Technical Report 895

The Comparability of an Armor Field and SIMulation NETworking (SIMNET) Performance Test

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June 1990

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The high costs and number of problems associated with field testing have prompted the use of simulators for performance testing. This report assesses the Simulation Networking (SIMNET) system as a cost-effective soldier evaluation device by comparing soldier performance on field and SIMNET tests using the multitrait-multimethod matrix and analysis of variance technique. These tests were developed for use in the Soldier Performance Research Project (SPRP), which tested 120 tank crews on tactical skills. Soldiers also rated the similarity of performing the tasks on SIMNET and performing them on the M1 tank. The command and control (C^2) and communications performance dimensions exhibited acceptable levels of internal consistency and correlated significantly across the two methods. Low levels of reliability for the position location and combat driving dimensions appear to be due to the low number of items composing those dimensions. Soldiers rated the performance of tasks on SIMNET to be similar to the performance of tasks on the M1 tank. Results are encouraging for the use of SIMNET as a performance testing device for (C^2) and communications skills.

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Human Performance Effectiveness and Simulation

FOREWORD

The Commanding General, U.S. Army Training and Doctrine Command (TRADOC), wants to ensure that soldiers have the cognitive skills and training opportunities necessary to use the Army's high-technology weapon systems. In support, the U.S. Army Armor Center (USAARMC), with the assistance of the Army Research Institute for Behavioral and Social Sciences (ARI) Fort Knox Field Unit, has completed a two-phased Armor Soldier Performance Research Project (SPRP). Phase I demonstrated the effects of mental ability on the individual gunnery performance of initial-entry soldiers. Phase II demonstrated the impact of mental ability on collective combat performance, with a focus on command, control, and communication skills. Crews with higher quality tank commanders and drivers were considerably more effective on a high realism field test and on platoon-level tactical exercise on the Simulation Networking (SIMNET) system. The research reported here completes the Armor SPRP Phase II analyses by examining the feasibility and appropriateness of soldier performance evaluations using simulations such as SIMNET.

The ARI Fort Knox Field Unit's SPRP assistance was provided as Technical Advisory Service to USAARMC. The Assistant Commandant, U.S. Army Armor School was briefed on the results, which were also provided to the Training and Doctrine Command (TRADOC), Deputy Chief of Staff for Resource Management, in May 1989. While this report demonstrates the Fort Knox Field Unit's ongoing assistance to the Armor Center, it also represents ARI's research efforts to identify the most cost-effective applications of simulation-based training and performance evaluation.

EDGAR M. JOHNSON
Technical Director

THE COMPARABILITY OF AN ARMOR FIELD AND SIMULATION NETWORKING (SIMNET) PERFORMANCE TEST

EXECUTIVE SUMMARY

Requirement:

While field testing is the preferred method of performance assessment, high costs, increasingly limited maneuver space, and problems affecting reliability have prompted the use of devices and simulators for performance testing. Device-based testing is potentially cost-effective and manageable, but its use hinges on the reliability and validity of performance scores. This research evaluates the psychometric properties of a test of Armor crewman skills on the Simulation Networking (SIMNET) system.

Procedure:

Using data from the Soldier Performance Research Project (SPRP), the research compared the performance of 120 crews on a single tank field exercise and a platoon-level tactical exercise on SIMNET. Similar tasks were selected from the field and SIMNET tests representing four dimensions of performance: (1) command and control (C^2), (2) communications, (3) position location, and (4) combat driving. Soldiers also rated the similarity of performing the tasks on SIMNET and performing them on the M1 tank.

Findings:

Significant, but low, correlations were found between the field test and SIMNET test for C^2 and communications performance. These dimensions also exhibited acceptable levels of internal consistency. Overall levels of performance were also similar across the field and SIMNET tests. Low levels of reliability for the position location and combat driving dimensions were likely due to fewer items in these dimensions. Soldiers largely rated performance of tasks on SIMNET as similar to the field. Considering that the conditions between the two tests were not ideal for this type of research (i.e., the tasks not identical, differing circumstances surrounded the performance of tasks), it is encouraging that significant correlations were obtained for the C^2 and communications dimensions, despite their low strength.

Utilization of Findings:

The results of this research have been provided to the Armor School and Armor testing community so they may be aware of SIMNET's utility as a performance evaluation tool, particularly for C^2 and communications skills. This research suggests that SIMNET may be a useful and appropriate alternative for the performance evaluation of C^2 and communications skills when expense or other problems preclude the use of field testing.

THE COMPARABILITY OF AN ARMOR FIELD AND SIMULATION NETWORKING (SIMNET) PERFORMANCE TEST

CONTENTS

	Page
INTRODUCTION	1
Construct Validation	2
Objectives of the Research	3
METHOD	3
Participants	3
Task Selection and Composites	4
Task Similarity Questionnaire	4
Data Analysis	6
RESULTS AND DISCUSSION	6
Descriptive Statistics	6
Internal Consistency Reliability	7
Convergent and Discriminant Validity	9
Task Similarity Questionnaire	13
Comparison of the Rank Order of Task Similarity Questionnaire Composites and Convergent Validity Coefficients	14
GENERAL DISCUSSION	15
REFERENCES	17
APPENDIX A. SPRP DESCRIPTION	A-1
B. THE MULTITRAIT-MULTIMETHOD MATRIX	B-1
C. FIELD TEST EVENTS	C-1
D. SIMNET TEST EVENTS	D-1
E. FIELD TEST TASK LIST	E-1
F. SIMNET TEST TASK LIST	F-1

Page

LIST OF TABLES

Table 1. Means and standard deviations for the performance dimensions of the field and SIMNET tests 7

2. Internal consistency reliability, corrected reliability, and number of scale items for the performance dimensions of the field and SIMNET tests. 8

3. The multitrait-multimethod matrix. 10

4. Analysis of variance 12

5. Means and standard deviations for the Task Similarity Questionnaire items and composites 14

6. Rank order of Task Similarity Questionnaire composite scores and convergent validity coefficients 15

LIST OF FIGURES

Figure 1. Task Similarity Questionnaire 5

THE COMPARABILITY OF AN ARMOR FIELD AND SIMULATION NETWORKING (SIMNET) PERFORMANCE TEST

Introduction

Testing is an integral part of Army personnel decision-making. It begins with a battery of entrance tests used to select and classify recruits, including the determination of military occupational specialties (MOS). Soldiers continue to be evaluated throughout their enlisted careers to include assessments of training proficiency, job performance, and skill qualification. The majority of Army testing is conducted within the context of training activities; soldiers are tested to determine if they have reached a desired proficiency level as specified by the Army standard.

Performance testing, outside of the training context, is conducted by Army research and testing agencies for special manpower and personnel decision-making purposes. Developing acceptable performance tests for research and personnel decision-making involves strict consideration of proper test development procedures. Test items must be selected from a domain of applicable tasks and geared to the ability level of the subjects. This is more of an ordeal outside of training because adequately detailed Army performance standards are rarely available for the unique testing scenarios required in research. Regardless of the nature of the performance testing, the utility of the results are determined by the meaningfulness and dependability of the scores derived from the performance measures. This is of great importance for research and personnel decision-making purposes when the results could have a far-reaching and critical impact on individual soldiers or Army policy.

