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ARMY TRAINING

Computer Simulations Can Improve Command Training in Large-Scale Exercises

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National Security and
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The Honorable Earl Hutto
Chairman, Subcommittee on Readiness
Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

This report shows that computer-simulated training can be an effective way to train commanders and staffs in large-scale exercises such as Return of Forces to Germany. This is particularly true when such exercises are conducted in an area where political, environmental, and other constraints limit free-play maneuvers across the countryside.

As you requested, we plan no further distribution of this report until 15 days after its issue date. At that time we will send copies to the Chairman of the Senate Committee on Armed Services; the Chairmen, House and Senate Committees on Appropriations; the Director, Office of Management and Budget; and the Secretary of the Army. Copies will also be made available to other interested parties upon request.

Please contact me at (202) 275-4141 if you or your staff have any questions concerning this report. GAO staff members who made major contributions to this report are listed in appendix V.

Sincerely yours,

Richard Davis

Richard Davis
Director, Army Issues

Executive Summary

Purpose

Conducting large-scale military exercises has been considered one of the best means, short of war, of testing the ability of military forces to effectively deploy and execute their missions. The Return of Forces to Germany (REFORGER) began in the 1960s and has become the Army's largest strategic deployment exercise. The 1990 version of this exercise was markedly different from previous ones because it made extensive use of computer simulations.

Because of concern about whether simulations can provide an effective alternative to large-scale field exercises, the Chairman of the Subcommittee on Readiness, House Committee on Armed Services, asked GAO to review the 1990 versions of this exercise to determine (1) how much it was scaled back, (2) the advantages and limitations of using simulations in comparison with large-scale ground maneuvers, (3) future plans for using simulations, and (4) how much money can be saved by relying increasingly on simulations for training. GAO also reviewed studies completed by other audit agencies concerning the acquisition of computer-assisted simulations.

Background

The REFORGER military exercise was initiated to demonstrate U.S. commitment and capability to rapidly reinforce and defend Europe. In time, it evolved into the military's premier strategic deployment training exercise. Over the years, however, increasing environmental concerns and constraints resulted in tighter restrictions on free-play maneuver exercises across the German countryside.

In the 1990 exercise, fewer U.S. troops participated, and emphasis was given to training staffs and leaders at higher organizational levels rather than lower level units. Training for higher echelon leaders, such as at brigade, division, and corps, was made possible by the extensive use of computer-assisted simulation.

Results in Brief

Senior Army officials considered REFORGER 1990 a successful training exercise. A consensus exists among many military officials that computer-simulated exercises, such as the REFORGER, offer the potential for effective training, particularly at higher organizational levels, where the focus is on battle planning and command and control. The quality of training that the 1990 exercise participants received varied, depending on their functional areas.

While the overall number of U.S. troops participating in the 1990 exercise was significantly lower than it was in previous years' exercises, the number of troops deployed from the United States was not reduced significantly.

The Army plans to expand the use of computer-simulated training for future large-scale exercises, as well as for training in general. However, future REFORGER exercises will vary in their use of simulations. Computer-simulations can produce savings in some costs traditionally associated with these exercises, such as transportation. However, because the development and fielding of simulations represent sizeable ongoing investment costs that the Army will continue to incur, GAO was unable to determine the extent of savings in future exercises.

Studies by other audit organizations have raised questions about whether appropriate acquisition procedures or funding sources have been used in acquiring a number of computer-related simulations in the United States and Europe. Questions have also been raised about the adequacy of policy guidance, coordination, and oversight by the Department of Defense (DOD).

Principal Findings

Number of Exercise Participants Reduced

The total number of U.S. troops participating in the 1990 exercise was 57,500, a reduction of about 56,000 from the approximately 114,000 troops who participated in the previous exercise conducted in 1988. At the same time, the number of troops deploying from the United States in 1990 was 14,699, down only 2,752 from the 17,451 that deployed in 1988. However, the actual battlefield portrayed in the exercise was enlarged, with a focus on training higher echelon leaders.

Training Benefits and Limitations

Computer simulation training in the 1990 exercise realized the following benefits: it (1) emphasized battle planning, staff procedures, and command and control; (2) made more efficient use of training time; (3) provided a focus on higher echelons that might be cost prohibitive otherwise; and (4) lessened adverse environmental and political impacts.

Previous REFORGER follow-on training exercises typically involved troops through the corps level. However, actual maneuver training was limited

to a large extent by safety and environmental concerns, which often limited tracked vehicles to paved roads and restricted cross-country maneuvers. Because it took a long time to physically reposition units during an exercise, there was less opportunity for repetitive training, and troops at lower echelons, such as those in squads and platoons, often received marginal maneuver training. Computer simulation permitted shortening the length and increasing the number of decision cycles commanders had to participate in. As a result, this simulation created a more stressful environment, and commanders and their staffs received more realistic training.

While overall there were benefits in using computer simulations, the quality of training in some respects varied by functional area. For example, in the command and control area, computer simulation sped up the pace of the exercise, and in the fire support area, simulations provided quicker and more accurate assessments of the effects of field artillery and allowed fire support missions to have more definite and immediate impacts. The intelligence functional area was the least effectively portrayed in the 1990 exercise. For example, the computer-simulated portion of the exercise did not provide information in a format suitable for training intelligence staffs.

Future Use of Simulations Will Vary

The Army is continuing to refine its simulations for future use in large-scale exercises, as well as for training in general. Simulations' use in future REFORGER exercises will, in part, depend on participants' willingness to use them. For example, current plans for REFORGER 1991 indicate that simulations will not be used as extensively as they were in the 1990 exercise because allies planning the 1991 exercise, despite their growing interest in the use of simulations, desire to continue maneuvering across the countryside.

Plans for REFORGER 1992 show how computer simulations, improved by satellite networking, offer the potential for large-scale military exercises without extensive deployment of troops. In REFORGER 1992, the U.S. Army, Europe, plans to make extensive use of simulations and satellite networking to maneuver and fight against an opposing force actually situated at Fort Leavenworth, Kansas. Accordingly, fewer troops may be required for the follow-on training exercise. The size of future deployments from the United States for REFORGER type exercises could be affected by the extent to which there is a perceived need for such deployments as a visible means of demonstrating U.S. commitment and resolve to help defend its allies.

Extent of Cost Savings Not Known

Comparing the cost of training based on computer simulations with the cost of traditional exercises may not be meaningful or practical. First, the training may be quite different, as in the case of the 1990 exercises, which focused on training in command and control and battle planning at higher echelons that might not have been possible in traditional exercises. Second, computer simulations are designed to assist multiple exercises; therefore, development and fielding costs are not allocated to individual exercises.

The 1990 exercise produced savings of over $4 million in Joint Chiefs of Staff-funded transportation and cargo-handling costs traditionally associated with such exercises. While maneuver damage claims have yet to be fully accounted for, Army officials project that the number of claims will be about 40 percent lower than those reported for REFORGER 1988. As of September 1990, the U.S. share of these 1988 claims totaled over $16 million. Offsetting the savings in traditional exercise costs, however, are the investment costs incurred to develop, field, and support computer simulations. The Army has already invested millions of dollars in computer simulations and plans to invest sizable sums of additional money over a period of years to develop future simulations. These costs will benefit multiple training exercises now and in the future. The cost of computer simulations is funded from many different sources, but the Army does not have a system in place that captures, in a central location, all of the costs incurred.

Management Improvements Needed

Studies by other audit organizations indicate that proper acquisition procedures were not always followed, nor were proper sources of funds always used in acquiring a number of computer-related simulations in the United States and Europe. These problems point to systemic weaknesses in the Army's internal control program that need to be corrected. The Army has initiated some corrective actions, and DOD is now undertaking a departmental simulation policy study to identify improvements needed in policy guidance concerning the development and use of simulations.

Recommendations

Because DOD is studying improvements needed in managing computer simulations, GAO is not making any recommendations.

Agency Comments

DOD concurred with the report's findings and conclusions. (See app. IV.)

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Abbreviations

BOS	Battlefield Operating System
CBS	Corps Battle Simulation
CFX	Combat Field Exercise
CPX	Command Post Exercise
DOD	Department of Defense
FTX	Field Training Exercise
GAO	General Accounting Office
NATO	North Atlantic Treaty Organization
POMCUS	prepositioning of materiel configured to unit sets
REFORGER	Return of Forces to Germany
SIMNET	Simulation Networking
USAREUR	United States Army, Europe
WPC	Warrior Preparation Center

Introduction

Large-scale military deployment exercises have been an essential element of the U.S. military forces' training programs. They have been considered one of the best means, short of war, of testing military forces' capabilities to effectively deploy and execute their missions. Many such exercises are sponsored annually by the Joint Chiefs of Staff. The largest of these exercises is called Return of Forces to Germany (REFORGER). REFORGER was initiated in the late 1960s and has evolved to become the Army's largest strategic deployment training exercise.

Tripartite Agreement

REFORGER's history can be traced to the 1967 Tripartite Agreement between the United States, the United Kingdom, and the Federal Republic of Germany. The agreement allowed the United States to bring back to the United States the headquarters and two brigades of the 24th Mechanized Infantry Division, leaving only one brigade of that division in Europe. To compensate for this reduction in troop strength, the agreement required that U.S. forces returning to the United States be held in a high state of readiness to ensure their capability to return rapidly to Europe in a crisis. The agreement also stipulated that the 24th Mechanized Infantry Division return the two U.S.-based brigades annually to Germany, draw prepositioned equipment, link up with the forward-deployed brigade, and then participate in a field training exercise (FTX). Subsequent informal arrangements have resulted in other units' deploying to Germany.

