

Training Ranges in the 21st Century

Executive Summary –



This paper portends operational issues presented by Army Transformation on future training ranges, and, considerations for requirement concepts of future training ranges. Plans for Army Transformation are proceeding along three vectors: the Objective Force, the Legacy Force, and the Interim Force –

The Objective Force represents the future full-spectrum force – organized, manned, equipped and trained to increase strategic responsiveness across the entire spectrum of military operations from Major Theater Wars to Homeland Security.

The Interim Force is a transition force that fills the near-term capabilities gap between The Army heavy and light forces. It combines characteristics of current Army forces – heavy, light, and Special Operations Forces – and leverages state-of-the-art technologies to bridge the capabilities gap between the Legacy Force and the arrival of the Objective Force.

The Legacy Force guarantees near-term warfighting readiness. This force continues to provide the strategic insurance policy for The Army's responsibility to fight and win decisively against any threat while The Army transforms. The Legacy Force allows The Army to meet today's challenges and provides the time and flexibility to get Transformation right.

The 21st Century finds Army units engaged in conflicts that are asymmetric and nonlinear in nature, but with many similarities to conventional warfare of the 20th Century. As the Army transforms, enhanced warfighting capabilities will significantly strain current training range capabilities. Field-based training exercises have always provided superior training in terms of engendering confidence in self and buddies, instilling leaders and soldiers with confidence in weapons and equipment, and engendering safe operations. Employment of smart weapons, non-line-of-sight weapons, new target acquisition systems, and digital command, control, and communications systems characterizes future combat evolution and will shape future training range concepts. Additional 21st Century range challenges include providing training venues for a wide range of possible operational scenarios in a complex political-military environment, integrating civilian population considerations, portraying the nature of an ambiguous and chameleon-like enemy, and, replicating the essential characteristics of the battlespace. Other major forces for change in training ranges are the non-linear and asymmetric nature of future combat. These aggregate factors must be satisfied in future training ranges.

At present there is no universal strategy for transforming Army training range capabilities. We suggest requirements that will drive such a strategy, however, the most controversial aspect of this strategy will be that virtually all unit types are able to participate in exercises stressing local and homeland defense. The need for such exercises comes from the increased probability that units not historically involved in direct-fire engagements with the enemy will be involved in such engagements on the

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Abstract This paper addresses and outlines issues that will drive requirements for future training ranges. In response, to Army Transformation, Army training range capabilities need to transform to synchronize with and conform to the Legacy, Interim, and Objective Force's training needs. A sustainable training range transformation strategy will consist of a long-term, integrated, systems approach to developing and achieving a robust training venue by simultaneously addressing operational, environmental, and economic issues. This paper presents a discussion of operational issues in hopes that an Army training range transformation strategy will emerge that ensures and enables superior combat training opportunities for the Army's leaders, soldiers, and units.		
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asymmetric battlefield. As a result, all units must be proficient in defending themselves and their activities because the conventional “safe” rear area could be the future primary battleground. Attempting to create training opportunities that reflect the situations faced on the asymmetric battlefield and in urban areas greatly exacerbates training range design problems, but failing to employ a relevant training venue trivializes training opportunities. The trend for amplified combined arms and Joint operations maneuver and live-fire training will continue, but increased opportunities for maneuver support and maneuver sustainment units also need to be augmented.

We address and outline issues, listed below, that will drive requirements for future training ranges. In response, to Army Transformation, Army training range capabilities need to transform to synchronize with and conform to the Legacy, Interim, and Objective Force’s training needs to initiate combat, to retain the initiative, build momentum quickly, and win decisively. A sustainable training range transformation strategy will consist of a long-term, integrated, systems approach to developing and achieving a robust training venue by simultaneously addressing operational, environmental, and economic issues. This paper presents a discussion of operational issues in hopes that an Army training range transformation strategy will emerge that ensures and enables superior combat training opportunities for the Army’s leaders, soldiers, and units.

OPERATIONAL ISSUES

What type of exercise will the Objective Force require and what training range capabilities will be required for each type?

What size battlespace will future training ranges support?

How can we repurpose existing training land for the Objective Force?

What training technologies and enablers are required to transform Army ranges to support Battle-Focused Training for the Objective Force?

What is the objective training range live and simulation-based integration strategy?