The majority of Armor crewmen evaluation involves field testing. The Armor community accepts field testing as the most relevant and realistic substitute for actual combat performance. However, high costs, increasingly limited tactical maneuver space, and problems affecting reliability and validity have prompted the use of devices and simulators for performance testing. Device-based testing is potentially cost-effective and manageable. It also has the potential to present a wide variety of scenarios that may better reflect battlefield conditions than traditional field tests, which must consider cost and safety. The utility of device-based testing hinges on the reliability and validity of the performance scores obtained.

The extent to which a test provides scores that are meaningful and dependable (that is, valid and reliable) is determined by the psychometric characteristics of the test. Reliability refers to the consistency of a test or its freedom from unsystematic errors which would make an individual's test score fluctuate. A particular type of reliability, internal consistency, is specifically concerned with the degree to which the items comprising a test are homogeneous. The closer the internal consistency reliability coefficient approximates + 1.0, the more the test items are measuring the same overall construct.

Adequate reliability is crucial because it sets a limit on validity. The more unsystematic variance present in the scores, the less true variance is present to correlate with a criterion. Validity refers to the ability of a test to measure what it purports to measure. This can be assessed by demonstrating that subject's test scores correlate with their scores on an already existing measure of that construct.

This report is concerned with the assessment of construct validity of a simulation-based performance testing device for M1 Armor crewmen. The determination of internal consistency and convergent and discriminant validity are two major parts of a construct validity paradigm. To this goal, this research uses data collected on a subset of items selected from a field test and a test using the Simulation Networking (SIMNET) system. These tests were developed and used in the Soldier Performance Research Project (SPRP) as measures of M1 Armor combat performance to determine if higher mental ability soldiers are better performers on combat critical skills (Graham, Leet, Elliott, Hamill, and Smith, 1989). The data selected for analysis in this research were from items that were similar across the two tests and represented four major areas of M1 Armor combat performance: command and control (C^2), communications, position location, and combat driving. Appendix A provides details of the SPRP field and SIMNET tests.

Construct Validation

Construct validation attempts to understand the construct or dimension of performance being measured and how well a test or tests measure the construct. Construct validity can not be determined through one study but requires an accumulation of evidence from several sources. Two sources of evidence for construct validity that will be assessed in this research are the internal consistency reliability and convergent and discriminant validity of the performance dimensions.

A popular method for assessing convergent and discriminant validity is through Campbell and Fiske's (1959) multitrait-multimethod (MTMM) matrix. Convergent validation seeks to demonstrate that scores on a construct measured by one method are related to scores on that construct as measured by another method. Discriminant validation seeks to show that scores on a measure of one construct are unrelated to scores on a measure of a different construct. See Appendix B for a thorough explanation of the MTMM matrix.

Although the popularity and utility of the MTMM matrix has been documented in the literature, it can be extremely awkward when dealing with several traits and/or methods. In response to this, Kavanagh, MacKinney, and Wolins (1971) proposed an analysis of variance (ANOVA) technique based on the correlation matrix used in the multitrait-multimethod approach. It transforms the correlation matrix into a more explicit, interpretable, and comparable form. Through this procedure, the variance contributions from the important sources can be determined. These four sources are a) Subject (convergent validity), b) Subject X Performance Dimension (discriminant validity), c) Subject X Method (method bias), and d) error. The quantification of method bias and error can not be determined through the MTMM matrix approach. This information can be especially useful to shed some practical light on the results.

Objectives of the Research

The problems associated with field testing have prompted the Army to search for relevant, dependable, and cost-effective means of assessing soldier performance. This research attempts to gather evidence concerning the construct validity of SIMNET as a device to measure soldier performance by comparing it to a well-planned and executed field test. The field and SIMNET test items were composited into four general areas of performance in the Armor combat performance domain. Specifically, this research is intended to:

1. Compare the performance levels attained on the four performance dimensions of the field and SIMNET tests.

2. Determine the internal consistency of the items comprising the performance dimensions of the field and SIMNET tests.

3. Gather convergent and discriminant validity evidence for the performance dimensions utilizing the MTMM matrix and ANOVA techniques.

4. Examine soldier's opinions concerning the similarity of task performance in the field and on SIMNET and to compare their opinions with the actual correlation of their performance on the two devices.

Method

Participants

The SPRP tested 120 TCs and 120 drivers MOS 19K (M1 Armor crewmen) soldiers which were selected from five Continental U.S. (CONUS) divisions (see Appendix A for more details of SPRP participant selection). The TC and driver pairs were combined with surrogate gunners and loaders to form reconstituted tank crews as part of a third day at war scenario. The SIMNET test also used surrogates to occupy the TC and driver positions of the other three tanks comprising the platoon. All 240 subjects completed the Task Similarity Questionnaire individually.

Task Selection and Composites

The data collected in the SPRP field and SIMNET tests provided an excellent opportunity to compare performance scores derived from a simulation exercise with actual field performance. Since the purpose of this research is to compare performance on the two tests, only the items that were similar across the two tests were selected for analysis. A subset of 87 tasks was selected from the field test which form four major performance dimensions: a) command and control (C^2), b) communications, c) position location, and d) combat driving. The 128 tasks selected from the SIMNET test represented the same four performance dimensions. Tasks were scored dichotomously for the field and SIMNET tests, Pass/Fail, according to Army criteria. Composite scores were determined by the sum of correct tasks and expressed as percentages. Appendices E and F contain the task lists for the field and SIMNET tests, respectively, including in which dimension each task is included.

Task Similarity Questionnaire

An additional measure designed specifically for this research is the Task Similarity Questionnaire. It is a ten item questionnaire which assesses soldier opinion concerning the similarity of performing tasks on SIMNET compared with the actual M1 tank.

Responses were given on a five-point Likert scale ranging from (1) completely different to (5) completely same task performance (Figure 1). Soldiers completed the questionnaire independently after completing the SIMNET test. Therefore, the unit of analysis is the soldier, not crew.

The first seven Task Similarity Questionnaire items were composited to parallel the four performance dimensions represented in the field and SIMNET tests. Items 1 and 2 were averaged to form the communications dimension, items 3 and 4 form the command and control dimension, items 5 and 6 form the position location dimension. Item 7 alone represented the combat driving dimension. Items 8, 9, and 10 were not included in the composites.

Task Similarity Questionnaire

This questionnaire asks you to compare the performance of the following activities on SIMNET with the performance of those activities on an actual M1 tank in the field. Please indicate your response by circling the appropriate number by each task.

Task	Task Similarity in SIMNET Compared to M1 Tank				
	Performed Differently............Performed Same				
	Completely Different	Mostly	Neutral	Mostly	Completely Same
	1	2	3	4	5
1. Giving combat reports	1	2	3	4	5
2. Following radio procedures	1	2	3	4	5
3. Commanding the crew	1	2	3	4	5
4. Directing engagements	1	2	3	4	5
5. Determining position location	1	2	3	4	5
6. Map reading	1	2	3	4	5
7. Combat driving	1	2	3	4	5
8. Security	1	2	3	4	5
9. Call and adjust indirect fire	1	2	3	4	5
10. Troop leading procedures	1	2	3	4	5

Figure 1. Task Similarity Questionnaire

One of SIMNET's design philosophies was selective fidelity. In an effort to limit costs, not all of the equipment was reproduced exactly as it appears on the M1, however, users should still perceive the module as realistic. Accordingly, the behavior necessary to carry out functions using the SIMNET M1 module should mimic the behavior required to carry out functions on the M1 tank. The Task Similarity Questionnaire was designed to determine if soldiers perceive a high degree of similarity between the performance of tasks on the SIMNET M1 module and the M1 tank. Soldier opinion of high similarity between the performance of tasks on the two pieces of equipment would lend support to the face validity of SIMNET. That is, SIMNET would appear to measure the skills or abilities that it purports to measure.