For over 20 years, the U.S. Army has deployed U.S.-based forces to Germany to participate in REFORGER exercises. The REFORGER exercises are the largest and most important deployment test for active duty, reserve, and national guard forces that have contingency missions to Europe. REFORGER and its associated follow-on FTXs have also provided large-scale maneuver training for U.S. forces based in Europe.

REFORGER exercises generally consist of three phases: deployment, employment, and redeployment. Table 1.1 shows the objectives and phases of the REFORGER exercises.

Table 1.1: Objectives and Phases of the REFORGER Exercises

Phase	Objectives
Deployment	Test procedures for receiving, equipping, and transporting REFORGER units to assembly areas for tactical employment and evaluate the condition of prepositioned equipment.
REFORGER follow-on employment exercise[a]	Provide combined arms training to REFORGER forces and orient deployed U.S. units with the European environment and their missions in the defense of Europe.
Redeployment	Clean the equipment and return it to storage and redeploy forces back to the United States.

[a]REFORGER, as a deployment exercise, is largely a U.S. Army, Europe (USAREUR), exercise, with support from the Air Force and Navy. Both the Army and Air Force conduct coordinated follow-on exercises. The Army's follow-on exercise for 1990 was called Centurion Shield, while the Air Force's was called Cold Fire 1990. Some people refer to the REFORGER phases and follow-on exercises collectively as REFORGER.

While the 1967 Tripartite Agreement initiated the REFORGER exercises, the exercises have been modified over the years to broaden the training objectives and include additional U.S.-based units. Since 1969, the number of Army troops deploying from the United States for REFORGER exercises has ranged from 9,938 to more than 30,000. (See app. I.)

REFORGER Exercises From 1969 Through 1974—A Period of Strong Support

The REFORGER exercises held from 1969 through 1974 fulfilled the political commitments of the 1967 Tripartite Agreement and provided maneuver training opportunities for forces deploying from the United States, as well as participating units based in Europe. During this period, Germany viewed the exercises as a stabilizing influence in Europe and strongly supported them.

In the REFORGER exercises held in 1969 through 1974, units from the 24th Mechanized Infantry Division, and later the 1st Mechanized Infantry Division, were deployed from the United States and participated in FTXs. The REFORGER objectives called for participating units to withdraw prepositioned materiel configured to unit sets (POMCUS), move to marshalling areas, and then on to assembly areas for tactical employment. Once the exercises were completed, the units returned their equipment to the POMCUS sites and redeployed to the United States.

In addition to the units deploying from the United States, forces based in Germany also took part in the REFORGER follow-on exercises. The two forward-deployed U.S. corps in Europe alternated responsibility for planning and umpiring the exercises.[1] The corps planning the exercise

[1]Since 1987, planning for REFORGER follow-on exercises has shifted to higher organizational levels or echelons; USAREUR planned REFORGER 1990.

provided the opposing force for the division deploying from the United States, while the other corps provided the necessary support staff.

Strong German Support for Early REFORGERs

During the first several years that the REFORGER exercises were held, the German public strongly supported the U.S. military presence in Germany and welcomed the REFORGER exercises as a demonstration of U.S. capability to participate in the defense of Western Europe. But, according to public opinion polls conducted between 1969 and 1974, the Germans were concerned that if REFORGER exercises were too successful in demonstrating capability to redeploy to Germany, further troop reductions could result.

Number of POMCUS Units Increase

From the beginning, withdrawing and conducting exercises with POMCUS equipment has been an integral part of REFORGER exercises. The POMCUS concept originated in 1961 when, after the crisis surrounding the erection of the Berlin wall, the United States began prepositioning supplies and equipment in Europe for 2 divisions and 10 support units that would be deployed to Europe in the event of war. The program was expanded in 1968, when POMCUS stocks were established for the two brigades of the 24th Infantry Division that were returned to the United States and designated as REFORGER units. Later, as additional POMCUS units were added, the number of units participating in REFORGER exercises increased.

REFORGER Exercises From 1975 Through 1988 —A Period of Expansion, but With Growing Constraints

The period between 1975 and 1988 was one great change for REFORGER. The number of U.S. combat forces stationed in Germany increased; the REFORGER exercises expanded into the Northern Army Group's area of responsibility; and the military underwent extensive modernization. The Army procured new equipment, increased weapons' capabilities, and modified training strategies to make training more realistic. During this time, German sentiments toward the U.S. military presence and training changed as well. As the perception of the Soviet threat diminished, particularly in recent years, defense-related issues became less important in relation to other factors, such as German sovereignty and the environment.

U.S. Units Expand to Northern Germany

Before 1975, USAREUR had only stationed forces in southern Germany. However, the DOD Appropriation Authorization Act of 1975 led to U.S. combat troops' being stationed in northern Germany.[2] With the addition of combat units in northern Germany, starting in 1975, the Army expanded REFORGER exercises to include allied units under allied control in northern Germany. By 1976, REFORGER included a multinational series of exercises in areas ranging from the North Atlantic Treaty Organization's (NATO) northern flank to its southern flank. As REFORGER evolved, the U.S. Army increased the emphasis on interoperability of U.S. units with other NATO forces by concentrating on standardizing doctrine and tactics and reinforcement capability.

Constraints on Training Land Affect REFORGER

The number of U.S. forces stationed in Europe increased from the mid-1970s into the 1980s, and equipment was being modernized to improve capabilities, but the number of USAREUR's training areas remained static, and maneuver restrictions were increasing in response to growing environmental concerns.

Army officials told us that as maneuver restrictions increased, the value of the maneuver training accomplished decreased. Tracked vehicle formations were generally forced to stay on roads, thus limiting opportunities for cross-country maneuvers.[3] Thus, while the early REFORGER exercises provided opportunities for extensive maneuver and interoperability training, by the mid-1970s, changed conditions also began to reshape REFORGER.

German Public Support for Exercises Wanes

The number of training exercises performed by the U.S. military increased during the 1970s and into the 1980s and employed thousands of troops and combat vehicles. German governmental authorities and

[2]The DOD Appropriation Authorization Act of 1975 required major reductions in the noncombat strength of the U.S. armed forces stationed in Europe. Specifically, the legislation required that the noncombat component of U.S. forces in Europe be reduced by 18,000 by June 30, 1976. It gave the Secretary of Defense authority to increase the combat strength of U.S. forces in Europe by the amount of the reduction of noncombat personnel. A brigade was stationed in northern Germany, and other combat units were re-stationed in Germany so that the number of U.S. combat forces in Germany once again reached a pre-1967 agreement level.

[3]More recently, units stationed in Germany have come to rely heavily on a 40,000-acre combat maneuver training center located at Hohenfels, Germany, to provide periodic free-play maneuver training for battalion-sized units. The combat maneuver training center permits free-play maneuvers against an opposition force with trained observer controllers, who identify training strengths and weaknesses. Improvements are underway at Hohenfels to make it comparable, though smaller, to its counterpart in the United States known as the National Training Center, located at Fort Irwin, California.

the general population became increasingly concerned about the maneuver damage that accompanied the increase in activities. In an August 1981 report completed by USAREUR's Office of the Deputy Chief of Staff, Host Nation Activities, REFORGER units were openly accused by host nation officials of causing unnecessary, arbitrary, or willful damage. Protests by farmers and government officials and the media coverage they attracted damaged USAREUR's relations with the host nation government and population.

Over the years, complaints and maneuver damage claims were received from German citizenry. As of September 25, 1990, nearly 16,000 maneuver damage claims valued at over $16 million were settled in connection with REFORGER 1988.[4]

REFORGER 1990—Growing Problems Required a New Strategy

Given the changing environmental and political conditions that constrained large-scale maneuver training exercises in Germany, the U.S. European Command and USAREUR recognized the need for a new training strategy and designed a strategy for REFORGER 1990. This strategy de-emphasized maneuver training for ground forces in large-scale exercises and began to focus on the use of computer simulations to train commanders and their staffs.

Objectives, Scope, and Methodology

Because of concern about whether simulations can provide an effective alternative to large-scale field exercises, the Chairman of the Subcommittee on Readiness, House Committee on Armed Services, asked us to review REFORGER 1990 to determine (1) how much it was scaled back, (2) the advantages and limitations of using simulations in comparison with large-scale ground maneuvers, (3) future plans for using simulations, and (4) how much money can be saved by relying increasingly on simulations for training. The scope of this review was limited to reviewing past REFORGERs to obtain perspective on the Army's use of computer simulations. We also reviewed studies by other audit agencies concerning how the development and acquisition of computer-assisted simulations are managed. We obtained data relating to REFORGER costs and the costs associated with computer simulations; however, we did not validate the accuracy and completeness of that data.

[4]We have issued prior reports on maneuver damage claims in Germany. See Military Damage Claims in Germany: A Growing Burden(GAO/ID-81-4, Oct. 9, 1980) and Maneuver Damage: DOD Needs to Strengthen U.S. Verification of Claims in Germany (GAO/NSIAD-88-191, Aug. 9, 1988). The latter report shows that the U.S. share of maneuver damage claims from REFORGER as well as other exercises for fiscal years 1980 to 1987 ranged from $18.6 million in 1986 to $52.5 million in 1982.

