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"ENGAGEMENT SIMULATION"

PRESENTATION BY

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For nearly three years the US Army has been experimenting with, refining, and implementing a series of training techniques which employ engagement simulation mechanisms, along with proven instructional models, to improve unit tactical training. Some see the advent of engagement simulation as merely another step along the Army's path toward increased realism in training. Others see engagement simulation as a near perfect simulation of combat, while still others believe engagement simulation is nothing new, and that in one form or another, "we have been doing this kind of thing for years." Probably none of the foregoing opinions on engagement simulation are entirely right, nor are any totally incorrect. More properly, the techniques at issue certainly simulate the violent interactions of weapons in combat, although imperfectly, and in so doing add much realism to our tactical training. And while we can point to excellent training with conventional techniques, some of the aspects of engagement simulation are truly new, or are at least substantial revisions of earlier ways of doing things.

The main thrust of engagement simulation has been directed toward small unit tactical training. Tactical training is a complex undertaking which we have normally handled by attempting to break it down into its lowest

common denominator or component tasks: firing a weapon, operating a radio, writing an order, or adjusting artillery fire. We train on these component tasks, and presume that in combat we can sum them into an effective whole. But until very recently we have had no means, short of combat, of actually testing our summations. Engagement simulation provides us one means of doing just that.

In an academic manner, engagement simulation can be defined as the employment of systems or devices to simulate with a high degree of fidelity the casualty producing effects of weapons found on the modern battlefield, during two-sided, free-play, tactical exercises. But what do we really mean by engagement simulation? In simple terms, we seek a believable way to say to the soldier in tactical training exercises, "You exposed yourself on this training battlefield in such a manner that an opposing soldier was able to draw a bead on you with his rifle, or put artillery fire on you, or with some other weapon, has caused you to become a casualty." For engagement simulation to be effective, the soldier must accept two things: first, he did indeed expose himself and get"hit", and second, this training occurrence has a one-for-one correspondence to combat. In his own mind the soldier must forge the link between a "casualty" in training and in combat. When we thus

confront him in a credible manner, he responds as he seldom did to other training. Our initial field evaluations of engagement simulation clearly establish that without further prompting, the average soldier will recognize his error, and take action to preclude a recurrence of the mistake that led to his being "hit." And while he will surely make other mistakes in other exercises, he rapidly learns through additional repetitions the fundamental lessons of combat, and modifies his behavior in a manner that influences and increases his chances of survival. When we have soldiers with the skills to survive in combat who use concealment, exploit all available cover, and employ suppressive fire to facilitate movement, we can turn our attention to training small tactical units in teamwork.

The objective of small unit tactical training is to provide combat units with the skills required to fight and survive on the modern battlefield. It differs from other types of training in that it must realistically simulate the combat environment. This environment involves the aforementioned violent interaction of two opposing forces who are out to destroy one another. To prepare our combat units to operate effectively in this environment, it is necessary to train them to operate against a realistic opposing force. It is not sufficient to merely train our units to fire at the enemy; we must train

them to fire and move against an enemy which is firing back, and doing everything in its power to neutralize or avoid our fire.

Perhaps the contribution that engagement simulation makes to tactical training is most easily understood by comparing it with traditional forms of combat training. Up until recently all of our tactical field exercises took one of two forms--live ammunition against cardboard targets, or blank ammunition fired toward a live opponent.

The effectiveness of live fire exercises against cardboard targets is somewhat deceptive. They often sound, smell, and look so much like combat that commanders are lulled into assuming they realistically simulate combat. Careful analysis, however, shows that they bear only a superficial resemblance to battle. Cardboard targets can not shoot back and hence scarcely represent the skilled and determined enemy we will face in combat; they don't try to hide themselves from us, and they don't try to suppress our fire. As a result, soldiers well trained with live fire exercises often encounter a tremendous shock when they first encounter real opposition, not because of the noise of combat, but because they are opposed by a determined enemy which they almost never see, which is trying to kill them, and which seems almost impervious to their fire.

