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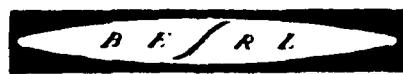
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**Research Memorandum 70-3**

**ANALYSIS OF OFFICER PERFORMANCE  
OF AN EXPERIMENTAL TASK:  
HIGHWAY TRAFFIC PLAN**

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6 ANALYSIS OF OFFICER PERFORMANCE OF AN EXPERIMENTAL TASK:  
HIGHWAY TRAFFIC PLAN

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ANALYSIS OF OFFICER PERFORMANCE OF AN EXPERIMENTAL TASK:  
HIGHWAY TRAFFIC PLAN

In response to recommendations from the Army Scientific Advisory Panel and to needs of the Army expressed by the Office of the Deputy Chief of Staff for Personnel, a major longitudinal research effort was undertaken to improve initial assignment of officers. Objectives were to provide techniques for early identification of effective combat leaders and to determine whether psychological measurement would be effective in classifying officers differentially to the broad domains of combat, technical, and administrative duties.

Within the overall effort, 4000 officers were given a two-day battery of experimental measures--the Differential Officer Battery (DOB)--at entry on active duty in 1961 and 1962. From this group a special sample of 900 composed of approximately 300 officers assigned to combat duties, 300 to technical duties, and 300 to administrative duties was chosen to participate in a special three-day performance simulation of a field exercise at the Officer Evaluation Center (OEC) established for the purpose at Fort McClellan, Alabama. The exercise comprised 15 situational tasks, to be performed in a simulated combat environment: 5 tasks designed specifically to represent the demands of each of the three domains--combat, technical, and administrative. For each task, a system of objective records of specific behaviors, products, and judgments was carefully designed. Teams of officers and enlisted men were trained to carry out the exercise as actor participants-observers. Recorded observations, evaluations, and results were then analyzed to yield dimensions of performance on each task. The present report describes findings from analysis of one of the administrative tasks, the Highway Traffic problem.

OBJECTIVES OF THE PRESENT ANALYSIS

The objectives of analysis of the Highway Traffic task were to identify the behavioral dimensions measured and to provide scores for use in relating those dimensions to behavior in the other 14 tasks, to predictor scores from the DOB, and to evaluations of performance in the real-life Army environment. Findings of this and parallel analyses of the other tasks are to be applied to indicate techniques for operational performance evaluation of junior officers, for early identification of potential commanders, and for initial classification of cadets in the various officer training programs prior to commissioning.

## METHOD OF ATTACK

### THE SITUATIONAL TASK

The Highway Traffic problem was designed to measure the resourcefulness and ingenuity of the examinee in accomplishing a logistical support mission, his ability to plan logistical support for a large-scale tactical operation and to initiate plans and decisions in response to rapid political and military changes, as well as his persistence despite tedium, time pressure, harassment, unforeseen contingencies, and fatigue. Specifically, the officer being tested was to designate routes for movement of supplies from rear areas to combat zones. He was to extract and utilize information from maps, overlays, and route reconnaissance reports in order to develop a highway regulation plan making maximum use of existing highway facilities. He was to select locations for control points to regulate traffic.

### SAMPLE

The full sample consisted of approximately 900 officers who attended the OEC. For the internal analysis presented here, however, only the last 732 cases were used because minor changes and additions in recording and evaluation procedures were made after earlier cases had gone through the Center. These changes are not sufficient to preclude applying certain scores derived here to the earlier cases for the validation of the DOB.

### VARIABLES

Two highway traffic plan problems were presented, each requiring a plan to deliver specific tonnages of Class I (subsistence supplies, Class III (petroleum fuel and products), and Class V (ammunition) supplies from available depots to specified forward supply points over a road network of which sections had been destroyed or damaged by enemy action. The destruction included complete interdiction of certain routes due to radiation from nuclear explosions. There were six scores for tonnage delivered--Class I, III, and V in each of two problems. In scoring, credit was given for delivery of the required tonnage by class to the forward supply points. Additional credit for minimizing the distance traversed (a ton-kilometer product) was given only if all required tonnage was delivered. Tonnage routed over interdiction routes or in excess of a route's capacity was considered not to have been delivered.

Performance variables consisted of the highway traffic plans produced as recorded by observers on the Highway Traffic Plan Worksheet and evaluations of examinee behavior by observers on the Highway Traffic Plan Checklist, the Rating Supplement, and the Descriptive Report. These instruments and the 44 variables derived from them are shown in Appendix Table A-1. The objective products (the plans produced) were scored

separately. The behaviors were observed and evaluated across traffic plans. A minimum of two raters is represented on all ratings used. Ratings were made independently and raters met to resolve differences to produce agreement on the evaluation. Table 1 categorizes the 44 performance variables selected for analysis from the observations and evaluations recorded.

