

February 2002

**2ICR REGIMENTAL
ARTILLERY AND AVIATION EVALUATION
FINAL REPORT**

**DEPARTMENT OF ARMY
US ARMY ARMOR CENTER
FORT KNOX , KENTUCKY
40121-5215**

20020314 048

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY <i>(Leave blank)</i>	2. REPORT DATE 27-Feb-02	3. REPORT TYPE AND DATES COVERED Final 27-Feb.-02	
4. TITLE AND SUBTITLE 2ICR REGIMENTAL ARTILLERY AND AVIATION EVALUATION FINAL REPORT		5. FUNDING NUMBERS	
6. AUTHOR(S) CPT David Lindow, Mr. Thomas Russell, Mr. Lawrence Vowels		8. PERFORMING ORGANIZATION REPORT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Armor Center Fort Knox, KY.		10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)		11. SUPPLEMENTARY NOTES	
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited		12b. DISTRIBUTION CODE	
13. ABSTRACT <i>(Maximum 200 words)</i> The 2ICR Regimental Artillery and Aviation Evaluation is an analytical evaluation using the Janus modeling software at Fort Knox, KY. The tested alternative structures consist of six 155mm towed howitzers combat versus twelve 120mm turreted mortars and four troops of OH58D helicopters, versus three troops of OH58 helicopters and one troop of AH64 attack helicopters. This evaluation focused on the performance of one squadron of the 2nd ICR performing a zone reconnaissance in a non linear eastern European environment in the 2004 time frame. The force effectiveness of the squadron was evaluated in terms of the contribution of the alternative regimental support assets.			
14. SUBJECT TERMS		15. NUMBER OF PAGES 24	16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT

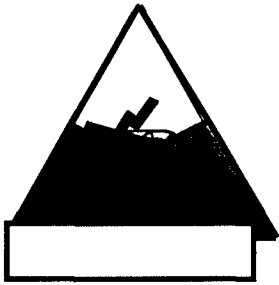
NOTICES

DISTRIBUTION STATEMENT

Approved for public release; distribution is unlimited.

DISCLAIMER

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.



2ICR REGIMENTAL ARTILLERY AND AVIATION EVALUATION

STUDY GIST

THE REASON FOR PERFORMING THE STUDY was to evaluate the combat effectiveness of the 2nd ICR regimental artillery support with 120mm turreted mortars versus lightweight 155mm towed howitzers and to evaluate the combat effectiveness of the 2nd ICR Regimental Aviation Squadron with either three troops of OH58 reconnaissance helicopters and one troop of AH64 attack helicopters versus four troops of OH58 reconnaissance helicopters

THE PRINCIPLE RESULTS OF THIS EVALUATION are that there are no demonstrated combat effectiveness differences between the tested regimental artillery alternatives and there are no demonstrated combat effectiveness differences between the Regimental Aviation Squadron alternatives as they were tested in this evaluation.

SCOPE: This evaluation focused on the performance of one squadron of the 2nd ICR performing a zone reconnaissance in a non linear eastern European environment. The force effectiveness of the squadron was evaluated in terms of the contribution of the alternative regimental support assets. The scenario was evaluated entirely on Janus which is an interactive, man in the loop, force on force combat modeling platform.

THE STUDY OBJECTIVES were to determine most force effective construct of of the alternative regimental combat elements. To examine the lethality and the survivability differences between the proposed alternatives. To examine the method of employment and determine that outcome on overall force effectiveness.

THE BASIC APPROACH used to accomplish this evaluation consisted of examination of combat capabilities of each alternative within the man in the loop simulation of the Janus modeling network located in the Mounted Maneuver Battle Lab at Ft Knox, KY.

THE STUDY PROPONENT / AGENCY was the United States Army Armor Center.