Blank fire exercises enable us to deal more effectively with the enemy because they permit two opposing forces to maneuver against one another, signaling an engagement by shooting blanks. However, while the blank rounds realistically simulate the act of firing, they provide no indication whatsoever of the effectiveness of the fire. This determination is left entirely to the subjective judgement of the NCO or officer who is controlling the exercise. Since he will normally be required to deal with many soldiers, and a relatively large number of diverse weapons in a fast moving, complex situation, and since he can often see only a portion of the entire action at any one time, his judgements are frequently quite general in nature--"this side won because it was four times larger" or "that side won because it had better cover and concealment." While information of this type is of some value in training combat units, it falls far short of that required to develop truly skilled and battlewise soldiers.

Engagement Simulation training systems overcome the shortcomings of both live and blank fire training methods. Engagement simulation consists of three steps, each of which encompasses a singularly important, and essential, training function.

Step 1 involves realistically exposing the soldier

to the lethality of weapons. We equip each soldier's weapon, each armored vehicle, and each weapon crew with devices which realistically simulate its casualty producing capability. Once so equipped, two opposing forces conduct a free-play tactical exercise under no more, or no less, constraints than exist on an actual battlefield. The employment of the simulation devices enables the battle to unfold exactly as it would in combat. When a soldier fires and hits another soldier, the soldier who is hit receives an immediate indication he has made a mistake, and is "out of action." Likewise, if the soldier who is firing does not take adequate precautions, he can be hit by return fire. In this manner, each soldier taking part in the engagement simulation exercise receives immediate feedback concerning his actions. If he uses proper techniques and tactics in each situation he encounters, he continues to contribute to his team; if he does not, he is eliminated. Immediate feedback is an essential element of all effective training systems; but until the development of engagement simulation training systems, we had no reliable way of obtaining it during tactical training.

Step 2 involves confronting each soldier with a critique of his actions, and begins at the completion of the two-sided, free-play tactical exercise. We bring both forces together and conduct a detailed afteraction review. During this review, each soldier who has hit

an opponent explains in detail how he was able to detect and engage him. This is followed by a mutual discussion of what the soldier who was hit could have done to prevent this happening. In this manner the techniques and tactics which enable soldiers to succeed are identified and discussed. Unlike traditional critiques which normally only involve the officer or NCO in charge lecturing the soldiers on mistakes he observed, these afteraction reviews get all the soldiers directly involved in the learning process. The officer or NCO in charge merely guides the discussion and summarizes key points. During field evaluations of engagement simulation training, it quickly becomes apparent that the most important training occurs during step 2, because it is during this step that the soldiers "learn" from their successes and mistakes.

Step 3 consists of successive repetitions of two-sided, free-play tactical exercises and afteraction reviews. During this step the soldiers have an opportunity to employ and reinforce their new skills, try out new tactics or techniques, and in turn gain additional skills. Successive repetitions of tactical exercises are an essential element of engagement simulation training, exposing soldiers to the complex interactions of ground, weapons and tactics. The techniques required to fight and survive on the battle-field cannot be mastered in only one or two exercises.

Repetition teaches coping with lethality, and adds another important feature--competition. Since the soldiers being trained quickly perceive that it is entirely within their power to team up to eliminate "enemy" soldiers, and accomplish their team mission in the process, they begin to view the training exercises as a contest. Each time they take part in an engagement simulation exercise they become more determined to defeat the opposing force. When they lose, they pay particular attention during afteraction reviews, and seek help from their leaders during breaks in order to develop the skills which will enable them to win the next time.

At the current time, two engagement simulation systems have been developed and their implementation throughout the Army is nearing completion.

The first system is called SCOPES, an acronym for Squad Combat Operations Exercise, Simulated. In this simulation, a six power telescope is attached to each soldier's rifle and three inch two-digit numbers are affixed to his helmet. The size of the number and the power of the telescope were chosen to simulate the weapon effect, in that the probability of reading another soldier's helmet number through the telescope at any given range, is close to the probability of hitting the soldier with live ammunition at the same range. When a soldier can read another soldier's number

through his telescope, he fires a blank and calls out the number. The controller with his fire team then radios it to the controller with the opposing fire team. That controller informs the soldier wearing the called number that he is a casualty and requires the soldier to remove his helmet and remain in place until the termination of the exercise. SCOPES was implemented Army-wide by the US Army Infantry School in 1974.

In early 1974 the US Army Research Institute (ARI) expanded SCOPES to permit the employment of artillery support, mines, tanks, and antitank weapons during two-sided, platoon level exercises. This system, known as REALTRAIN, has just been implemented in US Army Europe. Implementation in the remainder of the Army will commence later this year.