Introduction --



Why will training land requirements and usage change due to Army Transformation? Since 1775, Army forces have deterred, compelled, reassured and supported the Nation in war, conflict, and peace guided by law, national policy, strategy, and service visions. Army forces have fought 10 wars, from the American Revolution through the Cold War, the Gulf War, to the current War on Terrorism. The Army has participated in expeditions and contingency operations in U.S. territories and projected land power around the world. Modern strategic warfare traces its roots to Carl von Clausewitz's magnum opus, *On War*, written in 1832, unquestionably the most important single work ever written on the theory of warfare and of strategy. His less famous work, *Principles of War*, written in 1812, postulated the tactics and theory of combat, including principles for offense, defense, use of troops, and use of terrain, which was the basis for the Army's concept of operations and tactics that evolved from the Civil War through Korea, Viet Nam, and even Desert Storm. Throughout

the 20th Century, the Army built a training infrastructure for warfighting tactical principles established during the early 19th Century.

In making training as real as possible, in the spirit of "Train As We Fight," our predecessors in the training community made sure that most, if not all, of the U.S. Army's 20th Century training ranges were conceived, designed, constructed, and sustained to support their notion of how we fight. We call that notion the "linear battlefield," which was derived directly from Clausewitz's *Principles of War*. From the smallest range used to train small arms qualification, to the largest brigade-level maneuver lands operated at the three "dirt" Combat Training Centers, the use and layout of these training ranges reflect the footprint of the linear battlefield, where what's in front of you is the enemy, and, what's behind you and on both sides of you is friendly support forces. Thus, trainers in the 21st Century inherit maneuver areas, training ranges, duded impact areas, and non-duded areas; all laid out in a linear array of firing lines, targets, and safety fans. Army-wide, this development is a massive real estate investment, and the sunk cost is incalculable. Even though he's been dead for over a century-and-a-half, Clausewitz's legacy and monument is today embedded in the very earth on which we train Forces.

But, the circumstances and conditions for sustaining the Army's training ranges have drastically changed. It took bulldozers, concrete, and steel, and, more than a century of labor and investment to shape and build this resource. When populations were sparse, land available for military installations and training ranges was plentiful, with few use restrictions. Early on, installations were established in rural areas, but, during the last century, the population exploded, and some training areas found themselves in the midst of large urban areas. Encroachment concerns emerged, in the form of external influences that threaten or constrain training activities, such as, urban sprawl, endangered species, and environmental regulations of munitions. Urban sprawl often triggered conflicts with neighbors over noise and dust. As the Army developed more missiles, artillery, and airpower weapons, its demand on airspace associated with collective and Joint training ranges for ground combat became more intensive. We cannot overlook that use of the RF spectrum in training exercises had also become more restrictive, as the battlefield and commercial spectrum demands both increased dramatically, especially during the 1990s. Regrettably, as each generation of trainers tried to satisfy their contemporary needs they were not overly concerned for the ability of future generations to meet their own needs. As the 20th Century ended, officials sought assistance from Congress to draw clearer lines between readiness and protecting the land, environmental, legal, and other regulatory constraints

continued to increase, and live and weapons training on some military installations, ground to a halt.

Background ---

At the beginning of the 20th Century, the Elihu Root reforms established a new Army headquarters structure and a much expanded professional education system. The reforms transformed The Army from a constabulary force to a force projection Army. World War I saw the introduction of mechanized and air forces and World War II demonstrated the power of industrial age warfare and joint/combined operations. Korea introduced the helicopter, and Vietnam expanded its use operationally and logistically. The Cold War, Desert Storm, and the post Cold War period, to one extent or another, brought about changes in tactics, techniques, doctrine and equipment.



In 1999, The Army announced its resolve to transform itself into an Objective Force, a force which will be strategically responsive and dominant at every point on the spectrum of operations. Two documents articulated and defined this resolve. "The Army Vision (October 1999)" provides the intellectual underpinnings and direction to internal and external stakeholders. The "Transformation Campaign Plan (April 2001)" established the goals, objectives, and timelines to focus both the organizational energy and resources toward the Objective Force.

The Army Vision consists of three interdependent elements: people, readiness and transformation. People will remain the centerpiece of all the Army does — Soldiers, civilians, retirees and veterans. Nonnegotiable readiness, the foundation of the Army's contract with the American people to fight and win the Nation's war, hinges on the well-being of people. Transformation, a process,

defines how the Army changes the way it thinks and fights in order to develop the capabilities required in the 21st century.