Data Analysis

Means and standard deviations were calculated for the performance dimensions of the Field and SIMNET tests. The Kudor-Richardson Formula 20 (KR-20) was used to determine the internal consistency of the performance dimensions for both tests. The Spearman Brown prophecy formula was used to correct the reliabilities for the number of items in the dimension. Pearson product moment correlation coefficients were calculated on the intercorrelations of the dimensions as measured by the two tests and formed the MTMM matrix. The correction for attenuation formula was applied to the convergent validity coefficients. The ANOVA procedure was used to determine the variance attributable to the four sources.

Means and standard deviations were calculated for the Task Similarity Questionnaire test items and composites. The rank order of the performance dimension composites (1 being the highest degree of similarity) was compared to the rank order of the convergent validity coefficients (1 being the highest correlation) from the MTMM matrix to determine if soldier's perceptions match their actual performance.

Results and Discussion

Descriptive Statistics

Table 1 presents the means and standard deviations for the field and SIMNET tests' performance dimensions. Performance on the two tests is roughly equivalent. The overall mean of the field test was 57% while the overall mean of the SIMNET test was 60%. Performance on the dimensions ranged between 40% and 80% for the field test and from 49% to 74% for the SIMNET test. This indicates that the test items were an adequate degree of difficulty for the crews tested in this research to avoid floor or ceiling effects. Each of the performance dimensions appears to have a sufficient amount of variability to discriminate among tank crews as evidenced by the standard deviations ranging from 10% to 18%. The most difficult items on the field test were those comprising the position location dimension with a mean score of 40%. The most lenient dimension was combat driving with a mean score of 80%. On the SIMNET test, communications was the most difficult dimension with a mean of 49% followed closely by position location (51%). The most lenient dimension was again combat driving with 74% correct on average.

Table 1

Means and Standard Deviations for the Performance Dimensions of the Field and SIMNET Tests

PERFORMANCE DIMENSION (N = 120)		FIELD	SIMNET
Command and Control	Mean	.55	.67
	SD	.14	.15
Communications	Mean	.53	.49
	SD	.13	.10
Position Location	Mean	.40	.51
	SD	.14	.12
Combat Driving	Mean	.80	.74
	SD	.18	.14
Grand Mean	Mean	.57	.60
	SD	.15	.13

Internal Consistency Reliability

KR-20 was used to calculate the internal consistency estimates for the performance dimensions. Table 2 displays those results. The C^2 and communications dimensions have an acceptable level of internal consistency, exceeding .70, on both tests. Internal consistency for the position location and combat driving dimensions is low with coefficients ranging from .26 to .65.

Reliability is affected by the number of items in the dimension. Therefore, direct comparisons of reliabilities from dimensions with differing number of items does not tell us if one dimension appears to be inherently more reliable than another. The Spearman Brown prophecy formula was used to correct the obtained level of reliability to that which would be expected if the dimension had 56 items. Fifty-six was chosen because that is the number of items in the dimension with the greatest number of items, namely the communications dimension on the SIMNET test. This correction assumes that the additional items would be of the same quality (degree of homogeneity) as the original items. An examination of the corrected reliabilities indicates that the addition of new items would have a profound effect on the level of reliability that could be obtained for position location and combat driving on both tests. The corrected reliabilities for these dimensions are .69 and above. The most striking improvement occurred for the combat driving dimension which contained the least number of items, 6. The level of internal consistency improved from .26 to .77. By applying this correction, it is evident that the position location and combat driving dimensions are not inherently less reliable than the C^2 or communications dimension, but they are less reliable in this research because of the fewer number of items comprising these dimensions in the field and SIMNET tests.

Table 2

Internal Consistency Reliability, Corrected Reliability, and Number of Scale Items for the Performance Dimensions of the Field and SIMNET Tests.

PERFORMANCE DIMENSION (N = 120)		FIELD	SIMNET
Command and Control	KR-20	.71	.82
	$r_{cc'}$	.82	.89
	# of Items	31	32
Communications	KR-20	.78	.76
	$r_{cc'}$	.84	.76
	# of Items	38	56
Position Location	KR-20	.39	.41
	$r_{cc'}$	.78	.69
	# of Items	10	18
Combat Driving	KR-20	.26	.65
	$r_{cc'}$	.77	.83
	# of Items	6	22
Mean	KR-20	.54	.66
	$r_{cc'}$	.80	.79
	Total Items	85	128

Note. $r_{cc'}$ = corrected reliability.

The reliability results indicate a good degree of internal consistency for the C^2 and communications dimensions on both tests meaning the items comprising those dimensions appear to be measuring the same construct. However, there is not an adequate level of internal consistency for the position location and combat driving dimensions. The Spearman Brown prophecy formula illustrated that acceptable levels of reliability could be obtained for those dimensions with the addition of more items. However, the obtained levels of reliability, not the corrected reliabilities, are the main consideration in this research.

Convergent and Discriminant Validity

Table 3 presents the MTMM matrix. The traits refer to the performance dimensions: C^2, communications, position location, and combat driving. The methods refer to the field and SIMNET tests. The MTMM matrix displays the Pearson product moment correlation coefficients between the same dimension measured by the same method, different dimensions measured by the same method, the same dimension measured by different methods, and different dimensions measured by different methods. The matrix thereby shows the intercorrelations of the four dimensions measured by both the field and the SIMNET tests.

The convergent validity coefficients in the main diagonal of the different dimension, different method block are displayed in bold. These are correlations between the performance dimensions as measured by the field test and the SIMNET test. These correlations should be significantly different from zero to warrant further investigation. Two of the four coefficients meet this qualification, C^2 ($p < .05$) and communications ($p < .01$). Although significant, these correlations are low.

Although it was cited earlier that the C^2 and communications dimensions had an adequate degree of internal consistency, the reliability levels were still not perfect and therefore put a limit on the validity coefficient that could be obtained. However, it is possible to estimate the true correlation between performance on the dimensions as measured by the two methods by correcting for the unreliability in the measures (Cascio, 1982). This correction would estimate the true relationship between the two measures of the construct. More specifically, are the scores derived from the SIMNET test good measures of performance on the dimensions as defined through the field test? It is appropriate to apply the correction for attenuation formula to both measures. Through this process, the correlations for the C^2 and communications dimensions were increased from .20 and .43 to .26 and .56, respectively. The correlations do not increase substantially through this process and therefore were only slightly inhibited by unreliability in the measures. This procedure is not applied to the convergent validity coefficients for the position location and combat driving dimensions because they must be significant, there must be some relationship to begin with, to make tha correction meaningful.