CONTENTS

	page
SF298	i
Notices	ii
Study Gist.....	iii
Table of Contents	iv
List of Tables and Figures	v
Abstract.....	vii
Introduction.....	1
Equipment Description.....	1
Evaluation Scope.....	1
Alternatives	2
Methodology.....	5
Analysis.....	6
Conclusions.....	16
Recommendations.....	16

LIST OF TABLES AND FIGURES

	page
Figure 1. Regimental Artillery Alternatives	4
Figure 2. Regimental Aviation Squadrons	5
Table 1. Red Threat Forces	6
Table 2. Run Matrix	6
Table 3. 155mm Towed Howitzers and Alternate Regimental Aviation Squadron (LER)	8
Table 4 120mm Turreted Mortars and Alternate Regimental Aviation Squadron (LER).....	8
Table 5 Alternate 4 / 0 Aviation Squadron and 120mm Turreted Mortars (LER)	8
Table 6 Alternate 3 / 1 Aviation Squadron and 120mm Turreted Mortars (LER).....	9
Table 7 Red Dismounts Killed by Squadron Indirect Fire.....	9
Table 8 Red Systems Killed by Squadron Indirect Fire	10
Table 9. Alternative 3 / 1 Red Systems Killed by Regimental Aviation Squadron.....	10
Table 10. Alternative 4 / 0 Red Systems Killed by Regimental Aviation Squadron	11
Table 11. Towed Howitzer Survivability.....	11
Table 12. 120mm Turreted Mortar Survivability	11
Table 13. 3 / 1 Regimental Aviation Squadron Survivability.....	12
Table 14. 4 / 0 Regimental Aviation Squadron Survivability.....	12
Table 15. Rounds Fired by Squadron Indirect Fire Systems.....	13
Table 16. Hellfire Missiles Fired by 3 / 1 Regimental Aviation Squadron.....	13

Table 17. Hellfire Missiles Fired by 4 / 0 Regimental Aviation Squadron 13

Table 18. Indirect Fire System Distance Observations 15

ABSTRACT

The 2ICR Regimental Artillery and Aviation Evaluation is an analytical evaluation using the Janus modeling software at Fort Knox, KY. The tested alternative structures consist of six 155mm towed howitzers combat versus twelve 120mm turreted mortars and four troops of OH58D helicopters, versus three troops of OH58 helicopters and one troop of AH64 attack helicopters. This evaluation focused on the performance of one squadron of the 2nd ICR performing a zone reconnaissance in a non linear eastern European environment in the 2004 time frame. The force effectiveness of the squadron was evaluated in terms of the contribution of the alternative regimental support assets.

2ICR REGIMENTAL ARTILLERY AND AVIATION EVALUATION

1. INTRODUCTION

- a.) The Organizational Division of the Directorate of Force Development, Fort Knox, Ky. was directed by TRADOC to examine the feasibility of replacing the 155mm towed howitzers in the current proposed 2nd ICR Transformation with 120 turreted mortars and to examine the force effectiveness of using four troops of OH58 (4 / 0) vs. three troops of OH58s and one troop of AH64 (3 / 1) for the Regimental Aviation Squadron. On January 25, 2002 the simultaneous analysis of these four alternatives began.

2. EVALUATION OBJECTIVES

- a.) To determine the differences in the operational effectiveness of turreted mortar systems versus towed howitzers for squadron fire support.
- b.) To determine the differences in operational effectiveness impact of the Regimental Aviation Squadron being composed of four troops of OH-58D versus three troops of OH-58D and one troop of AH-64.

3. EQUIPMENT DESCRIPTION

- a.) The 2ICR Regimental Artillery and Aviation Evaluation utilized the simulation capabilities of the Janus gaming network located in the Mounted Maneuver Battle Lab at Ft Knox, KY. This consists of the Unix based Janus Host on a local network of 14 gamer workstations. Data collection was accomplished by the post processing capabilities that are part of the Janus modeling software suite.
- b.) The specific equipment used in the evaluation is as follows:
 1. The Janus host computer
 2. Four blue force troop gaming workstations
 3. One blue force artillery gaming workstation
 4. One blue force aviation gaming work stations
 5. Two red team gaming workstations

