Familiarity	69	40	4.4
S's and 8's	132	53	2.5
Medium Turns	138	62	2.5
Straight and Level	140	65	2.2
Take-off into Wind	140	63	2.0
Taxiing	140	65	2.0
Controls	101	42	1.9
Gliding Approach	139	61	1.6
Steep Turns	134	38	1.2
Climbs and Glides	140	64	1.1
Stalls and Spins	139	62	.9
Navigation	138	30	.7
Formation Flying	134	35	.6
Night Flying	99	27	.6
First Solo	98	33	.5
Instruments	139	39	.2
Forced Landing	140	51	.1
Rolls	102	23	0
Advanced Coordination	85	26	0
Power Approach	94	21	.7*

*The relationship is in the unexpected direction, that is, the washouts are less likely to receive unsatisfactory ratings.

TABLE 13

THE DEGREE OF RELATION OF BEING WASHED OUT TO RATINGS IN THE VARIOUS MANEUVERS
(Alternative Method)

(Lancaster 10, Miami 10, Ponca City 8, Terrell 10)

Maneuver	Retained Cadets	Wash-outs	Average Chi
Straight and Level	138	59	4.3
Climbs and Glides	138	58	4.2
Medium Turns	134	58	2.8
Take-off into Wind	140	60	2.7
Taxiing	139	59	2.4
Air Familiarity	72	25	2.4
Gliding Approach	138	59	2.3
Judgment	57	29	1.9
S's and 8's	90	32	1.8
Forced Landing	130	43	1.5
Stalls and Spins	139	52	1.3
Steep Turns	94	31	1.1
Cockpit Familiarity	72	24	.6

RESULTS OF THE THIRD (CONTINGENCY) METHOD OF ANALYSIS

Presented in Table 14 is the over-all summary of the analysis of these data by means of the mean square contingency coefficient $\sqrt{X^2 / X^2+N}$. The values of the contingency coefficient (C) are given as well as the rank orders of the maneuvers as obtained from this method of treatment. The column presenting the consistent and better (+), and poorer (#), represents the authors' interpretation of whether the maneuver is better or poorer than average, the "better" and "poorer" referring, respectively, to "more" or "less" emphasis on the elimination of cadets from flight training. Where the rank orders are inconsistent, neither (+) nor (#) is entered in the column for that maneuver.

Inspection of Table 14 indicates that the results are practically the same as those of the other two methods of analyses, i.e., the maneuvers received practically the same relative rank in terms of their relation to elimination from flight training.

Tables 15, 16, 17, and 18 present the detailed analyses of the maneuvers summarized in Table 14. Each of these tables presents the chi-squareds (X^2) and the coefficient of mean square contingency (C) for each maneuver, analyzed for the various classes included in the analysis. The maneuvers are arranged in order according to the magnitude of their X^2's and C's. As such, these tables are comparable to Tables 5, 6, 7, and 8 of the first method of treatment, and to Tables 10, 11, 12, and 13 of the alternative (average chi) analysis.

A comparison of the rank orders of the maneuvers obtained by this treatment and the rank orders resulting from the first two methods is presented in Tables 19, 20, 21, and 22.

TABLE 14

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY
(Contingency Method)