Table 3

The Multitrait-Multimethod Matrix

Method/ dimension (N = 120)	FIELD				SIMNET			
	C^2	CO	PL	CD	C^2	CO	PL	CD
FIELD								
C^2								
CO	.40**							
PL	.24**	.21*						
CD	.08	.02	.11					
SIMNET								
C^2	.20*	.03	.10	.11				
CO	.03	.43**	.15*	.01	.08			
PL	.12	.10	.09	.07	.07	.41**		
CD	.13	.03	.04	.03	.13	.16*	.58**	

Note. The main diagonal correlations in bold are convergent validity coefficients. The solid triangles enclose correlations between the performance dimensions measured by the same method. The dashed triangles enclose correlations between the performance dimensions measured by different methods. C^2 = command and control, CO = communications, PL = position location, CD = combat driving. Underlined correlations are negative.
* $p < .05$, ** $p < .01$.

The next step in interpreting the MTMM matrix involves the determination of discriminant validity for those dimensions with significant convergent validity coefficients. Evidence of discriminant validity is displayed if the correlations between the dimensions as measured by each method or the correlations of different dimensions as measured by different methods are lower than the convergent validity coefficients. The advantage of using the MTMM matrix is in being able to compare the size of correlations. Therefore, the convergent validity coefficients, same dimension measured by the two methods, should be higher, comparatively than the discriminant validity correlations in which different dimensions and different methods are employed.

Discriminant validity is assessed in three ways. First, the values in the validity diagonal should be higher than the values in its row or column in which neither dimension nor method are in common. The C^2 and communications dimensions meet this qualification in all six cases each.

Discriminant validity is also demonstrated if a variable correlates higher with a different method measuring the same dimension than with measures of different dimensions which employ the same method. Therefore, the validity coefficient for the C^2 dimension should be higher than the correlations of the C^2 dimension with the communications, position location, or combat driving dimensions as measured by each method. This requirement is met for C^2 in four of the six cases. The validity coefficient of .20 is surpassed by the correlation of .40 and .24 which are the correlations between the C^2 and communications dimensions and the C^2 and position location dimensions for the field test, respectively. This would imply that for these particular dimensions as measured by the field test, it matters more what method is used than which performance dimension is being measured. The communications dimension meets this requirement in all six cases.

The third way of assessing discriminant validity involves an examination into the pattern of dimension interrelationships. The same pattern should be present in all of the different dimension triangles of both the same method and different method blocks. Therefore, if the correlation between C^2 and communications is the highest one on the field test then it should also be highest on the SIMNET test. Then the next highest correlation should be maintained for both tests, etc. This would display stability of the relationships among the dimensions which would indicate that both methods are measuring these dimensions in the same way. This pattern does not occur. The correlation with C^2 and communications is highest for the field test but lowest for the SIMNET test. The correlation between combat driving and position location is the highest for SIMNET. Therefore, the same method correlations (solid triangles) do not substantiate this type of discriminant validity. Because all but one of the correlations in the different method block (dashed triangles) are non-significant and essentially equal to zero, this determination of pattern of dimension interrelationships can not be made. This indicates that the interrelationships among the dimensions are different depending upon the measuring device.

In sum, the MTMM matrix provides some evidence of convergent validity for the C^2 and communications performance dimensions. Evidence of discriminant validity exists for the C^2 dimension and more for the communications dimension. However, the differing patterns of dimension interrelationships dilutes this finding.

The analysis of variance procedure suggested by Kavanagh et al. (1971) provides a way of quantifying the amount of convergent and discriminant validity, as well as method bias and error. The results of this analysis are presented in Table 4. The results of the main effect and interactions indicate that each source is significant ($p < .001$). The significant Subject variance indicates that there is differentiation among test crews attributable to the method or test. In other words, there is a significant amount of convergent validity.

There is also ordering of test crews on the different performance dimensions as indicated by the significant Subject X Dimension interaction (discriminant validity). This implies a significant degree of method discriminations on dimensions by the test crews. The Subject X Method interaction is also significant indicating a large degree of method variance in the scores, which is not desirable. This indicates that a crew's score is dictated to some degree by the method being used.

Table 4

Analysis of Variance

Source	df	MS	F	Variance Component
Subject (test crews)	119	1.91	2.79*	.1850
Subject X Dimension	357	.94	1.39*	.1131
Subject X Method	119	1.29	1.88*	.1351
Error	357	.68		.6923

Note. * $p < .001$.

Through this procedure, it is desirable to attain significant F-ratios and large variance components for the convergent and discriminant validity effects and an insignificant F-ratio for method bias and low variance components for method bias and error. Although the F-ratios are significant for the convergent and discriminant validity effects, they do not account for a substantial amount of variance. Method bias accounts for more variance than discriminant validity. Also, there is a large degree of error variance, larger than any other effect. This indicates that more variance is attributable to other sources than to the methods and dimensions.

The results concerning the convergent and discriminant validity as determined through the ANOVA procedure are the same as was derived through the MTMM matrix. That is, there is some evidence, although not compelling, for the convergent and discriminant validity of the performance dimensions. The large amount of variance attributable to method bias supports the differing pattern of dimension interrelationships found through the MTMM matrix. The ANOVA procedure defined the importance and strength of this effect. The procedure also uncovered the large amount of error variance which questions the practical significance of the convergent and discriminant validity findings.

There are several possible reasons why the convergent validity coefficients were low. Ideally, for this type of research, the test items and the scenarios surrounding the performance of those items should be the same across the two methods. The tests were designed with a different purpose in mind for the SPRP, so these conditions were not met. Most of the items were the same across the two tests, although some were not. Some items were chosen because they were representative of the performance dimensions. The field test was a single tank exercise while the SIMNET test was platoon-level. Also, different scenarios and different enemy engagements were used for each test. Another explanation may be that the subjects were naive to SIMNET before their participation in the SPRP. Although they were trained on SIMNET as well as time and money allowed, this type of research should be conducted with subjects experienced on the device and in the field in order to maximize validity coefficients (Hoffman & Morrison, 1988).

All of these factors are likely to contribute to lower validity coefficients. Therefore, it is encouraging that even significant correlations were obtained for the C^2 and communications dimensions. Unfortunately, the low levels of reliability present in the position location and combat driving dimensions, hindered the attainment of significant convergent validity coefficients for those dimensions.

Task Similarity Questionnaire

The purpose of the Task Similarity Questionnaire is to determine how soldier's perceived performing tasks on SIMNET. Specifically, how similar was performing a task on SIMNET compared to performing that task on the M1 tank? The means and standard deviations for the Task Similarity Questionnaire items and composites are presented in Table 5. The unit of analysis for the Task Similarity Questionnaire was the individual soldier, not crew. Ratings on the ten items were made on a five-point scale ranging from "performed completely different" to "performed completely the same" on SIMNET compared to the M1 tank.

Opinion on the similarity of task performance is on the average "mostly the same". This indicates that soldier's perceived the SIMNET M1 module to have good face validity. That is, performing tasks on SIMNET was mostly the same as performing them on the M1 tank.

Table 5

Means and standard deviations for the Task Similarity Questionnaire items and composites.