4. EVALUATION SCOPE

- a.) The 2ICR Regimental Artillery and Aviation Evaluation is designed to give insights into the combat effectiveness of regimental combat elements of the proposed 2nd ICR Organization. This is accomplished by comparing the effectiveness of six 155mm towed howitzers to the combat effectiveness of twelve 120mm turreted mortars performing the same mission while simultaneously performing the combat comparison of four troops of OH58D helicopters, versus three troops of OH58D helicopters and one troop of AH64 attack helicopters.
- b.) This evaluation is based on a zone reconnaissance mission performed by one squadron of the proposed 2nd ICR transformation. The squadron equipment is held constant across all alternatives. Each troop participating in the evaluation, consisted of nine Interim Armored Vehicle (IAV) reconnaissance vehicles, eight Medium Gun Systems (MGS)

vehicles and two IAV troop mortar vehicles. Additionally, each IAV vehicle was loaded with one javelin gunner, one SAW gunner and three scouts. The entire squadron strength is arrived at by multiplying each troop by four, giving a total of thirty-six IAV reconnaissance vehicles, thirty-two MGS and eight IAV troop mortars. This configuration was held constant across all alternatives and each troop was controlled by one gamer at a individual Janus workstation. The non-varying squadron support consisted of eight MLRS systems, three Avenger ADA systems, four UAVs and one counter battery radar system. MLRS Systems were limited to counter battery fire and only one UAV could be in operation at any one time. The constant portion of regimental deployment was controlled along with the alternative artillery configurations by an individual gamer at a Janus workstation. The regimental aviation configuration, which varied for each of two alternatives was controlled separately by a gamer at a Janus workstation. The OPFOR strength consisted of mechanized brigade (+) of which one hundred and fifty-six vehicles are considered to have some probability of being targeted by the blue squadron. The terrain, in all alternatives consists of a heavily vegetated eastern European rolling terrain with a large number of watercourses of varying sizes and a large number of villages or towns connected by roadways. All watercourses are fordable, having few constructed or bridge crossings. The towns and villages are occupied by the red forces and by non-played, civilian populations. The blue artillery and aviation assets are restricted from firing missions directly into the cities. The areas between the urban sites are occupied by small pockets of the red forces. The distribution of these red forces is not uniformly distributed across any one area or troop area of operation. The terrain box played is approximately 30 kilometers wide by 50 kilometers long. Time frame for this scenario is 2004. Missions were continued until either the blue force had been attrited to fifty-percent of its original vehicle strength, or a number of vehicles greater than 50 percent of the original blue force had reached phase line Illinois at a distance of 50 kilometers.

- c.) The limited number of iterations for each alternative was constrained by available time for the gamer personnel. The limited number of iterations made the quantitative results sensitive to the extremes in output.
- d.) The participants in this evaluation consisted of six blue force gamers, two red force gamers, one commander and a systems administrator for Janus operations. With the exception of the Janus System administrator, all other personnel were provided by DFD, Fort Knox, Ky. Gamer training was limited to one trial run.

5. ALTERNATIVES

- a.) The 2ICR Regimental Artillery and Aviation Evaluation evaluated four alternative force structures. The four alternative force structures are as follows:
 - 1.) The Squadron artillery battery consisted of six 155mm lightweight

towed howitzers.

- 2.) The Squadron artillery battery consisted of twelve 120mm turreted mortars. Due to the unavailability of the proposed 120mm turreted mortar model, a turreted 120mm mortar from another system was mounted on an IAV recce vehicle. This surrogate model was then further modified to represent the proposed setup times and initial ammo loads. It retains the vulnerability data from the IAV model, with the target pairing being a function of the artillery targeting in the Janus modeling system. The lethality and range comes from the original weapon system before being copied on to the IAV recce vehicle. Figure 1 shows the entire squadron for both alternative 1 and alternative 2.
- 3.) The Regimental Aviation Squadron consists of 4 troops of OH58D helicopters. Since only one of three squadrons in the regiment were played, two troops totaling sixteen aircraft were played with anywhere from three to six in the zone at any one time. Aircraft not in the zone were on standby to be cycled in on rotation or to replace destroyed aircraft.
- 4.) The Regimental Aviation Squadron consists of 3 troops of OH58D helicopters and one troop of nine AH64 aircraft were used. Again since only one of three squadrons in the regiment were played, a troop of eight aircraft were played with anywhere from two to four OH58Ds in the zone at any one time. The OH58Ds not in the zone were on standby to be cycled in on rotation or to replace destroyed aircraft. The AH64s were used only once during each run to perform a specific mission and all nine were used to accomplish the mission. Figure 2 shows the entire regimental aviation squadron for both alternative 3 or alternative 4.