The Army will be able to initiate combat on its terms, to retain the initiative, build momentum quickly and win decisively. Army Transformation will proceed along three vectors — the Objective Force, the Legacy Force, and the Interim Force. The vision will also transform the Institutional Army and its business practices.

The Objective Force will represent the future full spectrum force — organized, manned, equipped and trained to increase strategic responsiveness across the entire spectrum of military operations from Major Theater Wars to Homeland Security.

The Interim Force will be a transition force that fills the near-term capabilities gap between The Army heavy and light forces. It will also combine characteristics of the current Army forces — heavy, light, and Special Operations Forces — and leverage today's state-of-the-art technologies to bridge the capabilities gap between the Legacy Force and the arrival of the Objective Force.

The Legacy Force will guarantee near-term warfighting readiness. This force will continue to provide the strategic insurance policy for The Army's responsibility to fight and win decisively against any threat while The Army transforms. Through selective modernization and recapitalization, the Legacy Force allows The Army to meet today's challenges and provides the time and flexibility to get Transformation right.

To support transformation and the achievement of the Objective Force in this decade, the Army also intends to transform the command and staff structures that support the operational forces, as well as the business and management practices that underlie The Army's Title 10 responsibilities. Thus, the Army will also build enterprise systems that exploit advances in better business

practices in general, and in information technologies in particular, to enable seamless global operations and transformation to the Objective Force.

Discussion



The Future War > The Future Range

What type of exercise will the Objective Force require and what training range capabilities will be required for each type?

Unit Training

Training ranges have unique qualities that will require configuration changes and technological enhancements to provide the Objective Force with support for training soldiers to apply the fundamentals of combat skills. The marksmanship skills mastered during training, practice, and record fire exercises must be applied to many combat situations (attack, assault, ambush, MOUT). Soldiers, units, and leaders use Training ranges to support training on:

- **Suppressive Fires** - In many tactical situations, fires will be directed to suppress enemy personnel or weapons positions. Some situations may require suppressive fire placed into a wide area such as a wood line, hedgerow, or small building. While at other times, the target may be a bunker or window. Suppressive fire is used to control the enemy and the area he occupies. Suppressive fire is used to kill the enemy or prevent him from observing the battlefield or effectively using his weapons.
- **MOPP (mission oriented protective posture) Firing** - All soldiers must effectively fire their weapons to accomplish combat missions in an NBC environment. With proper training

and practice, soldiers can gain confidence in their ability to effectively hit targets in full MOPP equipment.

- Moving Target Engagement - There are two primary techniques of engaging moving targets, tracking and trapping. Tracking involves the establishment and maintaining of the aiming point in relationship to the target and maintaining the sight picture (moving with the target). Trapping is the setting up of an aiming point forward of the target and along the target path; the trigger is squeezed as the target comes into the sights.
- Night Firing - All units must be able to fight during limited visibility. All soldiers should know the procedures for weapons employment during such time. Soldiers must experience the various conditions of night combat - from total darkness, to the many types of artificial illumination, to the use of surveillance aids.

Commanders select a particular training exercise or combination of exercises based on specific training objectives and on available resources. Any combination of weapons simulators, subcaliber devices, and organic weapons may be used to create the desired training effect. Specific exercise types are discussed below:

- Fire Coordination Exercises
- Situational Training Exercises
- Command Field Exercises
- Field Training Exercises
- Weapons Simulator Exercises
- Subcaliber Live-Fire Exercises
- Full-Scale Live Fire Exercises.

Fire Coordination Exercises (FCX) - The FCX is used to train the combined arms team chain of command and related fire control elements to rapidly synchronize fires on the battlefield. The exercise can use reduced-scale targets and ranges to depict combat situations. The chain of command exercises maneuver and fire coordination techniques and procedures. Each subunit is represented by a single weapon system which can be equipped with a subcaliber device and commanded by a platoon or section leader.

Situational Training Exercises (STX) - STXs are mission related, limited exercises designed to train one collective task, or a group of related tasks and drills, through practice. STXs teach the standard, preferred method for carrying out the task. They are more flexible than drills and usually include drills, leader tasks, and soldier tasks. The company commander trains STXs and other similar exercises while platoons execute combat and crew drills. The battalion commander does the same for company exercises. The final objective of the STX is to prepare units for larger scale exercises.