Task	Mean	SD
Giving combat reports	4.33	.95
Following radio procedures	4.44	.88
Commanding the crew	4.29	.90
Directing engagements	4.05	1.03
Determining position location	3.30	1.25
Map reading	3.36	1.28
Combat driving	3.36	1.26
Security	3.55	1.18
Call and adjust indirect fire	4.09	1.10
Troop leading procedures	4.23	.92
Grand Mean	3.89	1.08
C^2 Composite	4.17	.84
CO Composite	4.38	.81
PL Composite	3.33	1.13
CD Item	3.36	1.26

Note. N = 240. C^2 = Command and Control, CO = Communications, PL = Position Location, CD = Combat Driving.

Comparison of the Rank Order of Task Similarity Questionnaire Composites and Convergent Validity Coefficients

The rank order of the performance dimension composites on the Task Similarity Questionnaire and the rank order of convergent validity coefficients from the MTMM matrix are presented in Table 6. Rankings from the two sources are consistent. The communications dimension received the highest similarity score on the Task Similarity Questionnaire and was the highest convergent validity coefficient. The C^2 dimension received the second highest ranking in both cases. The position location and combat driving dimension convergent validity coefficients are non-significant and essentially equal to zero. Likewise, the composite Task Similarity Questionnaire scores for those two dimensions are not statistically different from one another (T-value = .40, p = .69). So, in both cases, the Task Similarity Questionnaire composites and convergent validity coefficients, the position location and combat driving dimensions basically tie for the third and fourth place rankings. Therefore, soldiers opinions on the similarity of task performance on the M1 tank and the SIMNET M1 module are similar to the correlations of their actual performance on the two pieces of equipment.

Table 6

Rank Order of Task Similarity Questionnaire Composite Scores and Convergent Validity Coefficients.

	Task Similarity Questionnaire	Convergent Validity Coefficients
C^2	2 (4.17)	2 (.20)
Communications	1 (4.38)	1 (.43)
Position Location	4 (3.33)	3 (.09)*
Combat Driving	3 (3.36)	4 (-.03)*

Note. * These coefficients are not significantly different from zero, therefore, essentially equal to zero, so their rankings could easily be reversed.

General Discussion

The results provide some evidence for the construct validity of the SIMNET performance dimensions measuring C^2 and communications skills. Therefore, expensive and perhaps psychometrically confounded field testing might be replaced by SIMNET testing for certain research and other personnel-related functions. The level of performance and degree of variability in the scores obtained on the dimensions through the SIMNET test were comparable to those obtained through the field test. The level of internal consistency was acceptable for the C^2 and communications dimensions on the SIMNET test and comparable to the field test. The MTMM matrix and ANOVA procedure provided some evidence for the convergent and discriminant validity of the C^2 and communications dimensions. Also, soldiers rated the performance of tasks on the SIMNET M1 module to be similar to the performance of tasks on the M1 tank. An examination of their ratings on performance dimension composites indicated that their ratings on the similarity were similar to the correlation of their performance on the two pieces of equipment.

Although the SPRP data provided an excellent opportunity to examine the relationship of crew performance in the field and using the SIMNET system, conditions were not ideal. Differing tasks and scenarios and device-naive subjects are all factors likely to have reduced the validity coefficients. With these obstacles working to impede high correlations between crew performance on the tests, it is encouraging that significant correlations were obtained for C^2 and communications anyway. It is likely that the correlations would be even higher if test scenarios and tasks were constant for the two tests.

It is also possible that significant correlations could be found for the position location and combat driving dimensions. The Spearman Brown prophecy formula demonstrated that sufficiently reliable tests could be developed for these dimensions if an adequate number of items were used.

In conclusion, SIMNET would appear to provide reliable and valid test scores for the C^2 and communications performance dimensions, but not for the position location or combat driving dimensions. This is consistent with SIMNET's design philosophy as it contends to train and test C^2 and communications skills. However, differences in equipment and design limitations make training and testing position location or combat driving skills questionable. But, the possibility still exists for significant correlations between performance as measured through the two methods for these dimensions which can only be determined when reliable tests are employed. This research suggests that SIMNET utility can be increased by applying it to performance evaluation in addition to its other applications.

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APPENDIX A

SPRP DESCRIPTION

Participants

The SPRP tested 120 TCs and 120 drivers MOS 19K (M1 Armor crewmen) soldiers which were selected from five Continental U.S. (CONUS) divisions. Soldiers were selected on the basis of their classification into one of four mental categories as defined by the Armed Forces Qualification Test (AFQT). An equal number of TCs and drivers were selected from each level of mental category. The 16-cell (4 x 4) design was filled systematically by TC and driver pairs distributed equally from the units in order to counterbalance unit training effects. Because testing took place by division, TCs and drivers were paired from the same division, but not platoon. The TC and driver pairs were combined with surrogate gunners and loaders to form reconstituted tank crews as part of a third day at war scenario. The SIMNET test also used surrogates to occupy the TC and driver positions of the other three tanks comprising the platoon.

Field Test

The field test was designed to measure M1 tank crew combat performance with the emphasis on C^2 and communications skills through a single tank tactical exercise performed in a realistic combat field setting. The test crews were required to prepare their tank for combat and move 15 kilometers to join their newly assigned company at the forward edge of the battle area. The crews' orders were to move as quickly as possible, but to engage any enemy stragglers encountered. Eight stations were ordered around the test course although the test appeared continuous to the test crews. Station 1 required the crew to prepare their tank for combat. Stations 2 through 8 involved encounters with friendly military police and engagements with enemy infantry and Armor forces. See Appendix C for a description of the field test stations.

The field test was designed to be realistic and stressful to best approximate an actual combat situation. Safety concerns warranted the use of blank ammunition so Hoffman charges were used to simulate tank fire. OPFOR vehicles, Sheridan tanks visually modified to resemble Soviet tanks, used fire extinguisher smoke to indicate destruction of their vehicle. The number of rounds fired to obtain a hit was held constant for each crew tested. To induce stress at one point during the test, the surrogate loader simulated his death from gunfire with the use of fake blood. The TC was then required to reconfigure for a three-man crew.

The field test data was gathered on task checklists and compiled onto a score sheet. Most of the data collectors were at an observation post which overlooked the field test site. The intercoms used by the test tanks to send reports and radios which relayed all of the conversations from within the test tank were monitored. Recordings were made of tank conversations and reports for subsequent verification of data. Some data collection was conducted by the confederate loaders and drivers within the test tanks and observers along the test course.

SIMNET Test

The SIMNET test was designed to measure crew combat performance through a platoon tactical exercise. The test crew and surrogate crews each occupied a SIMNET M1 module designed to accommodate the full range of command, control, and communications tasks. The CIG graphics displayed the SIMNET terrain and battle elements which the test crews viewed through their vision blocks. The test crews joined the platoon as wingman to the Platoon Sergeant. The operations order told the crew that the enemy was forming hasty battle positions at a designated point. Eight events, consisting of engagements with enemy tanks and helicopters and platoon formations, were ordered along the test course. See Appendix D for a description of the SIMNET test events.

Before being tested on SIMNET, the research participants underwent a training program to familiarize themselves with the SIMNET system. Training began with 20 minutes of classroom instruction. Next, the soldiers participated in 40 minutes of hands-on experience going through a familiarization course where the crews maneuvered cross country, engaged targets, and learned how the module reacted to terrain features. The last part of training included 60 minutes of exercises in which the instructor gave limited assistance. At the end of training, the soldiers were tested on a 30 minute certification course in which they had to complete all of the critical tasks satisfactorily.