To address these objectives, we (1) met with officials of the staff of the Joint Chiefs of Staff officials in Washington, D.C., and exercise planners and training officials at the U.S. European Command, USAREUR, 7th Army Training Command, and V and VII Corps; (2) interviewed simulation personnel at V and VII Corps' Battle Simulation Centers and the Warrior Preparation Center (WPC); (3) spoke with RAND Corporation representatives;[5] (4) observed portions of the follow-on exercise, Centurion Shield 1990; (5) spoke with exercise participants concerning the use of simulations; (6) reviewed USAREUR's Annual Historical Reviews to gather information on past REFORGER exercises; (7) reviewed Centurion Shield after action reports and evaluations; (8) gathered existing data on REFORGER costs from 1988 and 1990; and (9) spoke with USAREUR Host Nations Affairs and U.S. Embassy personnel in Germany to gather documents on the German public's perception of the continued military presence and use of large-scale maneuver exercises in Germany.

We sought to determine whether there was a consensus on the benefits and limitations of using computer simulations in REFORGER 1990 by synthesizing the views of numerous Army trainers and subject matter experts associated with REFORGER 1990. In doing so, we used a multistep process. We interviewed USAREUR's simulation experts and key exercise planners and reviewed after-action reports and other evaluations to develop matrices describing (1) how the seven battlefield operating systems (BOS)[6] were typically represented in previous REFORGER exercises, (2) how the BOSs were represented in REFORGER 1990, (3) how the use of simulations improved or detracted from realistically representing each of the BOSs, and (4) what the potential was for improving any simulation weaknesses identified during REFORGER 1990. We developed matrices to present the information collected and then refined the matrices based on discussions with exercise participants from both V and VII Corps and USAREUR's Deputy Chief of Staff for Operations. While we identified the benefits and limitations of using computer simulations and Army efforts to improve their models, we did not determine whether the Army had taken sufficient steps to ensure the accuracy of their models or determine the adequacy of standards pertaining to their use.

[5]The RAND Corporation has a contract with the U.S. Army to evaluate the use of computer simulations in military training exercises.

[6]BOSs are the major functions that occur on the battlefield. The seven BOSs are (1) command and control; (2) intelligence; (3) maneuver; (4) mobility, countermobility, and survivability; (5) fire support; (6) air defense; and (7) combat service support.

Our work involving the management of simulation programs was limited to a review of studies conducted by the Army Audit Agency and discussions with Department of Defense (DOD) and Army officials.

We conducted our work between January and August 1990 in accordance with generally accepted government auditing standards.

Agency Comments

DOD concurred with the report's findings and conclusions (see app. IV).

REFORGER 1990—A New Approach With Important Benefits Despite Some Limitations

REFORGER 1990, the 21st such exercise, marked a significant departure from previous exercises. The combined impacts of the reduced Soviet and Warsaw Pact threat; plans for German reunification; and environmental, political, and budgetary considerations led USAREUR to reshape REFORGER 1990 to focus on leaders at higher echelons (battalion through corps) and the use of computer simulations in the follow-on exercise. The new exercise concept realized important benefits in the areas of battle planning and command and control, key areas at higher echelons, but it had limitations in portraying some battlefield functions, such as intelligence. To address the limitations, the Army has taken steps to improve simulation capabilities for future exercises. Public concern about large-scale exercises was lessened during REFORGER 1990.

USAREUR Develops the REFORGER Enhancement Program

Rather than conduct a large-scale FTX in the REFORGER employment phase, as in prior years, USAREUR's REFORGER Enhancement Program called for connecting a computer-simulated command post exercise (CPX) with a combination command field exercise (CFX) and an FTX and conducting them simultaneously.[1] With the use of a computer-simulated CPX to focus the training at battalion through corps levels of command, the size of the battle was expanded, while the number of exercise participants did not increase commensurately. The use of simulations provided an interactive environment to help the commanders and staffs at the battalion through corps levels synchronize the use of all seven BOSs rather than just focusing primarily on one of them, maneuver, as they had done in the past.

CPXs require fewer troops and vehicles than FTXs since the focus is on training commanders and staff. Table 2.1 compares personnel and vehicle requirements of armored battalion-level CPXs, FTXs, and CFXs.

[1] REFORGER Enhancement Program is the formal name USAREUR used to identify the efforts associated with shifting the focus of REFORGER to the use of computer simulations with a focus on training military leaders at higher echelons.

Table 2.1: Troops and Vehicles Used in Different Types of Exercises

Requirement	FTX[a]	CFX[b]	CPX[c]
Tanks	56	16	0
Other tracked vehicles	40	28	10
Troops	520	300	60

[a]An FTX is a training exercise conducted in the field with participation of all echelons and battle functions against actual or simulated opposing forces.

[b]A CFX is a training exercise that involves fewer fielded forces than an FTX. It is a free-play, force-on-force maneuver employing support units and higher headquarters but with subordinate combat and combat support units operating only a small portion of their vehicles.

[c]A CPX is a scripted or computer-supported training exercise for commanders and staffs that involves no troops in the field. It is conducted from computer centers or from dispersed tactical headquarters linked to a network of computers.

As plans for the REFORGER Enhancement Program progressed, USAREUR officials delayed REFORGER 1989 until early 1990. By rescheduling REFORGER 1989, USAREUR was able to test the new REFORGER Enhancement Program concept during a corps-level training exercise, Caravan Guard, held in the fall of 1989, before implementing it in REFORGER 1990.

REFORGER 1990—A Combination of Live and Computer-Simulated Exercises

Following Caravan Guard, USAREUR began to finalize its plans for REFORGER 1990 and its Centurion Shield follow-on exercise. USAREUR exercise officials were still modifying plans for REFORGER 1990 up until December 1989, just before the exercise began.[2] According to USAREUR officials, the Army decided to reduce the size of the exercise late in the planning process in recognition of the democratic reforms in eastern Europe and to reduce the exercise costs.

In comparison to previous years' exercises, REFORGER 1990 required fewer POMCUS items to be withdrawn,[3] and a reduced number of troops and vehicles were used in the follow-on training exercise. Table 2.2 shows the reduced scope of REFORGER 1990 compared with REFORGER 1988.

[2]Troops began deploying from the United States to Europe for REFORGER 1990 on December 28, 1989, and the last unit redeployed to the United States on February 28, 1990.

[3]Appendix II discusses how the REFORGER Enhancement Program affected the training value of this phase of REFORGER.

Table 2.2: Troops, Equipment, and POMCUS Items Used for REFORGERs 1988 and 1990

	REFORGER		
	1988	1990	Change[a]
Total troops	113,889	57,500	(56,389)
Troops deployed from the United States	17,451	14,699	(2,752)
Tanks	1,200	0	(1,200)
Other tracked vehicles	7,000	2,000	(5,000)
Wheeled vehicles	15,000	18,000	3,000
POMCUS items[b]	4,425	1,955	(2,470)

[a]Parantheses indicate negative numbers.

[b]The POMCUS items drawn included some of the tracked and wheeled vehicles and other items, including camouflage nets, trailers, kitchens, lights, and other equipment for troops participating in the employment exercise in the maneuver area.

As previously mentioned, the total number of U.S. troops participating in REFORGER 1990 was reduced significantly over the previous REFORGER. However, the reduction in the total number of troops deployed from the United States was not significant. The number of troops participating could be reduced because, rather than attempting to train all exercise participants, as in previous REFORGERs, where training benefits at lower echelons were limited, REFORGER 1990 planners decided to focus training on commanders and staffs from the battalion through corps levels.