Maneuver	Consistent &: Better (+) Poorer (#)	Lancaster 7 Miami 7 Ponca City 5 Terrell 7 C	Rank Order	Lancaster 8 Miami 8 Ponca City 6 Terrell 8 C	Rank Order	Lancaster 9 Miami 9 Ponca City 7 Terrell 9-11 C	Rank Order	Lancaster 10 Miami 10 Ponca City 8 Terrell 10 C	Rank Order
Power Approach		.55	1	-	-	.20(a)	18	-	-
Climbs and Glides	+	.43	3	.56	3	.35	7.5	.50	2
Formation Flying		.43	3	.30	18	.06	14	-	-
Air Familiarity		.43	3	-	-	-	-	-	-
Take-off into Wind	+	.39	5.5	.58	2	.42*	5.5	.40	7
Straight and Level	+	.39*	5.5	.43	12	.61	1	.61	1
Gliding Approach	+	.38	7	.51	6	.47	4	.42	6
Taxiing	+	.37*	8	.43*	12	.51	2.5	.46	5
Medium Turns	+	.35	9.5	.48	7	.34	9	.48	3
Stalls and Spins		.35	9.5	.66	1	.22	12	.23	9.5
Night Flying	#	.31*	11	.35*	16	-	-	-	-
Forced Landing	#	.30	12	.34	17	.23	11	.23	9.5
Loops	#	.29	13	.41	14	-	-	-	-
S's and 8's	+	.26	14	.44	9.5	.42	5.5	.47	4
Advanced Coordination	#	.25	15	.29*	19	.18(a)	16.5	-	-
Navigation		.19	16	.52	4.5	.35*	7.5	-	-
Rolls	#	.18	17	.22	20	.18(a)	16.5	-	-
Steep Turns		.16	18	.52	4.5	.27	10	-	-
First Solo	#	.13	19	.36	15	.11	13	-	-
Instruments	#	.10	20	.43	12	0	15	-	-
Cockpit Familiarity	#	.03(a)	21	.44	9.5	-	-	.20(a)	11
Judgment		-	-	.47	8	-	-	.39	8
Controls		-	-	-	-	.51	2.5	-	-

(a) The relationship is in the unexpected direction, that is, the washouts are less likely to receive unsatisfactory grades.

*Average of 2 computed C's.

TABLE 15

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY
(Contingency Method)

(Lancaster 7, Miami 7, Ponca City 5, Terrell 7)

Schools*	Maneuver	Retained Cadets	Wash-outs	X^2	C
M, P	Power Approach	67	28	41.4	.55
L, M, P, T	Take-off into Wind	136	47	34.0	.39
L, M, P	Climbs and Glides	99	38	30.4	.43
M, P, T	Formation Flying	102	22	28.0	.43
P, T	Straight and Level	67	30	24.9	.45
(L, M)**	Straight and Level	(68)	(18)	(10.5)	(.33)
L, M	Taxiing	68	18	23.0	.46
(P, T)**	Taxiing	(67)	(31)	(8.0)	(.27)
L, M, P	Gliding Approach	96	32	21.7	.38
M, P	Air Familiarity	64	31	21.1	.43
L, M, P	Medium Turns	100	38	19.4	.35
L, M, P	Stalls and Spins	100	37	19.1	.35
L, M, P, T	Forced Landings	136	42	17.4	.30
L, P	Night Flying	65	14	15.1	.40
(M, T)**	Night Flying	(70)	(17)	(4.6)	(.22)
M, P, T	Loops	97	15	10.2	.29
L, M, P	S's and 8's	99	36	10.1	.26
L, M, P	Advanced Coordination	100	29	8.6	.25
M, P, T	Steep Turns	102	33	3.6	.16
L, P	Navigation	65	15	3.1	.19
P, T	Rolls	48	8	1.9	.18
L, P, T	Instruments	101	29	1.5	.10
M, P	First Solo	67	24	1.5	.13
L, T	Cockpit Familiarity	56	10	.1(a)	.03(a)

(a) The relationship is in the unexpected direction, that is, washouts are less likely to have unsatisfactory grades.

*L is Lancaster, M is Miami, P is Ponca City, and T is Terrell.

**Computation made separately for each pair of schools, because their distribution of ratings made this advisable.

TABLE 16

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY
(Contingency Method)

(Lancaster 8, Miami 8, Ponca City 6, Terrell 8)

Schools*	Maneuver	Retained Cadets	Wash-outs	X^2	C
L, M, P, T	Take-off into Wind	69	70	70.3	.58
L, M, P, T	Climbs and Glides	69	71	64.8	.56
P, T	Stalls and Spins	30	39	53.3	.66
L, M, T	Gliding Approach	54	49	36.2	.51
L, M, T	Medium Turns	55	49	30.9	.48
L, M, T	Straight and Level	55	51	24.3	.43
L, M, P, T	Instruments	69	38	23.7	.43
L, P	S's and 8's	41	34	18.0	.44
P, T	Taxiing	30	39	17.5	.45
(L, M)**	Taxiing	(39)	(33)	(14.5)	(.41)
L, T	Judgment	40	21	17.2	.47
M, T	Navigation	28	15	16.2	.52
L, M, P, T	Forced Landings	69	47	15.2	.34
M, P	Steep Turns	26	13	14.8	.52
M, P, T	Loops	41	18	12.0	.41
L, T	Cockpit Familiarity	30	14	10.5	.44
M, T	Night Flying	28	15	8.8	.41
(L, P)**	Night Flying	(41)	(18)	(4.9)	(.28)
L, P	Advanced Coordination	41	20	7.4	.33
(M, T)**	Advanced Coordination	(28)	(14)	(2.8)	(.25)
M, P, T	Formation Flying	42	22	6.5	.30
M, P	First Solo	25	18	6.3	.36
M, P	Rolls	19	8	1.4	.22

*L is Lancaster, M is Miami, P is Ponca City, and T is Terrell.