SIMNET data was gathered by multiple data collectors using checklists and compiled onto a master scoring sheet. The tank intercom and radio transmissions by the test crew to higher headquarters were monitored. The Plan View Display, which allows a "bird's eye view" of the battlefield, and shadowbox with three driver sites and the TC's middle site were also monitored. Some of the data were corroborated with the use of the DataLogger, which is a data collection and analysis feature of SIMNET.

APPENDIX B

THE MULTITRAIT-MULTIMETHOD MATRIX

A popular method for assessing convergent and discriminant validity is through Campbell and Fiske's (1959) multitrait-multimethod (MTMM) matrix. Convergent validation seeks to demonstrate that scores on a construct measured by one method are related to scores on that construct as measured by another method. Discriminant validation seeks to show that scores on a measure of one construct are unrelated to scores on a measure of a different construct.

		Method 1				Method 2			
	Traits	A_1	B_1	C_1	D_1	A_2	B_2	C_2	D_2
Method 1	A_1	(r_1)							
	B_1	x_{11}	(r_2)						
	C_1	x_{11}	x_{11}	(r_3)					
	D_1	x_{11}	x_{11}	x_{11}	(r_4)				
Method 2	A_2	(V_1)	x_{21}	x_{21}	x_{21}	(r_5)			
	B_2	x_{21}	(V_2)	x_{21}	x_{21}	x_{22}	(r_6)		
	C_2	x_{21}	x_{21}	(V_3)	x_{21}	x_{22}	x_{22}	(r_7)	
	D_2	x_{21}	x_{21}	x_{21}	(V_4)	x_{22}	x_{22}	x_{22}	(r_8)

Figure 2. An Example of a Multitrait-Multimethod Matrix

Figure 2 provides an illustration of a MTMM matrix using two methods (1 and 2) for measuring four traits (A, B, C, and D). The reliability diagonal (r_1 - r_8) represents internal consistency estimates for the items comprising each of the four traits as measured by each method. The validity diagonal (V_1 - V_4) contains correlations which represent the extent of agreement between the two methods for measuring the same trait (convergent validity). For example, V_1 is the correlation between subject's scores on Trait A, Method 1 and Trait A, Method 2. Convergent validity coefficients should be significantly different from zero to encourage further investigation. The higher the coefficient, the more the two methods are measuring the same trait.

Discriminant validity is assessed in three ways. First, the correlations in the validity diagonal should be higher than the correlations in its row or column in which neither trait nor method are in common. For example, V_1 should be greater than the

x_{21} correlations below or to the right of it. Discriminant validity is also demonstrated if the correlations between the same trait measured by the different methods are higher than the correlations of different traits measured by the same method. So, the correlation of A_1 with A_2 (V_1) should be greater than A_1 with B_1, C_1, or D_1 or A_2 with B_2, C_2, or D_2. Also, the same pattern of trait interrelationships should be shown in all of the different trait triangles of both the same method and different method blocks. Therefore, the intercorrelations of $A_1 - D_1$, and $A_2 - D_2$ (same method, solid triangles) should rank in a similar order and the correlations of $A_1 - D_1$ with $A_2 - D_2$ (different method, dashed triangles) should rank in a similar order. For example, if Trait A is most highly intercorrelated with Trait C using Method 1, they should also be the most highly correlated using Method 2. Likewise, if Trait A, Method 1 is most highly correlated with Trait B, Method 2, then Trait B, Method 1 should be most highly correlated with Trait A, Method 2. This would show that the relationship between the traits is the same for both methods.

APPENDIX C

FIELD TEST EVENTS

Station 1
Brigade Support Area

The brigade support area (BSA) was a tactical station which replicated, as closely as possible, a portion of a BSA in a combat situation. The crew members met each other for the first time and were told to prepare an M1 tank for combat. The TC was given the mission of taking the tank forward to a battalion currently in contact. The tank required ammunition upload, refueling, preventative maintenance checks and services (PMCS), and prepare-to-fire checks. There were four induced faults in the vehicle that the TC had to find and correct. In addition, the TC had to assist the gunner in preparing his station. The TC was required to conduct communications checks, enter a radio net, post an overlay, and review his orders with the crew. The operations order required that the time spent in the BSA was approximately two hours.

Station 2
Surprise Engagement with Disabled T72 and T72 in Overwatch

At a designated point in the road, the surrogate loader identified two tanks to be engaged at about 1200 meters. The TC was required to lay the main gun on the overwatch tank (most dangerous target) and give proper fire commands for the engagement. When the first T72 was engaged, it gave a visual signature that it has been hit (fire extinguisher smoke). The crew was then to engage the second T72. The second T72 gave an indication of having been hit after the first round was fired and its crew evacuated the vehicle and ran into the woods. The driver should have then turned the frontal armor toward the targets, terrain permitting. The TC was required to engage both crews with his machine gun. The TC should have reported the action to his higher headquarters giving a correct location and directing his crew to assume a battlecarry posture with SABOT loaded.

Station 3
ATGM Ambush in Minefield

The TC was required to correctly locate the minefield from an overlay he was given at the BSA. The TC should have directed the driver to a cleared and marked lane through the minefield and control the driver's progress through it. As the tank approached a point at about one-third through the minefield, it was engaged by an anti-tank guided missile (ATGM) from a vehicle partially concealed 1500-2000 meters to the direct front. The gunner was to acquire the ATGM blast and alert the TC who should have immediately issued a fire command against the OPFOR vehicle. The

TC should then have directed the driver to rapidly move forward out of danger firing at the OPFOR vehicle with the main gun and/or TC's machine gun. The gunner continued to engage until the TC determined the target was destroyed. Another possible solution to the situation was for the TC to direct the driver to move rapidly backward, activating vehicle smoke. In 15 to 20 seconds when the smoke had sufficiently cleared, the TC would lay the main gun on the target and continue to engage until destroyed. The TC would then direct the proper battlecarry posture and submit a correct report.

Station 4
Meeting Engagement with Enemy Stragglers: Loader Killed

At this station, the TC acquired three enemy soldiers at approximately 40 meters about the same time the enemy soldiers opened fire on the tank with automatic rifle fire. The loader was killed. The loader had a bag of fake blood which he squirted over the inside of the tank and the TC in order to make his death convincing and stressful to the TC. The TC engaged the enemy with the coax machine gun, or directed the gunner to engage the enemy with his machine gun. The TC checked the loader and determined him to be dead. The TC should have then submitted a correct report to his higher headquarters and requested instructions. He was told to leave the loader by the side of the road and he would be picked up later. The TC, gunner, and driver were to evacuate the loader to the side of the trail, prepare the tank for operation in a three-man crew configuration, and proceed.

Station 5
Military Police Traffic Check Point

As the tank approached the traffic check point (TCP), the TC should have recognized the TCP as friendly military police (MP). The TC stopped the tank, and the MP checked the TC's navigation. The TC then proceeded, according to the MP's directions, toward the correct location.

Station 6
Meeting Engagement with T72 and BMP at Short Range

A T72 leading an enemy infantry vehicle, or BMP, appeared heading the opposite way along the route of the tank at short range (under 500 meters). As soon as the TC acquired the T72 he should have layed on the main gun, announced "On the Way", and fired. After the first round was fired, there was no indication that the target had been hit. The TC was required to re-engage the T72. The TC was then to engage the BMP as it unmasks from behind the T72. The BMP was destroyed on the first round. The TC should have then directed the correct battlecarry posture and submitted a correct report of the action.