Table 1  
PERFORMANCE VARIABLES OF HIGHWAY TRAFFIC PLAN TASK

Instrument	Type of Variable	No. of Variables
Highway Traffic Plan Worksheet	Tons delivered--3 classes for each 2 plans	6
	Ton-kilometer products--1 for each plan	2
Highway Traffic Plan Checklist <sup>a</sup>	Necessary provisions of plan	23
Descriptive Report <sup>a</sup>	Aspects of task performance	10
Rating Supplement <sup>a</sup>	Motivation	1
	Attitude	1
	Understanding mission	1
Total		44

<sup>a</sup> A single score on each of the behavior variables was obtained across the two problems presented.

Population control variables were broad category of assignment (combat, technical, administrative), component (Regular Army or Reserve), and grade (first lieutenant or second lieutenant). Analysis with respect to these variables will be presented in a separate report covering other of the situational problems forming the simulated field exercise.

A factor analysis (in two steps) was performed as a basis for identifying the behavioral dimensions represented. The first step was to obtain distributions of the performance variables. On the basis of these distributions, the tonnage delivered and ton-kilometer product scores were coded in a single scale, yielding an objective score for each of the two problems. The 23 variables of the Highway Traffic Plan Checklist were correlated with scores on motivation, attitude, and understanding mission.

The resulting matrix of 26 variables was then factor-analyzed by the principal axes method using the highest off-diagonal entry as the communality estimate at each step. The factor matrix was rotated by the varimax method and eight factors were identified. Scales of items representing the factors were derived; these scales were then correlated in a new matrix with scores derived from the Descriptive Report and the Highway Traffic Plan Worksheet. Factoring and rotation of this new matrix of 17 variables yielded the final scales and total score for the situational task. These scales and total score included all the original variables except those with extreme p-values.

## RESULTS

### CODING OF OBJECTIVES SCORES

Distributions of the six scores for tonnage delivered proved to be U-shaped, 56% to 87% of the sample achieving full delivery and 11% to 29% achieving little or none. Table 2 shows the percentage achieving full, part, or negligible delivery. As a result of these findings, the raw tonnage scores were converted to a coded score, 9 being awarded for full delivery, 4 to 2 for partial delivery, and 0 for little or none.

For those who achieved full delivery of all classes of supply in a given problem, additional credits were awarded for efficiency of delivery, i.e., the smaller the total of ton-kilometer products, the greater the credit. Table 3 shows the percent of the sample who received additional credit up to 9 points. Thus, it was possible to achieve a maximum score of 36 points on each problem: 27 for delivery of the full tonnage requirement and 9 additional points for efficiency of delivery. The coded total score for each problem and the grand total were included in further analysis.

Table 2

#### PERCENT OF SAMPLE ACHIEVING DELIVERY OF FULL, PART, OR NONE OF REQUIRED TONNAGE

Requirement Met	Class I		Class III		Class V	
	Prob 1	Prob 2	Prob 1	Prob 2	Prob 1	Prob 2
Full	69	87	70	83	56	82
Part	12	2	16	6	15	6
Little or none	19	11	14	11	29	12

Table 3

PERCENT OF SAMPLE ACHIEVING ADDITIONAL CREDIT  
FOR EFFICIENCY OF DELIVERING REQUIRED TONNAGE

Credit Received	Problem 1	Problem 2
7-9	9	7
4-6	18	36
1-3	20	28
0 (Full delivery)	2	4
0 (Part delivery)	45	19
0 (Little-no delivery)	6	6

FACTOR ANALYSIS OF TRAFFIC PLAN CHECKLIST

In the factor analysis of observed behavior, 26 variables were included--23 aspects of the plan covered in the Checklist and the three additional rating variables, motivation, attitude, and understanding the mission. Eleven orthogonal factors were rotated to simple structure by the varimax method. The 8-factor solution was selected as offering the optimum level of differentiation and factor definition. Table 4 presents the items selected to represent each factor. Two factors represent overall performance on the problems, five represent specific aspects across problems, and one is concerned with effective motivation. The complete matrix is given in Table A-1.

FACTOR ANALYSIS OF TOTAL TASK PERFORMANCE

Analysis of a matrix of the eight factor scales, the three objective scores, and six items<sup>1</sup> from the Descriptive Report yielded 16 factors. Means and standard deviations appear in Table A-2. Of these factors, however, only the first six were retained. Table 5 presents the variables and loadings on these factors. Only loadings over .30 are given.