The next generation of engagement simulation devices is currently undergoing development. It involves a higher fidelity simulation of weapons than telescopes and numbers, but being more complex, it will be some years before it is fielded. Known as the Multiple Integrated Laser Engagement System (MILES), this approach uses low-power, eye-safe lasers to simulate the firing and effects of the direct fire weapons found on the modern battlefield. MILES consists of a series or family of laser devices, which are being developed for the M16 rifle, the full

family of machineguns, the VIPER, DRAGON, and TOW anti-tank weapons, the main battle tanks (M60A1, A2, A3), and the M551 Sheridan. Follow on efforts will expand the MILES System into air defense weapons, helicopter air-ground engagement systems, USAF aircraft and munitions, and eventually enemy weapons systems. The prototype packages consist of laser transmitters which simulate the direct fire characteristics of the weapons involved, a laser detector array which detects and decodes incoming laser signals, and hit indicating mechanisms which combine audio and visual signals to convey near misses, hits which are not kills, and kills. Each device is to be lightweight, and of such size and shape that its addition to the base weapon will not affect the normal handling, accuracy, or performance of that weapon. MILES includes a provision for a hierarchy of weapons effects. An infantryman, for example, can "kill" another infantryman with his M16 laser device, but cannot disable a tank. Conversely, a tank can "kill" not only another tank but also TOW crews and infantrymen. The key to this discrimination is distinct pulse codes for each weapon, and discrimination logic in each detector.

We anticipate that when MILES is fully fielded, it will add a previously unknown element to the credibility, immediacy, and effectiveness of casualty assessment on

the training battlefield. Given the development of the proper software to support the system (work which is already underway by the Army Research Institute) MILES has the potential to revolutionize military training.

The foregoing has described the state-of-the-art of engagement simulation and summarized the theoretical foundations of why and how it should work; that is, modify soldier behavior in the desired direction, and foster soldier learning. But we have still left unanswered the question, "Does it work in the real world?" Our evaluations over the past two years, principally involving SCOPES and REALTRAIN, tell us that it does.

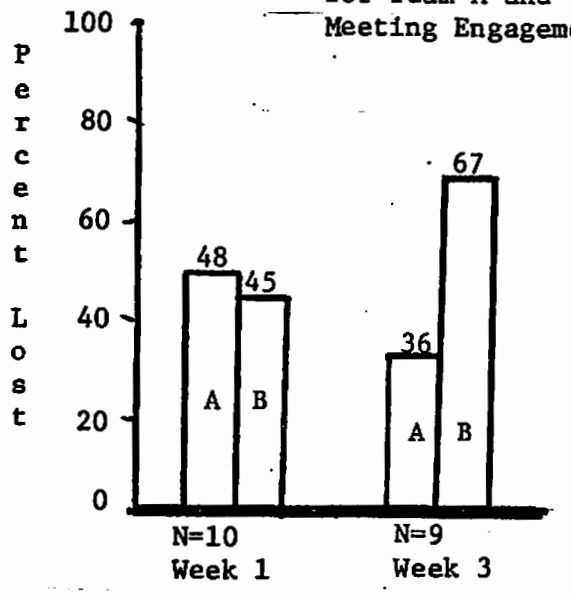
The US Army Training and Doctrine Command (TRADOC) has just concluded a six-month joint effort with US Army Europe and ARI to implement REALTRAIN in the divisions in Europe. While this effort was principally directed toward training controllers, a great deal of tactical training and data collection took place as well. And while not all of the data have been analyzed or even examined at length, a preliminary report has been prepared by ARI which summarizes some of the findings.

The implementation effort took place at four different sites, with three (and at one site--four) weeks of training at each site. Two groups were involved, "A" teams, which came and stayed throughout the entire period, the hypothesis being that their performance would improve as the training weeks passed, and "B" teams, who were changed every week, and were thus expected to be more inexpert and serve a control/ baseline function. The relative force ratio of 1:1 was maintained throughout the exercises, each side consisting of a tank platoon, two TOWs, and two Infantry Squads mounted in Armored-Personnel Carriers (APC). The missions assigned were limited to meeting engagements or attack/defense (delay).