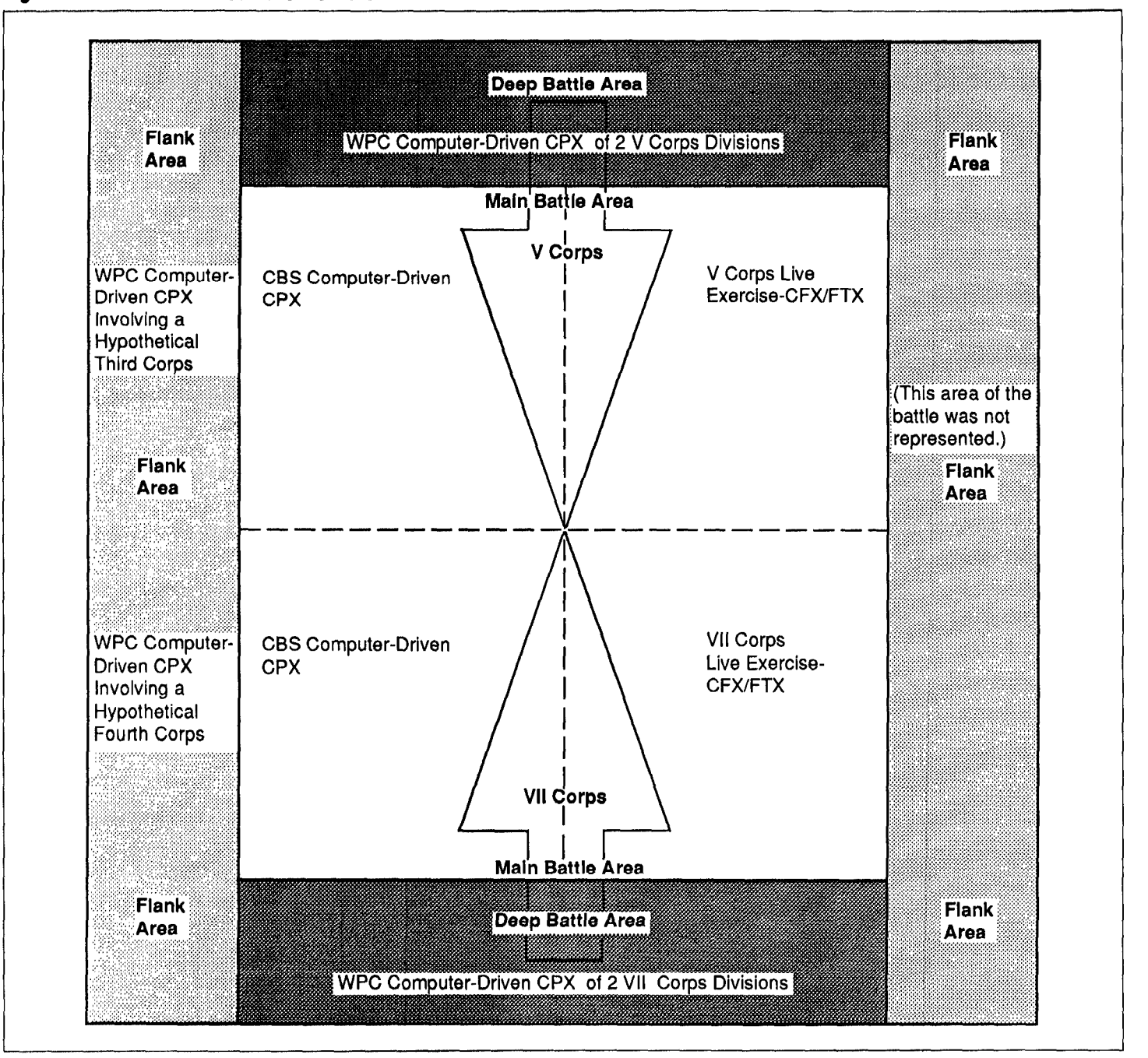
Centurion Shield linked a computer-driven CPX to a live battle simultaneously fought in a combined FTX and CFX format. As shown in figure 2.1, V and VII Corps opposed one another in the exercise. They commanded their own troops, as well as German troops and reinforcing units deployed from the United States. Each corps commanded one brigade in a CPX using a computer simulation called the Corps Battle Simulation (CBS). In addition, each corps commanded live troops on the ground. Most of the troops in the live battle were in a modified CFX format in which wheeled vehicles were substituted for tracked vehicles. The vehicles used panel markings and colored "nerf" balls on antennas to designate the type of unit they were representing. Only a few units, mostly light infantry, were in an FTX mode. In addition to the V and VII Corps forces, which used the CBS simulation, other forces were simulated using the Joint Warfare Simulation.[4] Through this second simulation, two

[4]Joint Warfare Simulation is a product of the WPC, a jointly run Army and Air Force training center designed to provide U.S. and allied battle commanders and their staffs the opportunity to train for the operational level of war using interactive computer simulations. The Joint Warfare Simulation consisted of a ground combat model called the Ground Warfare Simulation and an air combat model called the Air Warfare Simulation.

additional corps were simulated on the northern flank of the battle, and two additional divisions were simulated in each corps' deep battle area.[5]

[5]"Deep battle area" refers to the area beyond the main battle area—it is where reserve and support forces would be situated.

Figure 2.1: REFORGER 1990 Follow-on Exercise Structure



Training Benefits and Limitations in REFORGER 1990

Use of computer simulation to enhance training during REFORGER 1990 demonstrated the ability to achieve greater emphasis on (1) battle planning, staff procedures, and command and control; (2) making more efficient use of training time, especially for commanders and staffs; (3) providing needed focus on higher echelons that might be cost prohibitive otherwise; and (4) lessening adverse environmental and political impacts, when contrasted with previous REFORGER exercises. Nevertheless, some negative factors were associated with the use of computer simulations. These factors are best shown by their impacts on each of the seven BOSs that commanders must coordinate and synchronize. Table 2.3 summarizes the advantages and limitations of the REFORGER follow-on exercise by BOS.

Table 2.3: Advantages and Limitations of REFORGER 1990 Follow-on Exercise by BOS

Functional area	Advantages	Limitations
Command and control	Quicker and more frequent decisions Better synchronization of BOSs Larger, interactive battlefield	Unrealistic deep battle play
Intelligence	No consensus concerning significant advantage	Poor environment for intelligence collection Poor computer model for exercising intelligence analysis
Maneuver	More units represented	Poor terrain representation
Mobility, counter-mobility, and survivability	No consensus that computer simulation provided a significant advantage	Unrealistic representation of some obstacles Limited engineering activities in rear area
Fire support	Improved ability to assess mission effect More fire support missions	Unrealistic integration of fire support missions between live and simulated battles
Air defense artillery	Recognized potential for improving battle assessments despite limitations in REFORGER 1990 exercise	Unrealistic weapons effects Insufficient air play
Combat service support	No consensus concerning significant advantage	Most logistical constraints lifted and not allowed to affect the battle

Command and Control

Command and control is a principal form of training provided by computer simulations. At organizational levels of battalion through corps,[6] the focus of activity is increasingly on command and control, that is, battle planning and staff work that controls the movement of supplies, personnel, equipment, and so forth in executing operations. Other BOSS are important and are a part of battle planning and synchronization at higher echelons, but they are played out in battle execution at lower echelons. According to a USAREUR official, a key benefit of higher echelon computer simulations is that they highlight shortfalls in doctrine as well as errors in procedures as they occur through the simulated exercise.

Most exercise planners and participants we interviewed agreed that the command and control functional area was represented better in Centurion Shield than in previous REFORGER exercises because the use of computer simulations sped up the pace of the exercise. Various officials told us that command and control activities were unrealistically slow in previous REFORGERS. The large size and number of units made repositioning them a slow and laborious process and reduced training benefits, particularly for lower echelon troops. Environmental and safety restrictions also forced units to travel on certain roads and during specific time periods. Because the REFORGER 1990 exercise used fewer troops and less equipment in the field, they were able to move more quickly, and commanders were required to make faster and more frequent decisions. Decision-making was also quickened by the faster-paced, computer-simulated portion of the exercise. Decision-making gave commanders more practice in following staff procedures than previous exercises. By shortening the time for and, therefore, increasing the number of decision cycles commanders had to participate in, commanders and staffs were more stressed and actually received more training.

In addition to the faster and more stressful pace of the REFORGER 1990 exercise, training in command and control was better because commanders were forced to use and synchronize all the BOSS more than they had been in previous exercises. In prior REFORGERS, commanders tended to focus primarily on the maneuver BOS because it had more impact on the battle than the other BOSS. Before the use of computer simulations, exercise planners relied on a system of umpires to assess weapons' effects and battle damage. Umpires typically had difficulty locating

[6]See appendix III for a description of how different echelons view the battlefield and how simulations may be used at each echelon.

targets and assessing battle damage in a timely manner. Computer simulations, on the other hand, allowed other BOSS to affect the battle more in the REFORGER 1990 exercise than they had in the past.

A weakness in the computer-simulated representation of command and control during REFORGER 1990 was the unrealistic portrayal of units in the deep battle area and subsequently the inadequate attention given to these forces by corps commanders and their staffs. In previous exercises, deep battle activity was fairly limited and executed according to a predetermined plan. In the REFORGER 1990 exercise, a primary objective was to have corps commanders focus their efforts on the deep battle rather than exclusively on the close battle as they had in the past. Unfortunately, corps commanders and their staffs did not focus on the deep battle as much as the exercise planners had desired. According to a draft evaluation of REFORGER 1990 by the RAND Corporation, the exercise neither included enough activity in the deep battle area nor provided any penalty for not tracking and engaging enemy units. As a result, both corps' staffs tended to focus on the live, close battle during the exercise. This is an area exercise planners expect to give greater attention to in future exercises.

Intelligence

Intelligence consists of those means used to collect and produce information about the enemy, weather, and geographical features required by the commander for planning and conducting combat operations. Intelligence was adversely affected both in the modified field exercise in REFORGER 1990, as well as in the computer-simulated portion of the exercise, and did not provide a significant advantage over other REFORGERS. Intelligence was probably the least effectively portrayed BOS in REFORGER 1990.

Because REFORGER 1990's modified field exercise format reduced the density of troops and vehicles fielded at the company level and below, some of the best information sources were not present on the battlefield, thus reducing the effectiveness of intelligence sensors. For example, the exercise did not include enough unencrypted voice communications for intelligence signal collectors to monitor. Long-range surveillance units were also less valuable because when they maintained doctrinal distances from enemy units, they were not close enough to identify the markings on wheeled vehicles used to represent combat units. Imagery collectors were also less effective because they could not identify the types of units represented by the reduced troops and equipment in the maneuver area.

Exercise participants and planners also cited problems with the intelligence information produced by the computer simulations. Only the WPC simulations produced intelligence data, and the information generated was not presented in a format useful for training intelligence staffs. The intelligence model used in the exercise was designed to produce intelligence reports rather than train intelligence staffs to analyze information. For example, according to a RAND evaluation of the exercise, moving target indicator reports gave unit locations and identifications while in reality a report would only give the number of moving objects, such as aircraft or ground vehicles, in a particular location.

Maneuver

This BOS consists of moving and positioning forces and using artillery to attain an advantage over enemy ground forces. There were offsetting advantages and disadvantages involving this BOS between REFORGER 1990 and prior exercises. Computer simulation permitted the battlefield to be enlarged without having a corresponding increase in numbers of participants. However, because of the reduced number of troops participating at the company level and below, REFORGER 1990 offered fewer opportunities for maneuver training than did previous REFORGERS.[7]

In the computer-simulated portion of the exercise, portrayal of terrain was represented by contiguous hexagons overlaid on a map of the battlefield.[8] Computer simulations experts we spoke with stated that representing activities that affect only a portion of a hexagon was difficult. Further, they stated that terrain representations were such that when main supply routes were destroyed, secondary supply routes were also considered destroyed. Likewise, whenever artillery was fired into a hexagon, anything within it would also be hit. However, Army officials noted that there is a trade-off in seeking greater detail since it could slow down the pace of the exercise.