Figure 1 Alternative 1 and 2 Regimental Artillery

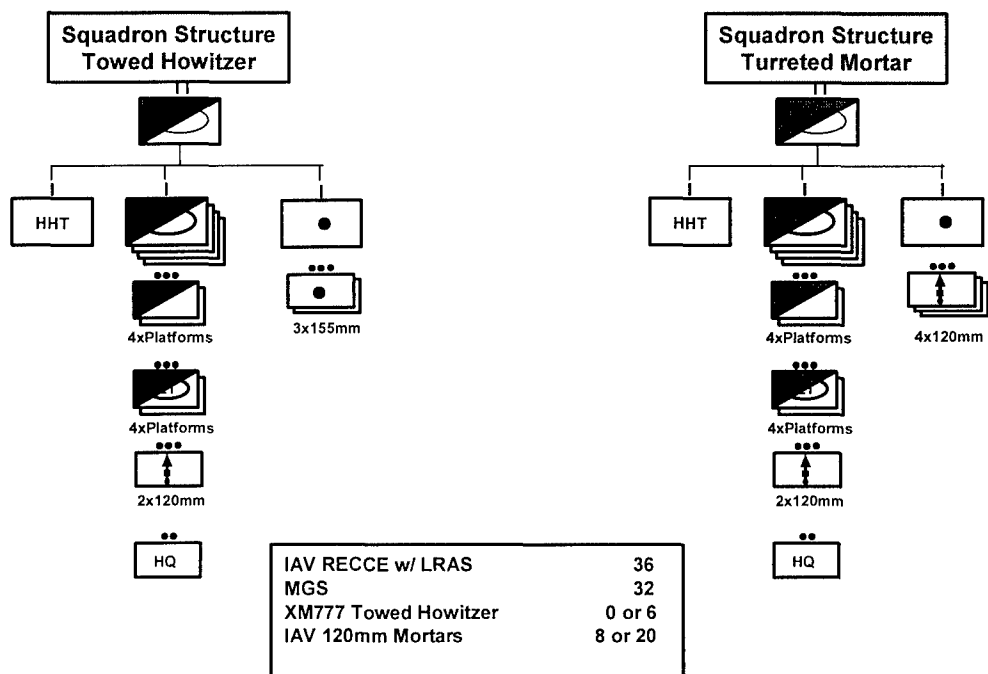
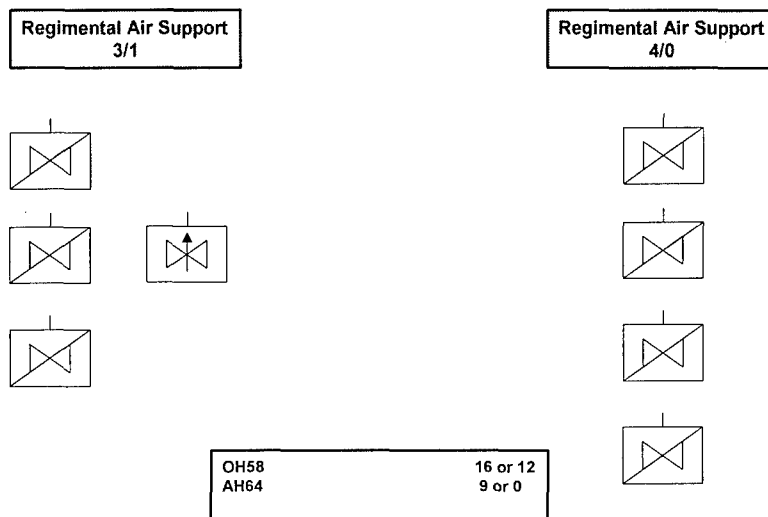


Figure 2 Alternative 3 and 4 Regimental Aviation Squadron



6. METHODOLOGY

- a.) The methodology used to accomplish this evaluation is limited to evaluating the operational effectiveness of each alternate force structure within the man in the loop Janus simulation.
- b.) The operational effectiveness of each alternate was examined using an eastern European terrain. The entire threat present in the scenario consisted of a mechanized brigade (+) however, the threat that existed within the squadron boundaries was substantially smaller and the threat vehicles that are considered in this evaluation total to one hundred and fifty-six vehicles. The approximate make up of the threat forces are listed in Table 1. There was also a substantial number of ADA and MLRS red systems that could target the blue forces, which were beyond the range and boundaries of any blue system that was used in this evaluation. These ADA systems severely limited the useful range of the regimental aviation squadron.