Command Field Exercises (CFX) - The CFX lies on a scale between the command post exercise (CPX) and the field training exercise (FTX). Available resources determine where the CFX fits on the scale. The CFX can also be a backup for the FTX if maneuver damage, weather, or other factors prohibit the planned FTX. The CFX is an FTX with reduced unit and vehicle density, but with full command and control (C2), combat service (CS), and combat service support (CSS).

Field Training Exercises (FTX) - FTXs are conducted under simulated combat conditions in the field. FTXs fully integrate the total force in a realistic combat environment. They involve combat arms, CS, and CSS units. FTXs encompass such training as battle drills, crew drills, and STXs to reinforce soldier and collective training integration. They are used to train the commander, staff, subordinate units, and slice elements:

- To move and maneuver units realistically
- To employ organic weapons systems effectively

- To build teamwork and cohesion
- To plan and coordinate supporting fires
- To plan and coordinate logistical activities to support tactical operation

Weapons Simulator Exercises - Weapons simulator exercises employ training devices that do not require live-fire range facilities. The most frequently used training devices use MILES (for force-on-force exercises) or TWGSS/PGS (for precision gunnery exercises). These training devices provide a relatively high degree of realism in training while allowing units a high degree of maneuver freedom not available in live-fire exercises (LFXs). Weapons simulator exercises allow training across the full combat spectrum or offensive and defensive missions. The absence of munitions in these simulator exercises enables units to overcome unrealistic, artificial range safety requirements associated with live-fire range operations, which, also, do not exist in a real battlefield, regardless of whether the training is conducted on maneuver land or on a traditional live-fire range. These exercises allow the commander to tailor the training by echelon and incorporate multi-echelon exercises based on the unit's specific training needs.

- Weapons simulator exercises are focused toward the synchronization of fires, maneuver, and command and control (C2) in a controlled environment. Weapons simulator exercises at the company level are primarily oriented towards direct fire control coordination with limited Battlefield Operating System (BOS) integration.
- Weapons simulator exercises at the battalion and brigade levels are primarily oriented towards commander and staff synchronization of direct and indirect fires with maneuver and C2. The weapons simulator exercises allow the commander to train his unit from company to brigade level in a realistic battlefield environment under actual weather, time, and distance conditions. This affords multi-echelon training on risk management, force projection, and fratricide areas prohibited during LFXs.

Subcaliber Live-Fire Exercises - Subcaliber LFXs are conducted on live-fire ranges using small caliber munitions to simulate organic main gun fires. Subcaliber devices increase the realism for combat vehicle crews, but limit the freedom of maneuver based on range restrictions and safety considerations in a live-fire environment. Subcaliber LFXs can be conducted on ranges varying in size from mini or scaled ranges to full-scale computerized multi-purpose range complexes (MPRC). The use of subcaliber training may be due to lack of main gun ammunition or the need to reduce training costs. The primary limitation of subcaliber device training is usually the availability of the subcaliber device. Availability of training devices varies among training areas and within active and reserve components. Full-scale ranges may be used with subcaliber devices to simulate main gun firing. The use of full-scale ranges provides more realistic conditions for vehicle crews and may provide enough room to incorporate complete units at a reduced cost of training. Subcaliber LFXs at the company level are primarily oriented towards direct fire coordination with limited BOS integration. Subcaliber LFXs at the battalion and brigade level are primarily oriented towards commander and staff synchronization of direct and indirect fires with selected BOS elements.

Full-Scale Live Fire Exercises - Full scale LFXs are conducted using organic weapons systems on a full scale range facility. The full-scale live fire exercise provides the commander with the most realistic training environment for synchronization of fires, maneuver, and C2, but is limited to organizational levels that can be trained without deploying to a major training area. It is normally too expensive to exercise a full brigade or battalion task force during homestation training events. This training can be conducted from company to brigade. The full-scale LFX may incorporate key leaders to platoon leaders or to company commanders depending on the higher commander's training objective. This provides a realistic environment for the commanders and staff while training leader vehicle crews on BOS integration and C2 tasks. The full-scale LFX emphasizes the effects of actual combat weapons systems while synchronizing BOS elements to maximize the effect. The effects of terrain and weather are integral to the training. This may include engagement area preparation that includes digging-in and weapons system sighting. Many weather conditions such as night, fog, and rain cannot be duplicated in simulations, making the

LFX an invaluable training experience. This exercise also emphasizes leader training and engenders, in soldiers and crews, knowledge of organic weapons systems in under actual environmental conditions. The primary limitations of a full-scale LFX are the amount of range resources required and the limited ability to conduct maneuver in conjunction with the live fire training.