Station 7
Automatic Weapons Ambush: TC and Gunner Killed

A close range (100 meters) automatic weapons ambush occurred in which the TC was immediately killed. The loader (formerly the gunner) was able to communicate to the driver that the TC was killed and he was hit and losing consciousness. At this point, the driver, under his own initiative, was to move the tank out of the kill zone, determine crew status, submit a report giving vehicle location, and report casualties. The driver was then directed to proceed. He was stopped at the end of the lane (a short time later) by controllers. He was then required to correctly identify his unit, mission, and determine his location.

APPENDIX D

SIMNET TEST EVENTS

Event I
Crew Joins Platoon as Wingman

The TC received an order and entered the platoon radio net. The crew then operated as part of a tank platoon during a tactical road march. The TC was required to properly supervise the positions of the tank during movement and short halts. At the direction of the platoon leader, the platoon assumed several formations such as the coil, herringbone, and vee. The tank was to move tactically as the wingman for the platoon sergeant (PSG). When told, the crew should have properly executed an action drill by orienting the main gun in the proper direction and maintaining movement, orientation, and position. Shortly thereafter, the tank was to perform an air attack drill. The TC was then to issue a proper fire command. The TC was asked by the PSG to determine the platoon's location.

Event II
Platoon Encounters Bridge

The platoon formation encountered a bridge. The driver was to maintain the proper position with respect to the PSGs tank and the proper overwatch. The TC must have determined the location of the bridge and send a spot report (SPOTREP) stating that they were crossing the bridge and give the bridge's correct location.

Event III
Three T72s are Observed

The platoon conducted a meeting engagement with an enemy tank platoon. The PSG acquired the targets, directed a contact drill, and asked the TC to issue a contact report. The crew then began an action drill. The driver was required to maintain proper position. The tank should have then used proper engagement priorities. When all enemy tanks had been destroyed, the TC should have sent a SPOTREP reporting their activity and location. Then the friendly platoon resumed movement during which execution of section formations and drills were evaluated.

Event IV
Enemy ATGM Attacks Formation

The platoon was attacked by helicopters. During the attack, the PSG's tank was destroyed. The tank should have engaged the helicopter, issued a contact report, executed a contact drill, and conducted an air attack drill. The platoon resumed movement with the tank now assuming the PSG position in the platoon. The TC was required to send a situation report stating the action encountered, casualties, location, and their new position in the platoon formation. The platoon resumed in a vee formation and the crew was evaluated on the execution of that formation and drills.

Event V
Reaction to ATGM Ambush

The crew reacted to an ATGM ambush, The TC was required to issue the contact report and fire command. The tank should have taken evasive action (TC and driver responsibility) and engaged the enemy until the enemy was destroyed. The TC was required to submit a proper SPOTREP.

Event VI
React to Indirect Fire

The crew reacted to indirect fire by speeding through the area. The TC was then required to give a SPOTREP describing what happened and the proper location of the activity.

Event VII
Engagement From Hasty Battle Position

The crew was required to assume a hasty fighting position and engage a reinforced motorized rifle company (MRC) as part of the platoon. The platoon leader issued a platoon fire command. As part of the platoon, the crew unmasked from a hill top and engaged the MRC. The MRC was in platoon columns approximately 2,500 meters in front of the fighting position. As the MRC was taken under fire, it returned fire and moved into a company line to assault the fighting position. All the enemy tanks were destroyed. The other friendly tank had a mobility failure (shears a sprocket) in a partially exposed position. The three surviving BMPs from the MRC took effective cover approximately 1,500 meters to the front of the fighting position. The test crew was aboard the only undamaged tank remaining in the platoon. The TC was required to enter the company radio net and report. The TC requested instructions.

Event VIII
Request and Adjust Indirect Fire

The Company Commander sent coordinates of other platoons. The tank could not take the targets under effective direct fire. The TC was required to call for and adjust indirect fire on the target.

APPENDIX E

FIELD TEST TASK LIST

	TASK	PERFORMANCE DIMENSION
1.	Minefield plotted on map	PL
2.	Plot matches decoded coordinates	PL
3.	TC lays on most dangerous target	C^2
4.	Proper fire command elements "Gunner"	C^2
5.	"Sabot" (or Battlesight)	C^2
6.	"Two tanks"	C^2
7.	"Right tank"	C^2
8.	Waits for "Up" & "Identified"	C^2
9.	"Fire and adjust"	C^2
10.	Drives at constant speed or seeks hull-down	CD
11.	Submits report without being cued	COMMO
12.	Elements of report -Correct call sign	COMMO
13.	Type of report: "Spotrep"	COMMO
14.	What happened: "Destroyed two T72s"	COMMO
15.	Grid: (+/- 200 meters)	PL
16.	Correct "Time"	COMMO
17.	What you are doing: "Continuing Mission"	COMMO
18.	TC directs driver to use cleared lane	C^2
19.	TC directs driver through minefield or dismounts loader	C^2
20.	Vehicle visibly stays in cleared lane	CD
21.	TC directs driver to speed up or backup and engage smoke	C^2

22.	Driver protects tank after ATGM is launched	CD
23.	Proper fire command elements "Gunner"	C^2
24.	"Sabot" (or Battlesight)	C^2
25.	"PC" (or BMP)	C^2
26.	"Fire"	C^2
27.	"Fire Heat"	C^2
28.	Submits report without being cued	COMMO
29.	Elements of report -Correct call sign	COMMO
30.	Type of report: "Spotrep"	COMMO
31.	What happened: "Destroyed 1 BMP"	COMMO
32.	Grid: (+/- 200 meters)	PL
33.	Correct "Time"	COMMO
34.	What you are doing: "Continuing Mission"	COMMO
35.	Proper fire command elements "Coax"	C^2
36.	"Troops"	C^2
37.	"Fire and Adjust"	C^2
38.	"Caliber .50"	C^2
39.	Driver positions tank appropriately	CD
40.	TC moves gunner to loader's position	C^2
41.	TC prepares weapon station	C^2
42.	Submits report without being cued	COMMO
43.	Elements of report -Correct call sign	COMMO
44.	Type of report: "Spotrep"	COMMO
45.	What happened: "Destroyed"	COMMO
46.	Grid: (+/- 200 meters)	PL
47.	Correct "Time"	COMMO

48.	What you are doing: "Continuing Mission"	COMMO
49.	Submits casualty report without being cued	COMMO
50.	Elements of report -Personnel battle loss report or "Red 2"	COMMO
51.	Identifies correct battle roster number	COMMO
52.	Correct "Date/Time"	COMMO
53.	"4A"	COMMO
54.	"Left body on tank"	COMMO
55.	Identifies correct grid (+/- 200 meters)	PL
56.	Identifies route on map correctly	PL
57.	Takes correct turns in route to Station 6	PL
58.	Proper fire command elements "Battlesight"	C^2
59.	"Tank"	C^2
60.	Waits for "Up"	C^2
61.	"On the way"	C^2
62.	Driver protects tank	CD
63.	TC announces "On The Way"	C^2
64.	TC or Driver announces "Target"	C^2
65.	TC engages BMP "On the Way"	C^2
66.	TC or Driver announces "Target"	C^2
67.	TC engages troops with CAL .50	C^2
68.	Proper fire command "Caliber .50"	C^2
69.	Submits report without being cued	COMMO
70.	Elements of report -Correct call sign	COMMO
71.	Type of report: "Spotrep"	COMMO
72.	What happened: "Destroyed T72 and PC"	COMMO