Table 1 Red Threat Forces

55	Armored Personnel Carriers
5	Dismounted Anti Tank Guns
6	Mobile Anti Tank Systems
7	Mobile Mortar Systems
22	Recon Vehicles
5	ADA Systems
33	Self Propelled Howitzers
8	Self Propelled Missile Launchers
1	Counter Battery Radar System
14	Tanks

d.) Four iterations of each alternative force structure were run on the simulation network. This was accomplished by running two alternative force structures per run. (See Table 2). Data was collected by the data logger to address each of the objectives of the evaluation.

Table 2 Run Matrix

Jan 25 02	155mm Howitzers and 3 / 1 Aviation Alternative
Jan 25 02	120mm Turreted Mortars and 3 / 1 Aviation Alternative
Jan 28 02	155mm Howitzers and 4 / 0 Aviation Alternative
Jan 28 02	120mm Turreted Mortars and 4 / 0 Aviation Alternative
Jan 29 02	155mm Howitzers and 3 / 1 Aviation Alternative
Jan 29 02	120mm Turreted Mortars and 3 / 1 Aviation Alternative
Jan 30 02	120mm Turreted Mortars and 4 / 0 Aviation Alternative
Jan 30 02	155mm Howitzers and 4 / 0 Aviation Alternative

7. ANALYSIS

- a.) The following measures of effectiveness (MOE) and measures of performance (MOP) were employed in the analysis of this evaluation. Measures of effectiveness were used to quantify the contributions of each alternative in terms of force effectiveness. Measures of performance were used to quantify the performance of each alternative force structure.
- b.) The MOEs that were employed in this evaluation to assess force effectiveness is as follows;
- 1.) Mission Accomplishment
This is a count of the number of times that the zone reconnaissance mission is considered to have been accomplished by arriving at phase line Illinois with more than fifty percent of the squadron
 - 2.) Loss Exchange Ratio, which is the following ratio:

$$\frac{\text{Red System Killed}}{\text{Blue Systems Killed}}$$

This ratio is inclusive of all systems lost by both the red and blue forces

- c.) The following MOPs were used in this evaluation. Only force attritions that dealt with either the helicopter or artillery systems are included directly in this section of the analysis.

1.) Lethality

- a.) The number of threat systems and dismounts killed by squadron indirect fire and number of threat systems killed by the regimental aviation squadron
- b.) The number of rounds fired by squadron indirect fire systems and the number of missiles fired by the regimental aviation squadron

2.) Survivability

- a.) Percent of squadron indirect fire systems remaining
- b.) Percent of regimental aviation squadron systems remaining

3.) Distance

The average distance as measured from most forward units to the average location of squadron indirect fire systems

- d.) In none of the eight runs did a number greater than 50% of the initial squadron strength reach phase line Illinois. This is not to say however, that the entire squadron was destroyed, some of the individual troops did consistently reach phase line Illinois with most of their combat power still intact. The individual troops would face differing amounts of resistance causing some troops to be consistently destroyed when clearing the zone.
- e.) The Loss exchange ratio does not show any significant advantage for any of the alternatives. Table 3 and Table 4 show the LERs which are arranged to show only the possible differences that could arise from the use of differing indirect fires alternatives. This ratio is based entirely on the number of systems lost and neither of the alternative squadron indirect fire systems provided a significant magnitude of the squadron's lethality. A measurably larger numerator in the LER cannot be attributed directly to these indirect fire systems. The 120mm turreted mortar was not as survivable as the 155mm howitzer and its greater number of losses would, if all other factors remained constant, tend to lower the LER in the mortar alternative. The exact amount that the 120mm mortar survivability effected the denominator of the LER is not calculated since the performance of all other systems cannot be held constant. The Janus post processor does not possess any facilities that would allow a metric to be assigned to any indirect effect. It cannot measure the effect of smoke or suppression missions.