Computer simulations did provide some improvements to maneuver representation. Specifically, the simulations allowed USAREUR to enlarge the battlefield and represent more combat units. As described in the command and control section, they provided the capability to represent additional deep units and play a more realistic deep battle than previous

[7]It must also be noted that even in other recent REFORGERs, maneuver training was limited by environmental and safety concerns, according to USAREUR exercise officials.

[8]The computer simulations used in REFORGER 1990 represented terrain in 3-kilometer or 3.2-kilometer hexes.

REFORGERs. However, according to exercise officials, this capability was not used as well as it could have been during Centurion Shield.

Mobility, Countermobility, and Survivability

This BOS consists of any engineering activities used to improve a force's movement capability relative to its enemy. The mobility, countermobility, and survivability operations were not as realistically represented during the 1990 exercise as was desired, although some exercise participants stated that computer simulations did ensure adherence to obstacles placed in the simulated portion of the exercise.

In previous REFORGER exercises, engineering units typically used concertina wire and engineering tape to simulate obstacles used in countermobility operations. They generally posted a soldier nearby to ensure the obstacles were respected by exercise participants. Exercise planners wanted to use computer simulations to better represent some obstacles and automate their enforcement in a portion of the CPX.

Similar to previous REFORGERs, the 1990 exercise also had difficulty representing obstacles. For example, CBS' representation of scatterable mines, according to a draft RAND study, allowed participants to block an unrealistically large portion of the battlefield. Exercise participants and planners also explained that realistic representation of this functional area is largely dependent on having the capability to represent terrain in great detail, which the simulations that were used could not do well.

A second problem with this functional area was that rear area engineer operations were not played much during the exercise and, therefore, did not have a major impact on the battle. Exercise planners explained that activities in the rear area were limited because WPC did not use a more sophisticated model during the REFORGER 1990 exercise. As a result, rear area operations had to be changed several times through manual intervention by exercise planners; consequently, this BOS did not work well.

Fire Support

Fire support includes the use of artillery, armed aircraft, and other means to support maneuver operations against ground targets. While fire support represented in REFORGER 1990 had some weaknesses, it was represented better than it had been in previous REFORGERs. Computer simulations quickly assessed the effect of field artillery and allowed fire support missions to have a more definite and immediate impact.

In prior exercises, exercise participants developed and executed fire support missions and relied on a system of umpires for assessing the outcome and battle damage. According to exercise planners, participants typically received good training in the fire support planning process in previous exercises; however, umpires typically had difficulty locating targets and adjudicating missions in a timely manner. This reduced the impact that fire support missions had on the overall battle.

Because computer simulations sped up and improved the assessment process, fire support personnel were able to fire more missions. For example, the 194th Separate Armored Brigade's Deputy Commander, who participated in the CBS-simulated CPX, noted that the computer-simulated exercise provided excellent training in planning and executing fire support missions. The commander stated that the 194th Separate Armored Brigade's staff was more stressed because the computer simulations assessed the outcome of battles quickly and provided the staff with immediate feedback on their actions.

While the use of simulations sped up the fire support mission assessments, some participants stated that the system for conducting fire support missions between the live FTX and CFX and the computer-simulated CPX battles did not work well. Representatives from VII Corps' Fire Support Element and V Corps Artillery stated that live FTX and CFX units were often fired upon and were sometimes defeated by computer-simulated units that they could not see or protect themselves against. They also stated that the effect of artillery in the exercise was unrealistically high and that mission effectiveness would have to be adjusted for more realistic results.

Air Defense

Air defense activities include any measures taken to reduce the effectiveness of hostile aircraft or missiles once they are airborne. REFORGER planners believe there is potential for computer simulations to improve training in this BOS, but they told us that it was not used as effectively as it could have been in REFORGER 1990, and overall this BOS was less effectively represented than in prior exercises. One reason for the poor representation of air defense in REFORGER 1990 was that the number of live and simulated air missions was too limited.

According to exercise planners and participants we spoke with, REFORGER exercises have historically had difficulty assessing air defense missions and battle damage from air missions. Consequently, air defense

had little impact on the battle in prior exercises and was usually ignored by commanders.

According to the Chief of USAREUR's REFORGER Planning Group, the Air Force flew fewer sorties in support of the Army's REFORGER 1990 exercise than in previous REFORGERs because the reduced density of troops and vehicles provided too few targets and because weather conditions restricted planes from flying. As noted in the RAND evaluation of REFORGER 1990, simulated as well as live air missions were limited by weather restrictions because the computer simulations were based on actual weather conditions—a real-world constraint. Another reason, as noted in the REFORGER 1990 After Action Report, is that the air defense weapons were not represented as effectively as they should be. The V and VII Corps air defense representatives we spoke with indicated that air defense weapons are much more effective than were portrayed in the exercise.

Despite the weaknesses previously mentioned, the chief of USAREUR's REFORGER Planning Group stated that computer simulations do offer the potential for improving air defense participation. As the simulated air defense weapons effects become more realistic, exercise planners are hopeful that the simplified battle assessment process will result in air defense weapons' being employed as they would be in wartime and have a greater impact on the battle.

Combat Service Support

This BOS includes the logistics, personnel, and medical support services provided to sustain combat operations. The combat service support BOS experienced some of the same problems it had in previous REFORGERs. There was not a consensus among Army officials on how well this BOS was executed using computer simulations.

In previous exercises, participants had to operate within both real-world and artificial limits placed on the resupply of personnel and equipment. According to exercise planners and participants, simulated supply constraints were frequently ignored or lifted during the exercise. As a result, these constraints did not have much effect on combat operations. Similar problems occurred during REFORGER 1990. For example, the supply limitations in the WPC's simulations were lifted because the model constrained one force more than its opposition. As a result, the WPC simulations placed no limit on fuel, ammunition, or personnel during the exercise. According to exercise planners, constraints had to be lifted to prevent combat operations from slowing down to the point where some

exercise participants were not being trained. Certain combat service support exercise participants also commented that the REFORGER 1990 exercise was less realistic than previous exercises because it had lifted more of the real-world supply constraints.

Combat service support representatives and exercise planners also stated that the lack of detailed terrain representation in the simulation models made it difficult to play combat service support realistically. For example, because the model represented terrain in 3-kilometer or 3.2-kilometer blocks, eliminating a primary supply route generally removed the secondary route as well. Combat service support representatives also said that the models used did not include enough supply categories to adequately stress logistics staff. Rather than being able to order specific types and amounts of supplies, logistics personnel were required to order items by the short ton.

Overall Benefits

Overall, senior USAREUR officials considered REFORGER 1990 to be a successful training exercise, particularly in the area of staff planning and procedures, despite limitations associated with specific BOSS.

While touring exercise facilities during the exercise, we heard numerous positive comments from commanders about the quality of the training provided through computer simulations, even from some who had previously not been positive about their use. One commander told us that despite some limitations in realism, the simulated exercise had provided the best training his staff had received since attending the Army's National Training Center in California, the Army's premier training facility. Another commander said that his staff had received good training in battle planning and the exercise had provided the opportunity to concentrate on war-fighting skills without having to worry about some of the administrative problems associated with a live field training exercise. We also heard comments from some commanders describing the negative aspects of computer simulations, such as those previously identified for individual BOSS.

The WPC Analysis Group surveyed REFORGER 1990 exercise participants and found that 72 percent of those responding to a question stated that the computer-simulated exercise had supported training "somewhat" to "very well"; 28 percent indicated that it had provided a "poor" to "very poor" training environment. Key strengths identified were in providing a good overall training environment and training staff procedures. Some weaknesses identified included insufficient pre-exercise training for

support personnel, poor representation of intelligence, unrealistic logistics and resupply operations, and the computer data base's not being fully prepared and tested before starting the exercise.

Simulation Improvements May Correct Some Weaknesses Identified in REFORGER 1990

According to exercise planners, plans are underway for improving the seven BOSS' representation. Exercise officials hope to improve the intelligence functional area representation with a new simulation called the Tactical Simulation, which runs with CBS. The Tactical Simulation simulates the collecting and reporting functions of selected U.S. reconnaissance assets. According to USAREUR simulation officials, the Tactical Simulation provides a better training experience for intelligence staffs because it provides data in a real-world format and requires intelligence staffs to analyze and integrate data to produce intelligence reports.

Exercise planners also stated that in the mobility, countermobility, and survivability BOS, representation of rear area engineering operations would be improved with the use of a new engineering model, which runs with the WPC simulations. Also, a new simulation called the Theater Transition and Sustainment Model is being developed to better exercise combat service support staff during the deployment portion of the exercise. Still under development, the Theater Transition and Sustainment Model will run with the WPC simulations and will be used to simulate logistics, personnel, and medical functions.

One weakness of computer simulations affecting command and control, as well as other BOSS cited by various Army officials, is that they cannot realistically represent the "fog" or "friction" of war—that is, those unanticipated things that go wrong. However, other Army officials note that things do not always go as planned, even in simulated exercises and that the fog or friction of war may be represented more realistically with modifications being developed for a newer version of one computer model used in REFORGER 1990. The new version will incorporate "human elements" into the exercise. For example, the model will reduce the effectiveness of units after they have been on the battlefield for a long time to take into account such effects as fatigue.