The primary objective data in a REALTRAIN exercise are the casualties incurred by both sides in two-sided, free-play exercises. With increases in tactical proficiency it would be expected that there would be changes in the number of casualties which occurred. These changes could come about in two ways. With increasing tactical proficiency, a combat unit should reduce the number of casualties it incurs (by proper use of cover, concealment, suppression, and proper movement techniques), while at the same time increasing the number of casualties it inflicts on the opposing force (by more effective employment of all available weapons).

Meeting Engagements: Figures 1 & 2 show the percent of casualties incurred by Team A (experienced) and Team B (inexperienced) for weeks one and three of training for tanks and infantry. Figure 1 for tank casualties, shows that both teams sustained approximately the same proportion of casualties during the first training week (Team A: 48%, Team B: 45%), as would be expected when both teams have had the same (limited) amount of tactical training.

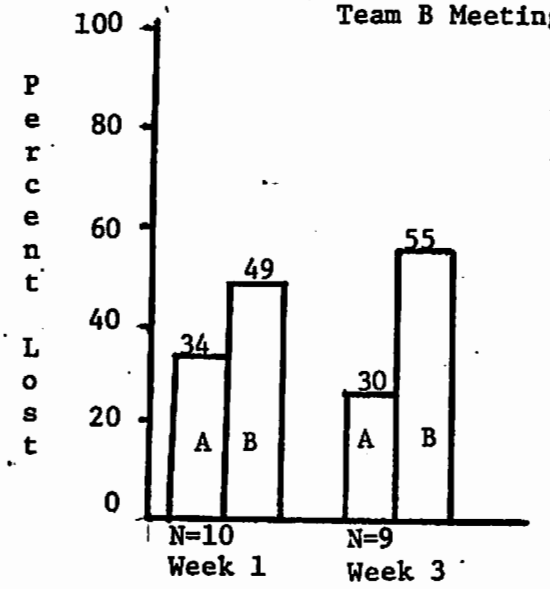
Figure 1: Comparison of Tank Casualties for Team A and Team B Meeting Engagements (N)



There is a large difference between the two teams for the third week; Team A sustained 35.7% casualties, while Team B sustained 66.7% casualties, thus indicating that REALTRAIN does increase tactical unit proficiency over time.

From Figure 2 it may be seen that during the first week of training Team B lost more infantrymen than Team A (49% vs 34%).

Figure 2: Comparison of Infantry Casualties for Team A and Team B Meeting Engagements (N)



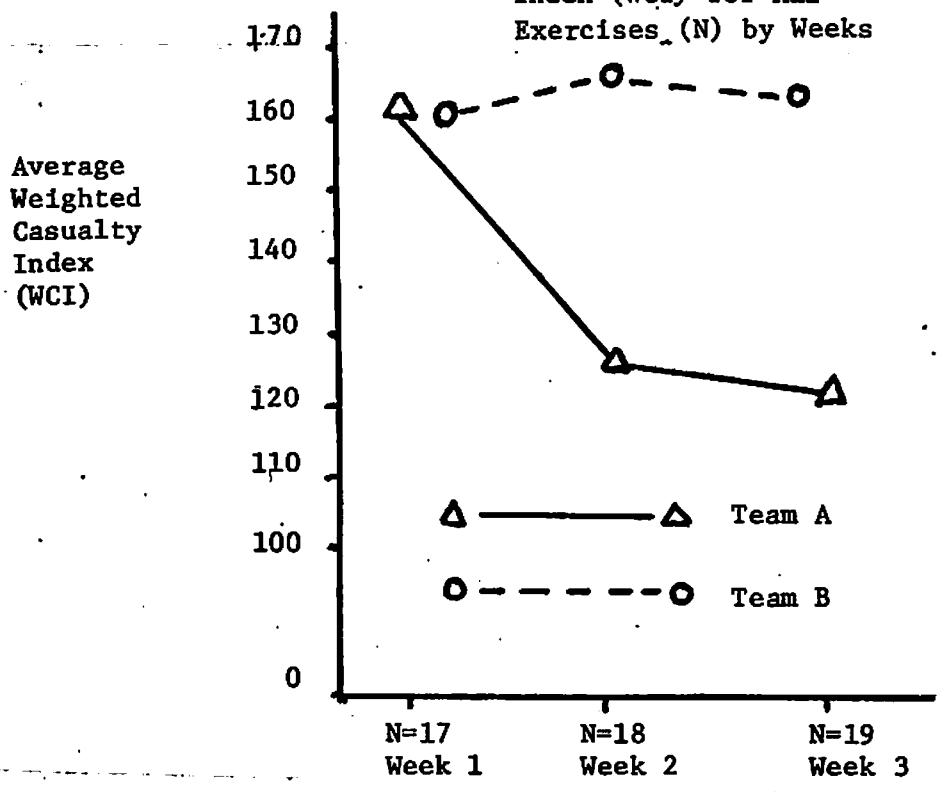
In the third week the A Team reduced its casualties slightly (34% to 30%), while the B Team casualties increased (49% to 55%). The results in terms of infantry casualties are not as clear-cut as they were for tank casualties, although there was a demonstrable performance difference during the third week of training between the two teams. By the third week, the A Teams were beginning "to get it all together"--reducing the casualties incurred on themselves and increasing the casualties inflicted on the B Teams.