Table 3 155mm Towed Howitzers and Alternate Regimental Aviation Squadron

Alternative	Blue Killed	Red Killed	LER
Towed Howitzers and 3 / 1 OH58 and AH64	47	42	0.894
Towed Howitzers and 4 / 0 OH58	44	56	1.273
Towed Howitzers and 3 / 1 OH58 and AH64	42	74	1.762
Towed Howitzers and 4 / 0 OH58	15	43	2.867
SUM	148	215	
AVG	37.0	53.8	1.453

Not statistically significant

Table 4 120mm Turreted Mortars and Alternate Regimental Aviation Squadron

Alternative	Blue Killed	Red Killed	LER
120mmTurreted Mortars and 3 / 1 OH58 and AH64	59	51	0.864
120mmTurreted Mortars and 4 / 0 OH58	51	59	1.157
120mmTurreted Mortars and 3 / 1 OH58 and AH64	43	70	1.628
120mmTurreted Mortars and 4 / 0 OH58	54	67	1.241
SUM	207	247	
AVG	51.8	61.8	1.193

Not statistically significant

Table 5 and Table 6 are arranged to show possible differences in LERs that could arise from differing aviation alternatives. The tables show only a small (0.131) difference in the overall LER. Since the Apache helicopters were employed to attack one armored column that consisted of a maximum of twenty two vehicles and they did not operate for the entire run, it is not possible to examine any difference they may have had in determining LERs. The lethality of the AH64 was limited by the number of missions and by the number of targets, not by survivability of the aircraft and since the threat that they were employed against never threatened the squadrons success, their effect is very likely muted.

Table 5 Alternate 4 / 0 Aviation Squadron and 120mm Turreted Mortars

Alternative	Blue Killed	Red Killed	LER
4 / 0 OH58 and Towed Howitzers	44	56	1.273
4 / 0 OH58 and Towed Howitzers	15	43	2.867
4 / 0 OH58 and 120mmTurreted Mortars	51	59	1.157
4 / 0 OH58 and 120mmTurreted Mortars	54	67	1.241
SUM	164	225	
AVG	41	56.25	1.372

Not statistically significant

Table 6 Alternate 3 / 1 Aviation Squadron and 120mm Turreted Mortars

Alternative	Blue Killed	Red Killed	LER
Towed Howitzers and 3 / 1 OH58 and AH64	47	42	0.894
Towed Howitzers and 3 / 1 OH58 and AH64	42	74	1.762
3 / 1 OH58 and AH64and 120mmTurreted Mortars	59	51	0.864
3 / 1 OH58 and AH64and 120mmTurreted Mortars	43	70	1.628
SUM	191	237	
AVG	47.75	59.25	1.241

Not statistically significant

f.) Neither squadron indirect fire alternative proved to be effective in killing either system or dismounts as evidenced by examining Tables 7 and 8. The lack of kills attributable to blue indirect fire systems may be related to the method of artillery targeting in Janus. With either ICM or HE munitions, an armored vehicle in Janus requires a direct hit in order to be destroyed. Targeting with indirect fire systems in Janus, requires a cursor position be recorded at a desired aim point which is usually placed on the targeted system's icon. In order to move icons by mouse, the screen icons representing systems must be large enough to be identifiable and when played on a large terrain box, the apparent dimensions of the icons are grossly overstated making the actual location of the target vehicle difficult to ascertain with the accuracy required to kill an armored vehicle. This can be overcome to some extent by zooming in to the maximum zoom level since the icons are scaled to zoom (not actual) dimensions but even then, when firing elements close to the maximum range, the targeting error in the model will usually prevent a direct hit. This is further complicated by reluctance to use the zoom on the Janus workstations because as the player waits the substantial amount of time for the redraw to occur, other units under his control are still actively participating in the simulation. An active system can become targeted by an enemy system while the screen is updating. The red force operators are also faced with the same potential shortcomings and their indirect fire also appeared to be equally ineffective.