Individual Training

Training ranges support two primary components of strategies for individual skill training : initial training and sustainment training. Training ranges support soldier training to use and maintain weapons and to hit targets. They learn land navigation, target detection, marksmanship fundamentals, and other skills needed to engage a target. Specific types of individual training are:

- Grouping - Shot grouping is a form of practice with two primary objectives: firing tight shot groups and consistently placing those groups in the same location
- Zeroing. The purpose of battle sight zeroing is to align the fire control system (sight) with the weapon bore, considering the ammunition ballistics.
- Downrange Feedback Training. The term downrange feedback describes any training method that provides precise knowledge of round strike (exactly where bullets hit or miss the intended target). The soldier gains confidence in his firing abilities by knowing what happens to rounds at range.
- Practice Record Fire - Practice record fire is a training exercise designed to progressively develop and refine the soldier's combat firing skills. During this exercise, the soldier is exposed to a more difficult course of fire with increased time stress to include single and multiple target engagements and identification of friendly/hostile targets. This exercise also provides the opportunity to practice and demonstrate skills learned during target detection.
- Record Fire - The objective of record firing is to assess and confirm individual proficiency of fires and the effectiveness of the training program.

The most controversial prospect for training the Objective Force may be that we should require virtually all unit types to participate in local defense live exercises, which may impossibly burden our training range resources. Maneuver units have the most obvious and immediate need in the short term, but maneuver support and maneuver sustainment units have a critical need looming with the future deployment of the Objective Force. The need for this type of exercise comes from the agility offered by "on-the-move" C4ISR and the increased probability that units not normally involved in direct fire engagements with the enemy can be involved in such engagements on the asynchronous battlefield. Attempting to create training ranges that reflect the situations faced on the non-linear battlefield greatly exacerbates safety problems, but failing to employ a non-linear setting reduces training realism. The Army needs a concept for a future live training range that can reduce safety risks without sacrificing realism.

What size battlespace will future training ranges support?

As Army Transformation proceeds and achieves its objectives, the training of Warfighters, responsible for using complex future weapon systems, will become increasingly challenging. This challenge will be driven by the complexities of the 21st Century and what will be required of full spectrum forces, responsive to ever-changing threats and situations across a wider range of regions and crises. Complexities include: the growing variety of weapon system features, the range of possible types of interactions between a growing number of weapon systems, and a growing range of operational scenarios. Compounding our training range transformation challenges further are the growing complications of warfare, including terrorism, narco-trafficking, organized crime, and the proliferation of weapons of mass destruction (WMD), and, the environmental and health factors plaguing many potential areas of operation.

Military installations are designed to house, administer, and maintain the units assigned to them. Training needs are met with space for ranges, impact areas, and terrain designated for tactical maneuver training. In addition, the Army controls land in the public domain, leased land, easements, and land available through lease or permit. Less than one-half of this land is available for training.

The hierarchy of training ranges and areas that support the Army approach to soldier and collective training is:

- Local training areas (LTAs)
 - o Active Component (AC), Continental United States (CONUS). Typically, homestation training for individual weapons proficiency and battalion level unit collective training is conducted in the LTA. LTA training facilities permit familiarization, qualification, and sustainment training with minimum on operating tempo (OPTEMPO) resources for travel to and from the training locations. Training facilities are focused on individual through platoon weapons proficiency and battalion ARTEP maneuver requirements.
 - o AC, Outside Continental United States (OCONUS) and Reserve Component (RC). Training land and range availability at overseas installations usually precludes training on a LTA, as described for the CONUS AC. RC centers, armories, and weekend training sites (WETS) typically face the same constraints. Nonetheless, these installations, communities, centers, and WETS are LTAs. Training is conducted to the extent available resources will support (normally, individual and collective weapons proficiency and small maneuver training).
- Major Training Areas (MTAs)
 - o Typically, a MTA has enough range and training land resources to support collective live fire proficiency, combined arms live fire exercises (CALFEX), and annual battalion ARTEP evaluations. MTAs are usually geographically separate from LTAs. Units conducting training at MTAs concentrate on large unit collective fire (platoon through battalion) and maneuver training (Battalion and brigade). An MTA allows for training which cannot be tactically or doctrinally accommodated at LTAs.
- Maneuver Combat Training Centers (MCTCs)
 - o The Army has three designated MCTCs for large unit fire and maneuver training: National Training Center (NTC), Fort Irwin, California; Combat Maneuver Training Center (CMTC), Hohenfels Training Area (HTA), Germany; and the Joint Readiness Training Center, Fort Polk, Louisiana.
 - o MCTCs focus on brigade task force training using a combination of live fire ranges and maneuver training land. MCTCs must have enough land to doctrinally accomplish fire and maneuver training with multiple scenarios over varied terrain. This allows for potential rehabilitation of the land. It precludes over familiarization with the terrain, which detracts from training realism.