<sup>1</sup> Four items were dropped because of insufficient variance--p values beyond 10 or 90.

Table 4

FACTOR LOADINGS OF OBSERVED BEHAVIOR AND MOTIVATION VARIABLES  
IN HIGHWAY TRAFFIC PLAN TASK

Factor/Items	Loadings	Factors/Items	Loadings
<u>I. Performance on First Problem</u>			
Control points	.60	<u>V. Designating Controls</u>	
Direction of travel	.59	2. Reserve MSR	.83
Clear routing	.54	1. Reserve MSR	.78
Use of capability info	.50	2. HRP, TCP	.66
Depot choices	.48	1. HRP, TCP	.61
Direct routing	.38		
<u>II. Identifying Depots</u>			
Problem 1	.98	<u>VI. Performance on Second Problem</u>	
Problem 2	.96	Use of capability info	.77
		Direction of travel	.68
		Control points	.65
		Direct routing	.59
		Clear routing	.54
		Depot choices	.40
<u>III. Designating Routes</u>			
1. Reserve march route	.99	<u>VII. Tonnage</u>	
2. Reserve march route	.88	1. Designate on all routes	.80
1. Clear routing	.52	2. Designate on all routes	.70
		1. Tonnage delivery	.65
		2. Tonnage delivery	.52
<u>IV. Noting Route Restrictions</u>			
Problem 1	.93	<u>VIII. Effective Motivation</u>	
Problem 2	.82	Attitude	.88
		Motivation	.85
		Understand mission	.62

Table 5

FACTOR LOADINGS OF PERFORMANCE VARIABLES  
IN HIGHWAY TRAFFIC PLAN TASK

Factor/Items	Loadings	Source
<u>I. Problem Solving</u>		
Coded total objective score	.95	HT Plan Worksheet
Coded score, problem 2	.84	HT Plan Worksheet
Tonnage factor	.77	HT Plan Checklist
Coded score, problem 1	.75	HT Plan Worksheet
Mission accomplishment	.51	Descriptive Report
Following instructions	.45	Descriptive Report
<u>II. Response to Stress</u>		
Endurance and stamina	.76	Descriptive Report
Cool, level-headed	.68	Descriptive Report
<u>III. Procedural Skills</u>		
Designating routes factor	.72	HT Plan Checklist
Designating controls factor	.60	HT Plan Checklist
Performance factor (prob. 2)	.60	HT Plan Checklist
Performance factor (prob. 1)	.54	HT Plan Checklist
<u>IV. Attention to Instructions</u>		
Noting route restrictions factor	.72	HT Plan Checklist
Following instructions	.60	Descriptive Report
Mission accomplishment	.52	Descriptive Report
Coded score, problem 1	.36	HT Plan Worksheet
<u>V. Identifying Depots</u>		
Identifying depots factor	.74	HT Plan Checklist
Noting route restrictions factor	.42	HT Plan Checklist
Bearing and assurance	.31	Descriptive Report
<u>VI. Style of Performance</u>		
Effective expression	.78	Descriptive Report
Bearing and assurance	.61	Descriptive Report
Effective motivation factor	.57	Rating Supplement

Factor I clearly defined the final product of the task: objective tonnage delivery score and rated effectiveness in carrying out the mission. Factor II refers to effective functioning under pressure. Completion of the important aspects of the task, or procedural skill, comprises Factor III. Although Factors IV and V are differentiable, they both appear to be concerned with attending to instructions and situational data, while Factor VI clearly reflects a confident style of performance. Loadings on the factors are given in Table A-3.

Based on these results, the following composite scores were identified to be used in further analysis across the full 15 situational tasks:

Coded Total Objective Score (first variable on I)

Response to Stress (both variables on II)

Procedural Skills (four variables on III)

Attention to Situational Requirements  
(first three variables on IV plus first on V)

Style of Performance (three variables on VI)

#### SUMMARY AND CONCLUSIONS

Factor analysis of relationships among the variables of the Highway Traffic Task--the objectively scored traffic plan, the observers' checklist of the plan's provisions, and ratings of aspects of the officer's performance, including attitude and motivation--yielded five major performance factors: These were 1) total objective score, 2) response to stress, 3) procedural skills, 4) attention to requirements, and 5) style of performance. These scores, together with certain single variables of interest, are to be analyzed in a matrix including scores derived from the other 14 situational tasks. Results are to be applied to problems of officer performance evaluation and early identification of the most promising officer leaders.