Public Concerns Minimized

While the German media did report some opposition about the REFORGER 1990, it was significantly less than in previous years. For example, according to USAREUR's analysis of host nation news reports, 75 percent of the REFORGER 1990 reports reviewed were positive, while only 45 percent of those on REFORGER 1988 were positive. The analysis noted that

the new exercise concept and reduced maneuver damage were two positive themes mentioned in the reports.

Conclusions

Overall, REFORGER 1990 was successful in improving many aspects of the training benefits derived from a large-scale training exercise for European-based forces and those deploying from the United States. Training benefits varied by functional area when contrasted with previous REFORGER exercises. Representation of both command and control and fire support was improved through the use of computer simulations and provided a more challenging and beneficial training exercise for participants in those functional areas. In other areas, such as intelligence, the use of simulations in the modified structure resulted in fewer training benefits.

Improvements to computer simulations are being made to correct some of the identified deficiencies. Significant training advantages accrued from a faster-paced exercise with repetitive training in battle planning and execution. In addition, computer simulation provided the ability to expand the scope of the battle while reducing the number of troops on the ground and minimized political and environmental effects. Thus, while trade-offs exist in using computer simulations, there appear to be significant benefits, given their usefulness in providing needed training opportunities in battle planning and command and control.

Future Plans for REFORGER Exercises

Various factors, such as allied countries' interests and environmental constraints, will affect the scope and frequency of future training exercises in Germany. Although USAREUR expects to expand the use of computer simulations in the future, this use could be tempered by U.S. allies' desire to rely more on actual ground maneuvers for the follow-on training exercise than on computer simulation.

Factors That Will Affect Future Large-Scale Exercises

Political changes have created numerous uncertainties regarding U.S. troops' presence in Europe, which could also affect the frequency, scope, and size of future large-scale military exercises there. Irrespective of political changes, environmental factors have brought increasing constraints on large-scale exercises, and they are unlikely to subside.

As the Army develops future exercises, it must take into account (1) the decreased German support for a U.S. military presence, (2) the decreased Warsaw Pact threat to NATO, and (3) the growing sensitivity of the German public to environmental issues. While the German public viewed REFORGER 1990's use of simulations to offset maneuver forces positively, support for a continued U.S. military presence in Germany is eroding. Polling analyses prepared for the German Federal Chancellory by the Allensbach Institute for Public Opinion Research indicates rapidly declining public support for continued U.S. presence in Germany as East-West tensions have lessened and perceptions of a Soviet threat have continually declined in recent years. Table 3.1 indicates how German public support has changed over time regarding U.S. troop presence.

Table 3.1: Changes Over Time in German Citizens' Wanting the United States to Withdraw Its Troops From Germany

Year	Percent favoring U.S. troop withdrawal
1982	21
1987	34
1990	52

According to Allensbach, West German support for the U.S. military presence has declined because the Soviet threat has diminished and the perception is that West German security no longer requires the permanent presence of U.S. troops.

As political reforms have taken place in eastern Europe, the United States has responded by developing plans to reduce and restructure its forces in Europe. When an agreement is made on the troop-level portion

of the Conventional Forces in Europe treaty, the U.S. presence in the European central region will likely be reduced to 195,000 troops, and the potential exists for even further reductions. It still has to be determined how long POMCUS equipment will be held in Germany. While exercise planners reduced the number of POMCUS stocks withdrawn in the REFORGER 1990, the chief of the exercise division stated that it is occasionally necessary to practice full POMCUS draws to exercise procedures and test the equipment. The chief also stated, however, that full POMCUS draws can be exercised apart from the REFORGER exercise.

Army officials expressed concern that it may be increasingly difficult to hold large-scale deployment and follow-on employment exercises as the defense budget is reduced. USAREUR officials stated that decreasing budget authority was a major factor in the Army's decision to develop the REFORGER Enhancement Program and increase the use of simulations. Simulations will continue to be used in large-scale exercises, such as REFORGER, as the Army seeks to use its training dollars wisely. Another option currently under consideration at the Joint Chiefs of Staff level is to conduct REFORGER exercises once every 2 years rather than annually. However, as of September 1990, the Joint Chiefs of Staff had not yet decided on this issue.

Future Plans for Using Computer Simulations

As of September 1990, specific plans for REFORGER had only been made through the 1992 exercise. In future exercises, USAREUR hopes to integrate the use of simulations to (1) conduct reduced scale exercises using computer simulations involving two different corps, (2) increase the use of satellite networking to include headquarters participation from garrison locations in Europe and in the United States, (3) expand the number of headquarters personnel being trained, and (4) link operational and tactical training.

Allies' Reluctance Could Limit Use of Simulations in the Future

Some European allies do not have as much experience as the United States in the use of simulations in training exercises. According to the Chief of the REFORGER Planning Group, the allies agree that using simulations instead of a full contingent of live forces may reduce maneuver damage claims and maintenance expenses and may decrease political friction with the host government. However, they have questions about the extent of training value provided by simulations. Yet Army officials indicate that the allies' interest in simulations is increasing, and they are demonstrating a growing interest in employing simulations for training purposes.

Simulations Will Have Reduced Role in REFORGER 1991

As of September 1990, plans for REFORGER 1991 call for the use of simulations in the employment exercise, but they will not be used as extensively as they were in REFORGER 1990. The REFORGER 1991 follow-on training exercise will be planned and controlled by NATO's Northern Army Group, under British command, with participation by American, British, Belgian, Dutch, and German forces.[1] Because the allies are less familiar with simulations and some NATO members want to use REFORGER for maneuver training, only one simulation system will be used in REFORGER 1991.

The units participating in the REFORGER 1991 employment exercise will train in a variety of modes. The American, British, and German units will train in modified CFX and CPX modes, using only command and control and wheeled vehicles, similar to the format used for REFORGER 1990. The CBS will be used to represent a force on the northern flank of the exercise maneuver area.

According to the Chief of the REFORGER Planning Group, the Dutch and certain Belgian units plan to operate in an FTX mode, using tanks and other tracked vehicles. These units do not have access to maneuver training facilities such as the U.S. Combat Maneuver Training Center in Hohenfels, Germany, and with increasing restrictions being placed on maneuver rights areas in Germany, they view the REFORGER 1991 employment exercise as an opportunity to provide maneuver training for their units.

Simulations' Role Will Increase in REFORGER 1992

USAREUR officials are planning to use simulations extensively in the REFORGER 1992 exercise, including full logistics play from battalion to theater levels. The exercise participants will operate in a computer-driven CPX exercise mode and will not use any tanks, armored personnel carriers, or self-propelled artillery. The only authorized tracked vehicles will be those for command and control, combat support, and combat service support. REFORGER 1992 will also place a greater emphasis on training deploying units and European-based support commands in POMCUS draws.

[1]The multinational forces scheduled to participate in REFORGER 1991 will be formed into two opposing forces. One force will consist of units from the U.S. III Corps, I Belgian Corps headquarters, a Belgian Mechanized Brigade, Northern Army Group airmobile division, I British Corps headquarters, and I German Corps headquarters. The other force will consist of units from III British Armored Division and II Dutch Armored Brigade.

Between 24,000 and 25,000 U.S. and allied troops are expected to participate in the employment exercise's maneuver area located in the V Corps area of responsibility. The CPX force will be a multinational force consisting of units from V American Corps, II German Corps, II French Corps, and a Canadian Mechanized Brigade. The opposing force will be located at Fort Leavenworth, Kansas. They will be linked to troops in Germany through satellite communications. This type of networking has been demonstrated in smaller exercises in recent years and demonstrates the capability for non-deployed units to participate in large-scale exercises from multiple locations. About 2,000 troops from U.S.-based units will be deployed exclusively to exercise POMCUS draws in REFORGER 1992.

Conclusions

With increasing political and environmental restrictions in Europe and budgetary constraints, the Army's modified REFORGER structure will likely provide a foundation for future large-scale exercises planned and controlled by USAREUR. However, future use of computer simulations in these exercises will also involve joint decisions by participating countries. As plans for REFORGERS 1991 and 1992 indicate, use can vary depending on an individual country's interests.

Cost Savings From Use of Computer Simulations Are Unclear/Improvements Are Needed in Program Management

Computer-simulated exercises offer the potential for some savings in costs associated with traditional FTXs, such as transportation costs. Offsetting the savings in traditional exercise costs, however, are the millions of dollars in investment costs the Army has incurred to develop, field, and support computer-simulated systems. In any event, comparisons of the cost of training based on computer simulations with the cost of traditional exercises may not be meaningful or practical. First, the training may be quite different, as in the case of REFORGER 1990, which focused on training in command and control and battle planning at higher echelons that might not have been possible in traditional exercises. Second, computer simulations are designed to assist multiple exercises; therefore, development and fielding costs are not allocated to individual exercises.

Management weaknesses associated with computer simulations have been recognized by the Army and DOD. Some steps are being taken to address them.

Extent of Cost Savings Is Unclear

To support REFORGER, the Army has relied on Joint Chiefs of Staff funds designated for exercises as well as funds from individual military services' operations and maintenance budgets. According to U.S. European Command cost data, REFORGER 1990 did have some measurable savings over the 1988 exercise in terms of Joint Chiefs' funded transportation costs, as shown in table 4.1.