**Computation made separately for each pair of schools, because their distribution of ratings made this advisable.

TABLE 17

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY
(Contingency Method)

(Lancaster 9, Miami 9, Ponca City 7, Terrell 9 & 11)

School*	Maneuver	Retained Cadets	Washouts	X^2	C
M, T	Take-off into Wind	75	33	65.8	.61
(L,P)**	Take-off into Wind	(65)	(30)	(4.9)	(.22)
M, T	Straight and Level	75	34	63.6	.61
L, P, T	Gliding Approach	102	51	44.1	.47
M, P	Controls	68	28	34.0	.51
M, P	Taxiing	69	28	33.8	.51
L, P	S's and 8's	65	29	20.4	.42
L, M, P	Climbs and Glides	102	41	19.8	.35
L, P	Medium Turns	65	31	12.6	.34
M, T	Navigation	75	17	12.1	.34
(L, P)**	Navigation	(63)	(13)	(11.6)	(.36)
L, M, P, T	Forced Landings	140	51	11.1	.23
M, T	Steep Turns	71	19	7.2	.27
L, P	Stalls and Spins	65	28	4.7	.22
M, P	Power Approach	66	13	3.5(a)	.20(a)
L, P	Advanced Coordination	65	13	2.7(a)	.18(a)
P, T	Rolls	69	14	2.7(a)	.18(a)
M, T	First Solo	72	24	1.2	.11
M, P, T	Formation Flying	106	18	.5	.06
L, P, T	Instruments	102	34	.1	0

(a) The relationship is in the unexpected direction, that is, washouts are less likely to have unsatisfactory grades.

*L is Lancaster, M is Miami, P is Ponca City and T is Terrell.

** Computation made separately for each pair of schools because their distribution of ratings made this advisable.

TABLE 19

THE RELATION BETWEEN WASHOUTS AND RETAINED CADETS IN THE PROPORTION OF GRADES WHICH WERE UNSATISFACTORY
(Contingency Method)

(Lancaster 10, Miami 10, Ponca City 8, Terrell 10)

Schools*	Maneuver	Retained Cadets	Wash-outs	X^2	C
M, P	Straight and Level	76	26	59.7	.61
L, M, P	Medium Turns	108	41	44.6	.48
L, M, P	Taxiing	108	41	39.4	.46
M, P	Climbs and Glides	76	25	34.5	.50
L, M, P	Gliding Approach	106	40	31.8	.42
L, M, P	Take-off Into Wind	108	41	29.0	.40
L, P	S's and 8's	69	27	27.2	.47
L, T	Judgment	57	29	15.7	.39
L, M, P	Forced Landings	99	25	6.9	.23
L, M	Stalls and Spins	69	23	5.0	.25
M, P	Cockpit Familiarity	72	24	4.2(a)	.20(a)
L, P	Air Familiarity	72	25	**	**

(a) The relationship is in the [illegible] direction, that is, washouts are less likely to [illegible] unsatisfactory grades.

* L [illegible] Ponca City, and [illegible]

** Three place distribution [illegible]

COMPARISON OF THE THREE METHODS OF TREATMENT

In the following tables (Tables 19, 20, 21, and 22) is presented a comparison of the ranks of the maneuvers as obtained in each form of analysis. It is reasonable to assume that the rank itself is of more importance than the consideration of the relative difference between the ranks. Although the rank difference correlations between all of the methods were not calculated it was demonstrated that the rho's between the ranks found in the first two methods for all classes fell between .81 and .89. Inspection of the data indicates that the rank difference correlations of each of the first two methods with the third (contingency method) would be approximately of the same magnitude.