Table 7 Red Dismounts Killed by Squadron Indirect Fire

Red Dismounts Killed by 120mm Turreted Mortar	% Total Red Dismount Losses	Red Dismounts Killed by 155mm Towed Howitzer	% Total Red Dismount Losses
0	0.0%	1	1.3%
0	0.0%	2	2.5%
0	0.0%	0	0.0%
6	7.6%	0	0.0%
1.5		0.75	

Average

Not statistically significant

Table 8 Red Systems Killed by Squadron Indirect Fire

Red Systems Killed by 120mm Turreted Mortars	% Total Red System Losses	Red Dismounts Killed by 155mm Towed Howitzers	% Total Red System Losses
0	0.0%	0	0.0%
0	0.0%	0	0.0%
0	0.0%	0	0.0%
1	1.5%	0	0.0%
0.25		0	
Average			

Not statistically significant

g.) The regimental Aviation Squadron shows the 3 / 1 alternative to have killed slightly more red systems than the 4 / 0 alternative. The 3 / 1 alternative killed on average 20 red systems compared to the 17.75 average for the 4 / 0 alternative. The small magnitude in the overall difference does not point to any significant advantage and is not statistically significant. This study does not point to an overwhelming advantage in the deployment of the AH64, it also cannot point to an overwhelming disadvantage in their use. The use of the AH64 helicopters is limited to the attacking of a maximum of twenty two vehicles in one mission. The number of targets available to the AH64 during some of the runs, is lessened when modified by direct fire systems acquisitions prior to the arrival of the attack helicopters.

Table 9 Alternative 3 / 1 Red Systems Killed by Regimental Aviation Squadron

Red Systems Killed by AH64	% Total Red System Losses	Red Systems Killed by OH58D	% Total Red System Losses	Red System Loss to Alternative 3/1	% Total Red System Losses
20	47.60%	2	4.80%	22	52.38%
7	9.50%	11	14.90%	18	24.32%
15	29.40%	5	9.80%	20	39.22%
12	17.10%	8	11.40%	20	28.57%
13.5		6.5		20	33.76%
Average					

Not statistically significant

Table 10 Alternative 4 / 0 Red Systems Killed by Regimental Aviation Squadron

Red Systems Killed by OH58	% Total Red System Losses	
19	33.9%	
14	32.6%	
20	33.9%	
18	26.9%	
17.75	20.23%	Average

Not statistically significant

h.) The 120mm turreted mortars proved to be more vulnerable to direct fire systems than the 155mm towed howitzer. Of the 22 mortars killed, 10 were lost to direct fire vehicles, 6 were lost to dismounted fire systems and 6 were lost to mine fields. The 155mm howitzers lost a total of 5 to mine fields and 1 to a direct fire vehicle. The difference in vulnerability between the mortars and the howitzers while not statistically significant, is large enough and consistent enough with some of the other MOPs, that it can be emphasized.

Table 11 Towed Howitzer Survivability

	Towed Howitzers Start	Number of Towed Howitzers Killed	% Towed Howitzers Surviving
	6	3	50.0%
	6	3	50.0%
	6	0	100.0%
	6	0	100.0%
AVG	6	1.5	75.0%

Not statistically significant

Table 12 120mm Turreted Mortar Survivability

	120mm Turreted Mortar Start	Number of 120mm Turreted Mortar Killed	% 120mm Turreted Mortar Surviving
	12	10	16.7%
	12	2	83.3%
	12	4	66.7%
	12	6	50.0%
AVG	12	5.5	54.2%

Not statistically significant

i.) The survivability assessment provides little insight into the survivability of the regimental aviation squadron since the AH64 were flown along a route without a substantial amount of threat ADA systems which is consistent with their method of employment. The OH58 aircraft were used primarily as reconnaissance aircraft and faced substantial ADA threat. The losses of the OH58 cannot be compared to that of the AH64 because they fulfilled different functions and therefore faced different levels of threat.

Table 13 3 / 1 Regimental Aviation Squadron Survivability

	AH64 Start	A64 Killed	OH58 Start	OH58 Killed
	9	1	8	2
	9	0	8	3
	9	0	8	4
	9	0	8	2
AVG	9	0.25	8	2.75

Not statistically significant

Table 14 4 / 0 Regimental Aviation Squadron Survivability

	OH58 Start	OH58 Killed
	16	1
	16	0
	16	6
	16	12
AVG	16	4.75

Not statistically significant

j.) The number of rounds fired by squadron indirect fire systems is used as a measure of the relative use of assets. In the case of the indirect fire assets, it is a measure of how many rounds each aggregate icon fires. The 120mm mortar icons were aggregated to 4 mortars per icon so that planning a one mission with one icon would result in 4 rounds times the number of volleys. The individual icons can suffer loss so the icon does not always maintain its original aggregate number. The 155mm howitzers were also aggregated except that they were aggregated to 3 systems per icon. The aggregate strength is not constant and the aggregate strength of any icon that could be used could vary from its original aggregate strength to an icon representing only one indirect fire system. The 155mm howitzers fired more rounds and this is consistent with their survivability and range when compared to the 120mm mortars. With the post processing facilities in Janus, it is not possible to count the number of missions or the number of targets that each indirect fire icon or group of indirect fire icons, was targeting.