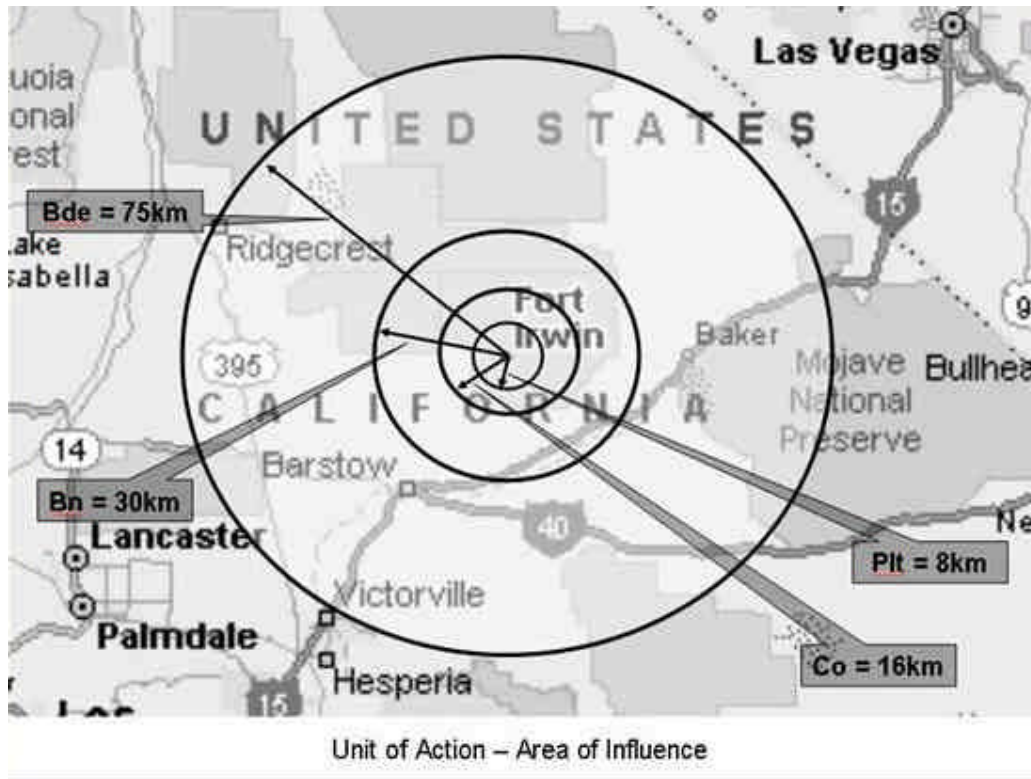
Homestation training is training conducted on facilities under the installation's direct purview and usually limited by contiguous boundaries. In addition, overseas locations frequently arrange for maneuver rights areas (MRAs) with local jurisdictions and landowners providing opportunities for periodic maneuver training on land not directly controlled by the Army.

Maneuver units need as much space to fire and maneuver in training as they would in combat. The minimum area needed to deploy and maneuver forces over realistic distances requires significant amounts of contiguous training land. Until deployment of the Objective Force Unit of Action (UA), the brigade is the lowest level where all battlefield operating systems can be integrated and synchronized. The extensive area required for training compared to the limited

land available limits this type of training at many installations; therefore, maneuver training at battalion task force level is currently the minimum requirement for the Army's major training areas and the MCTCs are required to support brigade-level training

"Smart" weapons, non-line-of-sight weapons, new target acquisition systems, and "on-the-move" digital command, control, and communications systems characterize the future battlespace and should be a substantial influence on future training range issues. The other major force for change in live-fire training is the non-linear nature of future combat. Prominent in the Army's challenges for the 21st Century will be a wide range of possible operational environments in terms of strategic goals, the political-military situation, and the nature of the enemy, civilian population considerations and, the characteristics of the battleground. These considerations must be addressed in the requirements and design of training range support strategies.