The ranks presented in these tables may be somewhat different from those in the tables which first presented values for each type of treatment because of exclusions of one or two maneuvers which were not common to all forms of analysis and because, in a few cases at the bottom of the ranking, "negative" relations were ranked above zero relations in the first method used in the study. Where two "0's" were available for the same maneuver, they were averaged before ranking.

Method 1 was employed because it was deemed advisable to report only as much data for each maneuver in each set of classes as could be conveniently and logically combined, and to neglect any other materials. Method 2 was employed in order to include more of the data for each maneuver, despite the attendant decrease in reliability of the results of such analysis. Method 3, probably the most acceptable from the viewpoint of statistics, because it somewhat controls the effect of varying populations used in the analysis of each maneuver, was employed in order to avoid many of the criticisms which might be made of the other two.

Comparison of the results obtained from the three different methods of analysis lends credence to the conclusion that the relative value of maneuvers is accurately established for this population, independent of the choice of statistical treatment.

TABLE 19

TABLE OF THE COMPARATIVE RANKS OF THE THREE METHODS OF TREATMENT

Advanced Classes

(Lancaster 7, Miami 7, Ponca City 5, Terrell 7)

Maneuver	Rank First Treatment	Rank Alternative Treatment	Rank Using Q
Power Approach	1	1	1
Take-off into Wind	2	6.5	5.5
Climbs and Glides	3	2.5	3
Formation Flying	4	4.5	3
Straight and Level	5	2.5	5.5
Taxiing	6	8.5	8
Gliding Approach	7	6.5	7
Air Familiarity	8	12	3
Medium Turns	9	4.5	9.5
Stalls, Spins	10	8.5	9.5
Forced Landing	11	10.5	12
Night Flying	12	10.5	11
Loops	13	18	13
S's and 8's	14	13	14
Advanced Coordination	15	16.5	15
Steep Turns	16	19	18
Navigation	17	14.5	16
Rolls	18	16.5	17
Instruments	19.5	14.5	20
First Solo	19.5	20	19
Cockpit Familiarity	21	21	21

			Rank Using C
[illegible]			2
Climbs and Glides			3
Stalls and Spins			1
Gliding Approach			6
Medium Turns			7
Straight and Level			12
Instruments			12
S's and 8's			9.5
Taxiing			12
Judgment	10	5.5	8
Navigation	11	20	4.5
Forced Landing	12	12.5	17
Steep Turns	13	10	4.5
Loops	14	15	14
Cockpit Familiarity	15	17	9.5
Night Flying	16	14	16
Advanced Coordination	17	12.5	19
Formation Flying	18	19	18
First Solo	19	17	15
Rolls	20	17	20

TABLE 21

TABLE OF THE COMPARATIVE RANKS OF THE THREE METHODS OF TREATMENT

(Lancaster 9, Miami 9, Ponca City 7, Terrell 9 & 11)

Maneuver	Rank First Treatment	Rank Alternative Treatment	Rank Using C
Take-off into Wind	1	4.5	5.5
Straight and Level	2	3	1
Gliding Approach	3	7	4
Controls	4	6	2.5
Taxiing	5	4.5	2.5
S's and 8's	6	1.5	5.5
Climbs and Glides	7	9	7.5
Medium Turns	8	1.5	9
Navigation	9	11	7.5
Forced Landing	10	15	11
Steep Turns	11	8	10
Stalls and Spins	12	10	12
First Solo	13	13	13
Formation Flying	14	12	14
Instruments	15	14	15
Advanced Coordination	16	17	16.5
Rolls	17	16	16.5
Power Approach	18	18	18

TABLE 2*

TABLE OF THE COMPARATIVE RANKS OF THE THREE METHODS OF TREATMENT

(Lancaster 10, Miami 10, Ponca City 9, Terrell 10)

Maneuver	Rank First Treatment	Rank Alternative Treatment	Rank Using C
Straight and Level	1	1	1
Medium Turns	2	3	3
Taxiing	3	5.5	5
Climbs and Glides	4	2	2
Gliding Approach	5	7	6
Take-off into Wind	6	4	7
S's and 8's	7	9	4
Air Familiarity	8*	5.5	**
Judgment	9	8	8
Forced Landing	10	10	9.5
Stalls and Spins	11	11	9.5
Cockpit Familiarity	12	12	11

* Two place chi-squared used.