The use of a Weighted Casualty Index (WCI) allows diverse categories of data to be integrated into a single measure. In addition, differences in the utility of various weapons systems can be taken into account. The weightings employed are based on expert military judgement and are in general agreement with weightings found in other firepower indices. For this WCI a lower value was better, that is, a force sustained fewer casualties itself. The Weighted Casualty Index used was:

WCI = 35 (# tanks immobilized or killed) + 25 (# TOWs killed) + 15 (# APCs killed) + 1 (infantry casualties)

Figure 3 presents training effectiveness across all exercises as measured by the Weighted Casualty Index.

Figure 3: Average Weighted Casualty Index (WCI) for All Exercises (N) by Weeks



During Week 1, no difference was observed between the A teams and the B teams, since the two teams had equivalent training exposure, and no difference would be expected.

However, data from the second and third weeks, comparing increasingly experienced A teams with inexperienced B teams, show that performance differences were observed. During the second week, A teams incurred smaller losses than the B teams, and in Week 3, Team A similarly incurred smaller losses than the B teams.

It is interesting to note that a comparison of the WCI for the A team alone for Weeks 1 and 3 shows a significant improvement in overall casualty reduction.

Indirect Fire: Indirect fire data were collected during the play of the exercises for each team. The critical data extracted from the artillery control sheets for this analysis were the number of simulated rounds fired by each team which were then converted into the number of rounds that would actually have been fired.

In reducing the raw data, casualty counts were based on casualties inflicted rather than casualties received. A casualty was defined as a vehicle, vehicle crewman, or infantryman killed or a vehicle

immobilized. For purposes of the indirect fire analysis, all casualties were equally weighted. For example, an immobilized tank was equivalent to a destroyed APC or an individual soldier killed. Since there was no way to directly link a casualty to a specific fire mission, it was not possible to analyze indirect fire usage as a function of type of casualty inflicted. Equal weighting of casualties seemed the most reasonable alternative.

Three summary statistics are reported: TOTAL CASUALTIES, TOTAL ROUNDS, and a CASUALTIES/ROUND measure of efficiency. TOTAL CASUALTIES (which are casualties inflicted, not incurred) and TOTAL ROUNDS, are found by summing the appropriate figures from all exercises included in the scope of the table. CASUALTIES/ROUND is calculated by dividing the TOTAL CASUALTIES by TOTAL ROUNDS, is a general index of the efficiency of the indirect fire use. Figure 4 summarizes the use of artillery for both A teams and B teams for all the training conducted at all sites during all 54 exercises.

Figure 4: Indirect Fire Analysis

All Sites/All Exercises (N)

	Teams	Total Casualties Inflicted	Total Rounds	Casualties/ Rounds
All Weeks (N.= 54)	A	356	3999	.089
	B	295	5491	.054

Overall, Team B fired considerably more rounds than Team A, while inflicting fewer casualties. Again, Team A was consistently more effective than Team B.

In order to determine if there were a relationship between which side initially detected and/or engaged the other and amount of training, this analysis looked at which team was able to detect and engage the other first, how quickly, and at what range. Figure 5 contains the number of times that each team made the initial detection and engagement for meeting engagements. The data are then summed over all weeks and sites.

Figure 5: Team Making Initial Detection and Initial Engagement for all Weeks (Meeting Engagements)

	Week 1		Week 2		Week 3		Weeks 1,2,3	
	Team A	Team B	Team A	Team B	Team A	Team B	Team A	Team B
All Sites								
Initial Detector	5	5	7	3	5	3	17	11
Initial Engager	6	4	9	1	6	3	21	8

Initial detection and engagement events were split equally between the teams in the first week. However, in the second week, and continuing on into the third, Team A clearly enjoyed the advantage in detecting and engaging their opponents.