The fundamental driver for the land requirement is the dimensions of the range needed to support a given training event. Here we encounter the most profound future training range issue. Consider, for example, Ft. Irwin, California. Today, and for the foreseeable future, Ft. Irwin is the home of the National Training Center (NTC), the Army's premier, and also its largest, training area, capable of training a brigade-sized task force. But, the Army's Force modernization goals include improving the range, precision, and effects of direct and indirect fires, and enhancing agility and C4ISR. Under the "Unit of Action" (UA) concept, the area of influence of each organizational level will increase dramatically to an unprecedented scale. A UA platoon will control an area of influence with a 16-km diameter, a company 32-km, a battalion 60-km, and a brigade, 150-km. Such enhanced capabilities will significantly influence requirements for support of live-fire and maneuver training. Overlaid on a map of Ft. Irwin, the training range size issue becomes obvious; the training capacity of our largest training range, measured in unit size, will shrink by 2-thirds (2/3). The future range capacity situation at other Combat Training Centers and for smaller ranges and training areas will be no better.



How can we repurpose existing training land for the Objective Force?

An intrinsic feature of training ranges is that they can support a variety of training types, including initial skills training, operator and maintenance training, refresher training, combat skills training, and/or sustainment training. Future training ranges will provide Warfighters with training modes that can deliver a broad spectrum of effective training strategies in a complex and rapidly changing operational and technological environment.

Most people think that training ranges are vast plots of empty, undeveloped, virgin land, when in fact; they are an intensively managed, finite, and precious resource. Training Land is a specific, designated, and inventoried category of land used by military organizations for specific readiness purposes. Training Land is further defined as having four sub-elements: Maneuver Areas, Training Ranges, Dudded Impact Areas, and Non-Dudded Areas.

- Maneuver Areas - Space for ground and air combat forces to practice movements and tactics as specified in the unit's Army Training and Evaluation Program (ARTEP). Different types of units may work in support of one another (combined arms), or the unit may operate on its own. The Maneuver Area category can be further broken down into heavy, light, and amphibious areas. Included the Maneuver Area category are bivouac sites, base camps, and other miscellaneous training areas.
- Training Ranges - Areas reserved and normally equipped for practice in weapons delivery and/or shooting at targets, are the active and most visible part of the Army's live-fire range capability. Range capacity is measured by the number of firing points. Firing points and lanes are perceived as being one and the same. Acreage includes the area from the firing line forward to just past the last target array, and possibly a back-blast area.
- Dudded Impact Areas - An area having designated boundaries within which all dud-producing ordnance will detonate or impact. Vehicle bodies are sometimes placed in the area to act as targets for artillery direct and indirect fire. Also part of the Army's live-fire capability, the primary function of the impact area is to contain weapon effects as much as possible using earthen berms or natural terrain features. Note that impact areas containing unexploded ordnance may not be used for maneuver.
- Non-Dudded Areas - An area having designated boundaries within which ordnance does not produce duds. This area is composed mostly of the safety fans for small arms ranges. The primary function of the impact area is to contain weapon effects as much as possible using earthen berms or natural terrain features. These areas may be used for maneuver, at the cost of curtailing use of weapon ranges.

What isn't apparent in these definitions is that each type of training land area may also have substantial latent features, such as, historical significance, restrictive easements, and associated infrastructure improvements, such as, roads, utilities, radio systems, targetry systems, buildings, and sewerage. Since many training exercises include close-air support or live-fire, airspace and over-fly rights are also a managed and controlled part of the training range-space, and may extend far beyond the range's actual land boundaries. In many training locations, throughout the world, host nation issues, including access rights and use of the RF spectrum must also be settled and negotiated under international treaties. Many training areas admit civilians for recreational and commercial purposes, such as hunters, birders, and timber cutters. Portions of live-fire ranges that have been used for decades can have countless unexploded ordnance devices invisibly embedded in their landscape and cannot be easily or safely converted to Maneuver Areas or demilitarized and used for civil purposes. Maneuver land cannot be casually repurposed to become a live-fire range, since that might be an irreversible decision. Gaining new training areas and lifting restrictions will be almost impossible, unless exigencies arise due to an Armageddon scenario. We face repurposing problems for training land use and other alteration that are a potentially massive legal and civil engineering task that always needs to be approached with extreme care and study.

What training technologies and enablers are required to transform Army ranges to support Battle-Focused Training for the Objective Force?