** Three place distribution was impossible.

SUMMARY AND CONCLUSIONS

The flight records of four classes of trainees from four RAF training centers were analysed to investigate the emphasis placed on various maneuvers in the elimination of cadets from flight training. Three methods of analysis were employed: First, the maneuvers were ranked in importance according to the chi-squared and chi values obtained from a comparison of retained cadets vs. washouts. Second, the maneuvers were ranked in terms of the average chi value to include data which necessarily had to be excluded when the first method was employed. Third, the maneuvers were ranked in terms of the Mean Square Contingency Coefficient (C) calculated from chi-squareds obtained from the same three-by-two contingency tables that were employed in the first method of analysis.

It may be seen (Tables 4, 9, 14, 19, 20, 21, and 22) that the results of the ranking of maneuvers according to their emphasis in flight failure are essentially the same for the three methods of analysis. The correlations between the ranks obtained by the three methods are consistent for all classes.

On the basis of these analyses, the maneuvers may be classified into 3 groups according to their relation to a constant criterion, i.e., whether they have better or poorer relations (more or less emphasis) in flight eliminations: (1) Those having consistently high relations with a washout criterion (called "better"), (2) those having consistently low relation with a washout criterion (called "poorer"), and (3) those which are inconsistent or which were not evaluated for all four classes. The maneuvers falling into each of these three classes are indicated in Table 23.

TABLE 23

MANEUVERS CATEGORIZED ACCORDING TO THEIR RELATION TO A WASHOUT CRITERION

Consistent in at least three out of four classes (better relations)	Consistent in at least three out of four classes (poorer relations)	Inconsistent or evaluated in only one or two classes
Take-off into Wind	Stalls and Spins	Power Approach
Climbs and Glides	Forced Landings	Formation Flying
Straight and Level	Night Flying	Taxiing
Gliding Approach	Loops	Air Familiarity
Medium Turn	Advanced Coordination	Instruments
S's and 8's	Steep Turns	Navigation
	Rolls	
	First Solo	
	Cockpit Familiarity	
	Judgment	

It must be noted, of course, that these results and conclusions are preliminary only and must await cross-validation on other populations before definite conclusions can be drawn.

It should also be pointed out that the records for those trainees who were failed in the early stages of primary training were not available for this analysis. Hence, the relationships found with this population may change markedly when these early [illegible] included.

It is recommended that the coefficient of Mean Square Contingency be employed in future analyses of materials of this sort since it seems to be a more generally acceptable method and yields substantially the same results as the other forms of treatment.

APPENDIX A

Maneuvers not included in the body of the report because of insufficient data.

MANEUVERS NOT INCLUDED IN THE BODY OF THE REPORT
BECAUSE OF INSUFFICIENT DATA

Maneuver	Retained Cadets	Wash-outs	Average Chi
Lancaster 7, Miami 7, Ponca City 5, Terrell 7			
Rectangular Course	33	6	1.1
Immelmann	33	6	.9
Judgment	33	6	.9
Progress	33	6	.9
Cross-wind, Out of Wind	24	7	0
90° Accuracy	32	6	.3*
Lancaster 8, Miami 8, Ponca City 6, Terrell 8			
Progress	42	22	2.5
Power Approach	26	27	2.1
Immelmann	24	5	1.7
Air Familiarity	12	18	.7
Rectangular Course	23	14	0
Lancaster 9, Miami 9, Ponca City 7, Terrell 9-11			
Low Flying	36	8	3.0
Cockpit Familiarity	55	23	2.9
Judgment	70	37	2.5
Progress	71	37	2.4
Rectangular Course	33	14	1.5
Slips	20	7	1.2
90° Accuracy	25	11	1.0
Spirals	10	5	.7
Loops	12	19	.2
Immelmann	26	5	0
Lancaster 10, Miami 10, Ponca City 8, Terrell 10			
Control	69	28	3.0
Progress	57	31	2.4
Rectangular Course	25	14	2.0
Advanced Coordination	33	11	.5
Instruments	16	8	.5
90° Accuracy	24	7	.4
First Solo	63	15	.3
Spirals	31	5	0

* The relationship is in the opposite direction, that is, the men were less likely to receive satisfactory ratings.