Table 4.1: Comparison of Selected Costs for REFORGERs 1988 and 1990

Dollars in millions

	Costs		
Cost category	**1988**	**1990**	**Reduction**
Airlift and sealift	$29.5	$27.9	$1.6
Port handling and inland transportation	9.3	6.5[a]	2.8

[a]Estimated costs provided by U.S. European Command and USAREUR officials.

In addition to the cost savings shown in table 4.1, USAREUR officials expect that maneuver damage claims will be significantly lower than previous years' REFORGERs because no tanks and fewer tracked vehicles were used in the exercise. USAREUR officials estimate that the amount of maneuver damage claims for REFORGER 1990 would be about 40 percent lower than those reported for REFORGER 1988. According to the U.S. Army Claims Service, as of September 25, 1990, the U.S. share of maneuver damage claims for REFORGER 1988 was about $16.4 million.

Maneuver damage costs for REFORGER 1990, however, cannot yet be determined because these claims are still being processed.

The modified REFORGER format shifted the focus to training a greater number of higher echelon commanders and staffs. Therefore, relatively fewer lower echelon troops participated in REFORGER 1990 than in prior exercises. Training of these lower echelon troops continued at home stations—funding associated with this training would not be reflected in REFORGER costs. Overall, this training would absorb some costs that might otherwise have been saved.

Offsetting the savings in traditional exercise costs, however, are the investment costs incurred to develop, field, and support computer simulations. The Army has already invested millions of dollars in computer simulations and plans to invest sizable sums of money over a period of years to develop simulations for future use. Because these costs will benefit multiple training exercises now and in the future, they are not allocated to individual exercises. The cost of computer simulations is funded from many different sources, but neither the Army nor DOD has a system in place that captures, in a central location, all of the costs incurred.

USAREUR estimates that about $312,000 in simulation support costs were incurred specifically for the REFORGER 1990 follow-on training exercise for field simulation centers, temporary duty for personnel, communication links, and other miscellaneous costs. However, computer simulations also involve ongoing operational costs at specific locations as well as long-term investment costs Army-wide. For example, USAREUR, operates seven battle simulation centers to support ongoing training programs. Using primarily contract personnel, these centers set up and operate computer simulations in support of individual exercises, as well as maintain the computer hardware and software associated with these operations. USAREUR estimates the cost of these operations at $4.2 million in fiscal year 1990 and $7.6 million in fiscal year 1991.

The Army's National Simulation Center at Fort Leavenworth, Kansas, is developing a plan for fielding a family of simulations to be used Army-wide. It indicates that $5 million in research, development, test, and evaluation costs were associated with the CBS simulation in fiscal year 1990. Additional costs would be incurred in subsequent years for any additional modifications to this simulation. Development costs, of course, are associated with other computer simulations used in REFORGER 1990 and other exercises provided by the WPC. USAREUR has

taken the lead in developing the Theatre Transition and Sustainment Model, which, as previously mentioned, will be used to better simulate combat service support operations. According to a USAREUR official, USAREUR has spent $2 million in development costs to date and expects that total model development will cost $17 million. USAREUR is trying to find other users to help allocate its costs.

Simulations may result in some cost savings over large-scale field exercises because, when used as the primary focus of an exercise, they require fewer personnel in the field and lower equipment operation and maintenance costs. Much will depend on the extent to which troops continue to be deployed overseas and in the field to participate in field training exercises as a complement to computer-simulated exercises. The extent of overseas troop deployments for such exercises can be affected by the extent to which it is deemed necessary to use such deployments as a more visible means of demonstrating national resolve in support of an ally.

Internal Control Weaknesses Identified

Studies by other audit organizations involving Army activities in the United States and Europe raise questions about whether appropriate acquisition procedures have been followed and proper funding sources used to acquire a number of computer-related simulations.

The chief internal review officer at Fort Leavenworth, Kansas, reacting to reports by the Army Audit Agency of irregularities in contracting for computer simulations,[1] completed his own review, during the summer of 1990, of selected transactions at that installation. The chief identified instances in which improper sources of funds had been used to acquire simulation-related hardware and software. The chief reported to the commander of Fort Leavenworth that internal controls necessary to prevent the improper use of funds had not been used and recommended making adjustments in funding sources and reporting a systemic internal control weakness in accordance with the Army's Internal Control Program. Efforts are now underway to correct the errors in funding sources for acquisitions initiated at Fort Leavenworth.

[1]Report of Audit: The Army Model Improvement Program (U.S. Army Audit Agency, SW 90-205, Apr. 9, 1990). Also, as of September 1990, the Army Audit Agency was awaiting formal Army comments on a draft audit report, which provides a more detailed review of third party contracting related to the acquisition of computer-related simulation equipment, software, training, maintenance, and personnel. That review was conducted at multiple locations in the United States and Germany—it suggests that problems associated with third party contracting may be widespread.

Greater Coordination and Oversight by DOD Is Needed

We became aware during our review of some problems related to interagency management of simulations and efforts by DOD to begin addressing them. In an April 1990 testimony before the House Armed Services' Subcommittee on Readiness,[2] we referenced a recent Defense Science Board report that found insufficient coordination among the many DOD organizations that are building simulations, particularly simulations representing activities of more than one military service.[3] The report stated that a lack of coordination "results in redundant databases with less quality, less data validation, and less ability to maintain accurate data over time than could be achieved." DOD officials also told us about the need for greater coordination and oversight within DOD to focus on simulation policy pertaining to the development and use of simulations.

In September 1990, the Assistant Secretary of Defense for Force Management and Personnel and the Director of Defense Research and Engineering jointly notified the Secretaries of the military services and the Chairman of the Joint Chiefs of Staff that a departmental simulation policy study had been initiated. The study's charter is to assess and propose DOD policy on simulations with a final report due by March 1991. Working groups representing departmental users will be convened to examine policy issues in each of the following areas: (1) military training; (2) evaluation of operational plans, concepts, doctrine, or force structure; (3) research and development; and (4) test and evaluation.

Conclusions

Computer simulations offer the potential for savings in traditional costs of large-scale field exercises. The extent of cost reductions could vary over time, depending on the mix of field and computer-simulated training and the extent of the deployment of troops from the United States to Germany. More extensive assessments of potential savings are not possible since there are ongoing and future long-term investment costs associated with simulation technology that will benefit multiple exercises. In any event, cost comparisons of computer-simulated training and traditional training may not be meaningful because the training itself may be quite different. Internal control weaknesses and the need for improved oversight and policy guidance at the DOD level have been recognized either by the Army or DOD, and some corrective

[2]Lessons Learned During GAO's Reviews That Can Be Applied to the Restructuring and Training of U.S. Forces (GAO/T-NSIAD-90-13, Apr. 4, 1990).

[3]Computer Applications to Training and Wargaming, Report of the Defense Science Board Task Force (May 1988).

measures have been initiated. We did not evaluate the adequacy of the corrective actions. As indicated by the Army Audit Agency's draft report, problems associated with third party contracting for the acquisition of computer-related simulation equipment, software, and so forth may be widespread.

REFORGER Exercises From 1969 to 1990

REFORGER Exercise year	Date Start	Date End	Number of days	U.S. troops deployed
1969	Jan. 6, 1969	Mar. 23, 1969	76	12,187
1970	Oct. 5, 1970	Nov. 25, 1970	51	11,402
1971	Sept. 26, 1971	Nov. 17, 1971	52	11,807
1973 (1)	Jan. 9, 1971	Mar. 5, 1973	55	9,938
1973 (2)	Sept. 29, 1973	Nov. 22, 1973	54	11,126
1974	Sept. 30, 1974	Nov. 23, 1974	54	11,628
1975	Oct. 1, 1975	Nov. 17, 1975	47	10,393
1976	July 22, 1976	Oct. 29, 1976	99	12,836
1977	Aug. 11, 1977	Oct. 18, 1977	68	12,417
1978	Aug. 15, 1978	Oct. 15, 1978	61	14,694
1979	Jan. 3, 1979	Mar. 1, 1979	57	14,509
1980	Aug. 18, 1980	Oct. 20, 1980	63	15,779
1981	Aug. 22, 1981	Oct. 25, 1981	64	16,666
1982	Aug. 21, 1982	Oct. 22, 1982	62	18,516
1983	Aug. 25, 1983	Oct. 28, 1983	64	16,044
1984	Aug. 29, 1984	Oct. 28, 1984	60	16,966
1985	Jan. 1, 1985	Mar. 1, 1985	59	18,000+
1986	Jan. 1, 1986	Mar. 9, 1986	67	19,751
1987	Aug. 23, 1987	Oct. 19, 1987	57	30,000+
1988	Aug. 20, 1988	Oct. 31, 1988	72	17,451
1990	Dec. 28, 1989	Feb. 28, 1990	62	14,699

Sources: USAREUR Annual Historical Reviews and REFORGER Planning Group.

POMCUS Training Value Reduced in REFORGER 1990

According to the Chief of Staff, Combat Equipment Group, Europe,[1] while REFORGER 1990 provided training in planning for a POMCUS draw, the reduced size of the exercise resulted in some training loss since equipment was not issued according to wartime contingency plans. Instead, each combat equipment company had to reorganize its warehouses to put the designated REFORGER equipment in front of the issue points.[2]

While there were limitations in training benefits involving POMCUS for REFORGER 1990, we were told that there are ways to compensate for these limitations. One way to compensate, according to a USAREUR official, is to have troops specifically deployed to draw and test POMCUS equipment without necessarily participating in the follow-on training exercise. Further, this official told us that, while practicing POMCUS draws are important, they could be practiced in the future by having similar units stationed in Europe draw entire sets of POMCUS equipment. The official stated that this practice would reduce costs while providing realistic and beneficial training to the Combat Equipment Group, Europe, staff.