In addition to noting who detected first, the times and distances for these detections were also collected and summarized. Figure 6 shows detection time and range for all weeks and all exercises.

Figure 6: Initial Detection (In minutes after start and range) by Team for All Weeks/All Sites

	TM A Initial Detection		TM B Initial Detection	
	Minutes After Start	Range	Minutes After Start	Range
All Weeks (1-3)	14.4	844.1	15.9	615.5

Overall, Team A detected the enemy in shorter times than did Team B. Time equating to distance, as it does in this case, this earlier detection time means detection at greater average distances as Figure 6 illustrates. This greater distance of course translates into more space for small unit commanders to deal with the enemy, and bring into play sooner the increased lethality of all the weapons found on the modern battlefield.

Finally, the data for weapons inflicting the first casualties is displayed in Figure 7.

Figure 7: Weapon Inflicting First Casualty (All Missions)

	All Missions	Percent of Total
Tank	9	15.3%
TOW	10	16.9%
Infantry	10	16.9%
Unobserved Fire	17	28.8%
Unobserved Fire	13	22.0%

In summation, it appears as if increased training resulted in an increased ability to detect and engage the enemy first, at least in meeting engagements. The time required to detect the enemy was shorter for the trained (Team A) than it was for the untrained (Team B). The data for weapons inflicting the initial casualties tend to indicate that artillery, particularly preplanned fires, account for the majority of early casualties.

Tank Losses: The results presented up to this point have been related to training effectiveness. The data collected also shows evidence of realistic and credible simulation of weapons effects during the REALTRAIN exercises, thus

it is possible to look at the data in terms of weapons effectiveness.

The following figures (8 & 9) depict the percent of casualties inflicted by each weapon type.

Figure 8: Tank Losses as Function of Weapon Type

$$\frac{\text{Tanks Killed}}{\text{Tanks Played}} = \frac{219}{539} = 41\%$$

Percent of Kills By:	All Sites
Tanks	51%
TOWs	25%
DRAGON	4%**
90mm & LAW	19%
Grenade	2%

** Dragon not played at all sites.

Figure 8, tank losses, indicates that across all sites approximately 50% of the tanks killed were killed by other tanks, 25% by TOWS and 25% by a combination of weapons in the hands of the individual foot soldier--the LAW (Light Anti-tank Weapon), 90mm recoilless rifle (RR), grenades, and the Dragon.

Figure 9 shows data from two of the training sites which was amalgamated in Figure 8.

Figure 9: Tank Losses as Function of Weapon Type

	Baumholder Large Open Area	Friedberg Small Wooded Area (Heavy Fog)
Tanks Killed / Tanks Played	$\frac{69}{132} = 52\%$	$\frac{46}{139} = 35\%$
Percent of Kills By:		
Tanks	55%	39%
TOW	32%	15%
LAW	4%	9%
90mm RR	9%	30%
Grenade	0%	7%

One of the things Figure 9 illustrates is that REALTRAIN provides a simulation of weapons effects and capabilities with face validity. In the large open area with longer fields of fire, the long range antitank weapons (tank guns and TOWs) did nearly 90% of the tank killing. On the other hand, when visibility and fields of fire became restricted in the smaller area, nearly half of the tank kills were with short range infantry weapons, LAW, 90mm RR, and the grenade.

No discussion of engagement simulation can be considered complete without some discussion of the acid test of any training system--troop acceptance.

For a system to be successful the soldier must believe that he can use it, with confidence, and that its use will benefit him. During post-exercise interviews during the USAREUR REALTRAIN implementation, soldiers, leaders, and controllers were polled on their perceptions about engagement simulation training.

A Leader-Controller Questionnaire was administered to 343 controllers and 38 leaders ranging in grades from E-4 to O-3. Most respondents were in grades E-6, E-7, O-1 and O-2, representing primarily squad and platoon level NCOs and officers.

The questionnaire sought to obtain data about recent unit training experiences (other than REALTRAIN) as well as reactions to REALTRAIN and, for controllers, their reaction to their experience as controllers. Responses were typically quite favorable to REALTRAIN. As Figure 10 shows, REALTRAIN was reported as more effective than live fire exercises and traditional field exercises.