APPENDIX. DETAILED RESULTS OF ANALYSES - HIGHWAY TRAFFIC PLAN TASK

Table A-1  
 FACTOR MATRIX OF OBSERVED BEHAVIOR AND MOTIVATION VARIABLES

Problem	Item	Factor Loadings								h <sup>2</sup>
		I	II	III	IV	V	VI	VII	VIII	
1	Identified depots	02	98	02	06	04	04	06	16	00
2	Identified depots	00	96	-01	02	06	02	08	15	00
1	Used direct routes	38	06	00	18	-07	20	17	13	27
2	Used direct routes	00	13	05	11	-01	59	17	23	40
1	Used closest depots	48	15	03	05	12	20	34	21	46
2	Used closest depots	02	07	02	-23	01	40	17	07	25
1	Desig. control points	60	19	10	-04	61	26	00	06	04
2	Desig. control points	37	11	19	05	66	65	02	02	1.04 <sup>a</sup>
1	Desig. reserve MSR	-09	06	-04	02	78	-17	16	17	70
2	Desig. reserve MSR	-06	-03	13	08	83	05	09	12	74
1	Refrained from alt. routes	54	-07	52	-07	23	-03	40	-11	00
2	Refrained from alt. routes	-14	-06	99	11	17	46	33	11	1.37 <sup>a</sup>
1	Noted route restrictions	09	06	10	03	03	08	09	17	03
2	Noted route restrictions	06	07	-04	82	06	09	09	00	72
1	Desig. travel direction	59	-17	01	-02	-05	37	21	24	62
2	Desig. travel direction	20	-06	11	04	-08	68	21	20	61
1	Desig. route tonnage	37	02	10	-02	-01	05	80	18	82
2	Desig. route tonnage	02	03	17	-04	09	43	70	24	78
1	Correct tonnage deliv.	17	11	-04	19	11	23	65	07	57
2	Correct tonnage deliv.	01	05	-03	17	21	38	52	09	50
1	Used routes on hwy capabil.	50	00	-01	04	-04	-06	02	06	26
2	Used routes on hwy capabil.	11	-14	05	33	06	77	13	10	77
1	Reserved march route	08	09	88	00	04	01	-11	05	60
Understanding mission		05	22	10	07	17	10	15	62	52
Motivation rating		23	11	01	18	08	27	10	85	04
Attitude rating		22	10	-02	13	10	25	08	88	02

<sup>a</sup> Loadings above 1.00 are believed to be due to use of tetrachoric correlations or to the fact that communalities were not reestablished.

Table A-2

MEANS AND STANDARD DEVIATIONS OF FINAL VARIABLES  
SELECTED IN HIGHWAY TRAFFIC PLAN TASK

Variable	M	SD
Problem 1 solution	21.11	11.09
Problem 2 solution	26.11	9.50
Sum of 2 solutions	47.22	17.16
Bearing and assurance	1.11	.57
Effective expression	1.02	.34
Cool, level-headedness	1.04	.29
Endurance and stamina	1.03	.40
Following instructions	.78	.88
Mission accomplishment	.73	.86
Problem 1 performance	4.43	1.02
Problem 2 performance	4.38	1.12
Identifying depots	1.25	.95
Designating routes	2.21	.55
Noting restrictions	1.63	.46
Designating controls	2.86	1.11
Specifying tonnage	2.99	1.19
Effective motivation	9.61	2.22

Table A-3

FACTOR MATRIX OF FINAL VARIABLES SELECTED  
IN HIGHWAY TRAFFIC PLAN TASK

Variable	Factor <sup>a</sup> Loadings						h <sup>2</sup>
	I	II	III	IV	V	VI	
Problem 1 solution	75	04	02	36	-08	11	71
Problem 2 solution	84	01	12	-16	22	06	80
Sum of 2 solutions	95	03	08	14	07	10	94
Bearing and assurance	12	23	14	07	31	61	56
Effective expression	11	-03	10	02	-04	78	64
Cool, level-headedness	-01	68	-02	08	00	21	51
Endurance and stamina	12	76	12	-04	09	-03	61
Following instructions	45	17	15	60	-17	17	67
Mission accomplishment	51	25	10	52	-16	20	67
Problem 1 performance	22	06	54	30	-18	31	57
Problem 2 performance	22	13	60	08	-11	29	52
Identifying depots	10	10	03	06	74	16	60
Designating routes	01	15	72	-02	18	-22	62
Noting restrictions	-02	-10	09	72	41	02	71
Designating controls	10	-11	60	04	06	23	45
Specifying tonnage	77	07	23	06	06	19	69
Effective motivation	25	24	15	22	15	57	54

<sup>a</sup> The six factors accounted for 63.73% of the total variance.