U.S.-based units could practice equipment draws in the United States at places like the National Training Center. We were recently told by National Training Center officials at Fort Irwin, California, that they had developed a proposal for increasing the amount of equipment prepositioned at the center as a way to reduce the transportation costs of units deploying there for training.

[1]The Combat Equipment Group, Europe, is responsible for issuing and maintaining POMCUS equipment. It is a subordinate command of the 21st Theater Army Area Command, which has overall responsibility for coordinating logistical support for the deployment and redeployment of U.S. forces.

[2]The Combat Equipment Companies are directly responsible for the storage and maintenance of equipment at the POMCUS sites under the direction of the Combat Equipment Group, Europe.

Portraying the Battlefield—Reality Versus Simulations

Army leaders, at various unit levels, view the battlefield and fight the battle from different perspectives. Leaders in units closer to the battle see the battle directly and respond quickly to battlefield situations. Army leaders in units further from the battle observe and fight the battle based on information from subordinate units. Computer simulations provide the means for improving training, particularly at echelons above brigade, where it may be less feasible or beneficial for all echelons to train simultaneously in the field.

Fighting the Battle—Reality

Leaders in units closer to the battle (squads, platoons, and companies) direct their units to fire and maneuver against individual soldiers, vehicles, and small units; their planning activities are more limited than at higher organizational levels. Leaders of units further from the battle (battalions, brigades, and above) have staffs that collect information from subordinate units in contact with the enemy and show the battle on a map. The commanders and staffs of units further from the battle provide guidance and prepare orders directing subordinate units to maneuver and engage enemy units at specific geographic locations. In addition, the staffs develop various courses of action and perform significant activities to sustain combat operations, as well as plan for future battle actions, depending upon the outcome of the current battle.

Squad Viewpoint and Actions

The squad leader (a sergeant or staff sergeant) directs the actions of one vehicle and/or a group of about eight soldiers. The squad leader views the battle personally as the squad is in direct (visual) contact with the enemy. The squad leader moves the squad to specific locations, directs soldiers to prepare fighting positions, and employs squad weapons. The squad leader generally acts on the direction of the platoon leader and/or platoon sergeant and reports squad actions and observations to his superiors. The squad leader does relatively little planning other than looking out for the welfare of the squad—making certain the squad has enough food, water, ammunition, and other supplies. The squad leader rarely uses the map to plan squad actions and generally follows the directions of the platoon leader, although a map may be used in land navigation.

Platoon Viewpoint and Actions

The platoon leader (a lieutenant) directs the actions of 4 to 8 vehicles and 16 to 40 soldiers. The platoon leader sees the battle personally and coordinates the actions of the squads and/or individual vehicles. The platoon leader, with the assistance of the platoon sergeant, ensures that

the subordinate squads can fight as a group and control the platoon's assigned area of responsibility. The leaders of the platoon ensure that platoon weapons are properly employed so the fire from these weapons covers the platoon's area of responsibility. The platoon leader implements the company commander's orders based on mission, enemy, terrain, time, and available troops. The platoon leader frequently uses a map to plan and direct actions, and the company commander may provide a map overlay showing the upcoming actions.

Company Viewpoint and Actions

The company commander, usually a captain, directs the actions of about 15 vehicles and about 100 soldiers. The company commander sees the battle and directs the actions of platoons. The company commander, with the assistance of the executive officer and first sergeant, coordinates the actions of the platoons to ensure that the company can accomplish assigned missions. The company commander assigns individual platoons areas of responsibility and checks to ensure that weapon systems can effectively engage targets. The commander directs the movement of the platoons based on the battalion operational order. The battalion staff generally provides each company a map overlay showing the scheme of maneuver and the company's proposed route in the upcoming operations. The company commander regularly uses a map to plan his operations and if he has time, may provide a map overlay to his platoon leaders showing the company's plan of maneuver and the platoons' roles in the plan.

Battalion Viewpoint and Actions

The battalion commander, usually a lieutenant colonel, commands a force of over 100 vehicles and approximately 700 soldiers. The battalion commander has a staff of about 40 soldiers to control the battle. Subordinate units provide information to the battalion about enemy forces, and the battalion staff shows this information on a map. This is how a battalion commander and staff see the battle, although they may frequently go forward to see units down to the platoon level in action. The battalion commander fights the battle by directing friendly units to move and engage enemy units. The battalion staff also coordinates the actions of other forces, such as artillery, engineers, and support forces to help the battalion accomplish its mission. In addition, the staff coordinates support forces to provide food, fuel, ammunition, medical care, and so forth for the companies. The battalion commander and the battalion staff use maps extensively to coordinate movement and direct combat. The battalions usually issue overlays to the companies to show

upcoming actions and frequently receive map overlays from brigades showing the brigade operation.

Brigade Viewpoint and Actions

The brigade commander, usually a colonel, commands a force of about 500 vehicles and over 3,000 soldiers. The brigade commander has a staff of about 100 soldiers to help control the actions of the brigade. Subordinate units provide information to the brigade on enemy actions, similar to information provided the battalion, and the staff places the information on a map reflecting the current situation. As with the battalion, the brigade sees the battle from the perspective of a map. The brigade commander directs friendly units (battalions or companies) to maneuver and engage enemy units. The brigade staff controls the actions of other forces, such as air defense assets, artillery, engineers, and air support to influence the battle. The brigade allocates combat support and some combat service support assets to subordinate battalions to help subordinate units accomplish their missions. The brigade also coordinates support forces to provide assistance to the subordinate battalions. The brigade commander and brigade staff see the battle from the perspective of a map, although they occasionally move forward to observe the battle. The brigade supplements orders with a map overlay to help describe the upcoming operation, and the division normally provides a map overlay to reflect the division's plan of action.

Echelons Above Brigade Viewpoint and Actions

General officers command forces above brigade, such as divisions, corps, corps support commands, armies, and other major commands. These forces consist of thousands of vehicles and thousands of soldiers. Large staffs assist commanders of these organizations direct and control various military operations. These staff coordinate the activities of the units described earlier, primarily battalions and brigades. As with previous organizations farther from the front, echelons above brigade see the battle based on information provided by subordinate units, and this information is shown on a map. Echelons above brigade are heavily involved with staff work, which controls the movement of supplies, personnel, equipment, and so forth. The various staffs move units, direct large-scale activities and generally shape the operational and strategic aspects of the battle. Commanders above brigade actually see the battle infrequently and rely heavily on a map to show the battlefield. Maps and map overlays are extensively used to portray operations above the brigade level.

Fighting the Battle—Simulations

Army plans for the future indicate a significant priority will be given to greater reliance on advanced training devices, including simulator systems and simulated wargaming. The Army is developing a family of simulations designed to provide enhanced training capabilities.

Army computer simulations, like various units, view and fight the battle differently. One simulation system, simulation networking (SIMNET), which is used to replicate key functions of tanks or armored personnel carriers, sees the battle from the viewpoint of individuals in combat units. Other simulations, such as Army Training Battle Simulation System, Air Warfare Simulation, Brigade/Battalion Battle Simulation, Corps Battle Simulation, Ground Warfare Simulation, and JANUS, are not designed to replicate specific weapon systems but to provide a view of the battle on a map, viewed on a television monitor, showing units on the map as icons (unit symbols). These simulations require the unit commander and staff to plan and coordinate unit maneuvers and combat.

Direct View of the Battlefield

The Army computer simulation SIMNET directly views the battlefield and addresses small unit activities. SIMNET views the battle from the small unit perspective, focusing on individual, crew, and platoon actions. The system can also incorporate platoons and companies into a battalion exercise. SIMNET views the battle out of the vision port of a vehicle or aircraft, thus requiring crew members to react to what they see on the battlefield. The vehicle driver selects an appropriate route to the objective, while the commander and gunner coordinate their activities to engage enemy targets. Vehicle commanders coordinate crew activities and report their progress to the platoon leader while reacting to enemy activity. The platoon leader coordinates the actions of individual vehicles and reports the platoon's actions and enemy contact to superiors.

Indirect View of the Battlefield

Simulations other than SIMNET view the battle from above (looking down on a map) and focus on commander and staff coordination and control of combat operations. Most of these simulations show units on the map with unit symbols, while the JANUS simulation uses a map and silhouettes of miniature vehicles, equipment, and personnel. These simulations train units that are generally farther away from the battlefield, battalion level, and higher echelons, although JANUS is used by units closer to the battle—platoons and companies.

Other simulations show the battle on a map, use icons to represent units on the battlefield and focus on leaders' control and coordination of the

battlefield. These simulations use various symbols and types of maps to show the various units in the area of operations. The symbols, or icons, then represent the actual number of vehicles and personnel of the designated unit or whole units. These simulations seek to train leaders and staff in the command and control of combat operations. These simulations also focus on Army organizations at battalion level and above, up to the Army group level.

Comments From the Department of Defense

ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301-4000

FORCE MANAGEMENT
AND PERSONNEL

30 NOV 1990

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "ARMY TRAINING: Computer Simulation Can Improve Training Benefits of Large-Scale Military Exercises," dated November 7, 1990 (GAO Code 393379/OSD Case 8538).

The DoD has reviewed the report and concurs without further comment. Suggested technical changes have been provided separately. The Department appreciates the opportunity to review the report in draft form.

Sincerely,

Christopher John

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