Figure 10 Comparison of REALTRAIN to Other Methods of Collective Training

REALTRAIN Compared to: is:	Live Fire	Field Exercise
More Effective	77%	97%
About the Same	21%	2%
Less Effective	2%	1%

Controllers were also asked about their experiences as controllers. Responses in Figure 11 demonstrate that 86% of controllers feel that the tactical training value of REALTRAIN exercises while serving as controllers was equal to or greater than the value for a participant.

Figure 11: Tactical Training Value of REALTRAIN Exercises for Controllers

Training value of REALTRAIN exercises for a controller as compared to participants:

Equal to or greater than:	86%
Less than:	14%

Figure 12 indicates that 90% of the controllers and leaders considered REALTRAIN "very effective" for training in use of terrain for cover and concealment, 73% felt it was "very effective" in training on employment of all available weapons, while 62% felt it was "very effective" in training on employment of indirect fire.

Figure 12: Effectiveness of REALTRAIN for Tactical Training

How effective do you consider REALTRAIN to be for training units to:

	Very Effective	Effective	Not Effective
a. Use terrain for cover and concealment	90%	9%	1%
b. Employ indirect fire	62%	35%	3%
c. Properly employ all available weapons	73%	25%	2%

Finally, we turn to the soldiers themselves, those who participated in the tactical exercises. Their acceptance was overwhelming.

A questionnaire was completed by 542 soldier participants: 302 with an infantry MOS (56%) and 240 with an armor MOS (44%). The response to the questionnaire shows no systematic or significant differences in responses among sites, teams, armor versus infantry, or rank of respondent. Therefore, the results presented below discuss the results of all participants without any further breakdowns.

The responses to a question on the perceived state of training before and after participation in REALTRAIN are summarized in Figure 13: The results speak for themselves!

Figure 13: Troop Perceptions of State of Unit Training

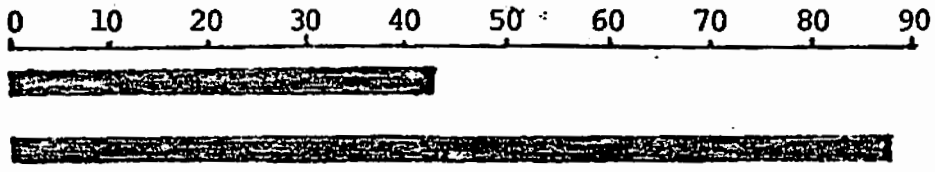


Figure 13 shows graphically that prior to REALTRAIN only 43% felt that they were adequately trained, but that after exposure to REALTRAIN training, 86% felt that were adequately trained.

Probably underlying the perceived improvement in state of unit training is the fact that most participants felt that REALTRAIN provided more effective training than their normal unit training.

* When the soldiers talked about REALTRAIN, their universal acceptance was really evident. Said one sergeant:

> "You can see it. In REALTRAIN you see your mistakes and talk about them. Why did I get killed? Why did that TOW see me? How did this infantryman get on top of my track and throw a grenade inside? You can see it and you know your mistakes, and very rarely do you make the same one twice." Staff Sgt, Co B, 3d Bn, 32 Armor (A Team).

* An infantry squad leader commented on the realism and utility of the REALTRAIN engagement simulation system:

> "I am a combat vet. Most of the guys out here didn't have any idea about it, not in my squad. But right now they know what's involved and they are keeping their heads down, their tails down, they're moving fast and they're moving right. They are working as teams."

* Concerning combined arms tactics this same squad leader said:

> "Killing tanks! You want to get the tanks. We found out, the tankers have found out, that we infantry can get those tanks. Once we can get those tanks in the woods we can tear them up; they can get us in open terrain, that's their meat. Staff Sgt, Co C, 1st Bn, 36th Inf (Team A).

* Perhaps though, the most telling and eloquent comment of all is this one from a armor company platoon sergeant, after 3½ weeks of training.

> "I say it's the best training I've seen since I have been in the army--it just can't be compared with anything else. My men want to stay another month. Since we began training, I've had a total of three sick calls and those were because of the flu epidemic. My appointments are just emergency type things. Accountability and morale is 100 percent. <u>It has been beautiful.</u>"