73.	Grid: (+/- 200 meters)	PL
74.	Correct "Time"	COMMO
75.	What you are doing: "Continuing Mission"	COMMO
76.	Driver protects tank	CD
77.	Driver submits report without being cued	COMMO
78.	Elements of report -Correct call sign	COMMO
79.	Type of report: "Spotrep"	COMMO
80.	What happened: "Four to Six/Infantry Ambush"	COMMO
81.	What you are doing: "Continuing Mission"	COMMO
82.	Submits casualty report without being cued	COMMO
83.	Elements of report -Identifies TC as casualty	COMMO
84.	Identifies gunner as casualty	COMMO
85.	Driver locates his position	PL

APPENDIX F

SIMNET TEST TASK LIST

	TASK	PERFORMANCE DIMENSION
1.	Maintains visual contact with PSG's tank	CD
2.	Maintains position 100-150 meters from PSG's tank	CD
3.	Takes up position on opposite side of column from PSG's tank	CD
4.	Maintains correct gun tube orientation	PL
5.	Driver orients vehicle at 3 o'clock position	CD
6.	Driver maintains gun tube orientation	PL
7.	Driver takes proper position	CD
8.	Driver pulls tank off route and stops	CD
9.	TC ensures gun covers the column's rear and tank is within sight of the other tanks	C^2
10.	Wingman takes proper position	CD
11.	Wingman maintains overwatch	CD
12.	Driver turns vehicle 90 degrees to left	CD
13.	Maintains visual contact with PSG	CD
14.	Driver takes proper position	CD
15.	Gun tube orientation	PL
16.	Makes sudden turns	CD
17.	Driver changes speed	CD
18.	Maintains proper gun tube orientation	PL
19.	Driver orients vehicle at 3 o'clock position	CD
20.	Gun tube orientation	PL
21.	Grid coordinates (+/- 200 meters)	PL

22. Driver maintains proper position	CD
23. Proper overwatch	CD
24. Sends Spot Report without cue	COMMO
25. Elements of report -Grid coordinates (+/- 200 meters)	PL
26. Activity "Crossing Bridge"	COMMO
27. "Continuing mission"	COMMO
28. Contact Report elements "Contact"	COMMO
29. "Three tanks"	COMMO
30. "WEST"	PL
31. Driver turns own tank toward enemy tank	CD
32. Driver maintains proper position	CD
33. Proper fire command elements "Gunner"	C^2
34. "Sabot"	C^2
35. "Three tanks"	C^2
36. "Left tank first"	C^2
37. "Fire"	C^2
38. Wingman bounds, maintains proper position	CD
39. Engages until all tanks are destroyed	C^2
40. Sends report to platoon leader w/o cue	COMMO
41. Elements of report -Identifies "SPOTREP"	COMMO
42. Correct Call sign ("red 3")	COMMO
43. "Destroyed three T72s"	COMMO
44. Number of rounds fired	COMMO
45. Driver maintains proper position	CD
46. Gun tube orientation	PL
47. Contact Report elements "Contact"	COMMO

48.	"North"	PL
49.	"BMP"	COMMO
50.	Driver turns tank 45 degrees from attacking aircraft	CD
51.	Proper fire command elements "Gunner"	C^2
52.	"Sabot"	C^2
53.	"PC"	C^2
54.	"Fire"	C^2
55.	"Fire Heat"	C^2
56.	Elements of report -Correct call signs	COMMO
57.	Type of report: "Sitrep"	COMMO
58.	Correct DTG	COMMO
59.	"Destroyed enemy BMP"	COMMO
60.	Grid: (+/- 200 meters)	PL
61.	Line 4: "Correct"	COMMO
62.	Line 5: "None"	COMMO
63.	Line 6: "Red"	COMMO
64.	Correct ammo status	COMMO
65.	Correct fuel status	COMMO
66.	"Continuing mission"	COMMO
67.	TC assumes proper position	C^2
68.	TC maintains visual contact	C^2
69.	Proper gun tube orientation	PL
70.	Contact report elements "Contact"	COMMO
71.	"Northeast"	PL
72.	"Missile"	COMMO

73.	Driver takes evasive action	CD
74.	Proper fire command elements "Gunner"	C^2
75.	"Sabot"	C^2
76.	"PC"	C^2
77.	"Fire"	C^2
78.	"Fire Heat"	C^2
79.	Submits report without cue	COMMO
80.	Elements of report -Correct call signs	COMMO
81.	Type of report: "Spotrep"	COMMO
82.	What happened: "Destroyed BMP"	COMMO
83.	Grid: (+/- 200 meters)	PL
84.	Correct "Time"	COMMO
85.	What you are doing: "Continuing Mission"	COMMO
86.	Submits report without cue	COMMO
87.	Elements of report -Type of report: "Spotrep"	COMMO
88.	What happened: "Observing Indirect Fire"	COMMO
89.	Grid: (+/- 200 meters)	PL
90.	Correct "Time"	COMMO
91.	Proper fire command elements "Gunner"	C^2
92.	"Sabot"	C^2
93.	"Tanks"	C^2
94.	"Rear tank"	C^2
95.	"Fire"	C^2
96.	Fires at rear tanks first, works forward	C^2
97.	Submits report without cue	COMMO
98.	Elements of report -Correct call sign	COMMO

99.	Type of report: "Spotrep"	COMMO
100.	"Engaged (Correct #) Tanks and BMPs"	COMMO
101.	Grid: (+/- 200 meters)	PL
102.	Correct "Time"	COMMO
103.	What you are doing: "Continuing Mission"	COMMO
104.	Proper fire command "Gunner"	C^2
105.	"Sabot"	C^2
106.	"Tanks"	C^2
107.	"Left tank"	C^2
108.	"Fire"	C^2
109.	TC engages left tank first	C^2
110.	TC directs fire to move left to right	C^2
111.	Submits report without cue	COMMO
112.	Elements of report -Correct call sign	COMMO
113.	Type of report: "Spotrep"	COMMO
114.	"Engaged or Destroyed (Correct number)"	COMMO
115.	Grid: (+/- 200 meters)	PL
116.	Correct "Time"	COMMO
117.	What you are doing: "Continuing Mission"	COMMO
118.	Contacts company commander without cue	COMMO
119.	Elements of report -Type of report: "Sitrep"	COMMO
120.	DTG	COMMO
121.	What happened: "Engaged two enemy company sized-units"	COMMO
122.	Grid: (+/- 200 meters)	PL
123.	"Line 4d; one/Red 1 destroyed/Red 2 mobility kill/ I have assumed Red 1 duties"	COMMO

124.	"None"	COMMO
125.	"Black"	COMMO
126.	Ammunition "Black" Fuel "Black"	COMMO
127.	Requests instructions	COMMO
128.	TC contacts company FIST/CO	COMMO