Table 15 Rounds Fired by Squadron Indirect Fire Systems

	# Rounds by 155mm Towed Howitzers	# Rounds by IF MORT 120mm Turreted Mortars
	165	140
	68	32
	249	20
	27	81
AVG	127.25	68.25

Not statistically significant

The regimental aviation squadron fired about the same number of missiles in total regardless of the alternative. The principle difference is in which system fired. When the AH64 is used, the OH58 fire fewer missiles. This result is consistent with the lethality that was observed with the aviation alternatives.

Table 16 Hellfire Missiles Fired by 3 / 1 Regimental Aviation Squadron

	Rounds by AH64	Rounds by OH58	Total
	25	4	29
	12	20	32
	19	8	27
	20	18	38
AVG	19	12.5	31.5

Table 17 Hellfire Missiles Fired by 4 / 0 Regimental Aviation Squadron

	Rounds by OH58
	39
	29
	40
	35
AVG	35.75

- k.) The distance is defined as the average distance as measured from most forward units to the average location of squadron indirect fire systems. This measurement was recorded at approximately fifteen minute intervals during each simulation and is a snap shot at a given time of the distance between the most forward location of the squadron and the location of the indirect fire

support units. A straight line could not be drawn through most forward units of the squadron since troops did not advance at a uniform rate through their zones and would usually be located at different points for any one particular time. A visual centering, based on observation of the Janus playbacks, was used to determine the best-fit line that could constitute the forward line. The same methodology was used to approximate the line about which the squadron indirect fire units could be said to center about. The length of a perpendicular line between these two parallel lines is the measure of one sample that is used to determine this metric. The distance is not the distance between the forward line and the indirect fire support elements for each of the troops, it implies the distance between the indirect fire support elements and the majority of the troops, since the visual placement of the forward line would be weighted toward the position of the majority of the troops. The Janus icon for the 120mm mortar was aggregated to three icons of four mortars each and the 155mm howitzers icon represented 3 howitzers for each of its two icons. With the greater range of the howitzers, it was easier to maintain a location where most of the troops could be supported. While the positional placement of icons is a function of how the units were modeled and played, the notion of the placement of the 120mm mortars being more critical due to a limited range is a valid assessment. The 120mm turreted mortar was seldom within its 8km range for a particular munitions type while the 155mm was usually within its 22.5 km range for the same munitions type.

Table 18 Indirect Fire System Distance Observations

	155mm Howitzers		120mm Mortars
Run #	Distances km	Run #	Distances km
800005	13	802005	7
	10		10
	16		20
	19		17
	17		10
	11		20
	12		10
	11		7.5
800006	12		10
	15	802006	16
	17		16
	16		20
	18		20
	18		25
	21		25
	24		25
800007	13		22.5
	13		25
	17	802007	12
	16		15
	20		15
	22.5		15
	27		15
	28		12
	32		10
800008	12	802008	11
	15		9
	13		7
	13		12.5
	13		15.5
	12		15
	11		18
Var	29.41		30.81
St Dev	5.42		5.55
Average	17.02		15.25

8. CONCLUSIONS

- a.) None of the results in this study can be considered statistically significant.
- b.) The AH64 analysis was hampered by the limited number of targets and missions.
- c.) The 120mm mortars are more vulnerable to direct fire systems.
- d.) Lethality was approximately the same for all alternatives.
- e.) Janus is not the proper modeling system for modeling indirect fire systems. Any future study of this issue should attempt to acquire a more suitable modeling system.

9. RECOMENDATIONS. This study did not demonstrate any differences in any of the tested alternatives therefore a recommendation cannot be made. Additional testing should refrain from using Janus as a constructive model in testing indirect fire systems.