Providing the training support for Warfighters, responsible for using complex Objective Force weapons in combat will be challenging. The knowledge required to operate these systems effectively will be very complex and will change very rapidly as OF capabilities develop. Contrary to traditional training concepts, where training is carried out using occasional courses and long-term accumulation of experience gained by participation in progressively challenging training exercises, current and future Warfighters will need their weapons to supply new training modes that can deliver a full spectrum of effective training strategies in a complex and rapidly changing operational and technological environment. This possibility has profound ramifications for the training range infrastructure. Future training ranges will require specific training technology development and integration to provide the enablers for the Objective Force.

The primary idea underlying the future training range concept is to provide a full-spectrum training capability by augmenting individual weapon system modes and capabilities with training support capabilities, and then, integrate this capability with a training range infrastructure. This permits a training range exercise controller to:

- Create simulated scenarios
- Collect training event data and assess operator responses to these simulated scenarios
- Enable dynamic monitoring and control of scenarios and training activities

This paper provides a conceptual training foundation for the technologies and enablers required for “battle-focused” (i.e., combat) training. Combat training requirements fall into 8 main subjects. These “battle focused” training subjects are inter-dependent and complimentary, each providing a discrete piece of the future training range solution. The 8 “battle-focused” training subjects are:

- Electronic Warfare (EW) Engagements
- Engineer Warfare and Countermining (EWC) Operations
- Nuclear, Biological, and Chemical (NBC) Operations
- Ground-to-Ground (GTG) Engagements
- Ground-to-Air (GTA) Engagements
- Air-to-Air/Air-to-Ground (ATA/ATG) Engagements
- Smart (Fire-and-Forget) Weapon Systems (SFFS) Engagements
- Intelligence Operations and Communications (ICS)

Electronic Warfare (EW) Engagements

Electronic Warfare (EW) Threat Engagement training will require that training ranges integrate capabilities to simulate electronic emitters, conduct an EW attack through tactical engagement simulation, measure the impact of the attack on a unit, and report on the unit's response to the attack. This requires the enhanced integration of training capabilities to replicate signatures of electronic emitters; replicate electronic attack and defense; and collect training data from electronic attack target acquisition sensors, emitters, and defense actions.

EW requires the development of a new functionality on training ranges to replicate EW sources through actual or replicated signals that stimulate sensors and simulate the tactical engagement of communications systems. This synergistic effort must combine aspects of TES replication and instrumented data collection to provide a realistic electronic warfare training capability.

Warfighter Impact If Not Executed - Soldiers operating Objective force weapons in battle will be unable to effectively employ electronic warfare sensors or electronic attack devices. Soldiers will be unable to practice immediate reaction drills in response to electronic attack. Commanders will be unable to prepare units for combat on an electronic battlefield. Reliance upon increasingly sophisticated computer communications systems requires effective preparation of immediate reaction to attack. Observer Controllers (OCs) and training analysts will be unable to provide

feedback concerning the employment of EW sensors, employment of EW attack capability, or information on a unit's reaction to electronic attack.

Engineer Warfare and Countermine (EWC) Operations Training

Engineer Warfare and Countermine Operations Training will require that training ranges integrate capabilities that provide engagement simulations to replicate minefield deployment, attack, breaching, and reduction. This training also requires capabilities to collect training performance information on minefield deployment, attack, breaching, and reduction.

Engineer warfare and countermine training activities require development of a method for replicating the presence of a minefield and sensing the presence of mines. In general:

- EWC training range capabilities will replicate intelligent minefield capabilities.
- EWC training range capabilities will stimulate handheld and vehicular mounted sensors, and mine hunter-killer sensors by simulating a variety of metallic and non-metallic mines in surface, buried, side attack, and scatterable modes.
- EWC training range capabilities must allow and support collection of data about the use of intelligent minefield employment.
- EWC training range capabilities designs must facilitate collection of mine sensor system data.

Warfighter Impact If Not Executed - Soldiers will be unable to train to engage in engineer warfare, or to detect, and to counter minefields in a realistic manner. Commanders will be unable to develop the techniques required to train their units to engage in engineer warfare and to react to and negate the effects of a minefield. Observer Controllers (OCs) and training analysts will be unable to provide training feedback concerning a unit's ability to perform engineer warfare or detect, neutralize, and cross a minefield.

Nuclear, Biological, and Chemical (NBC) Operations

Nuclear, Biological, and Chemical (NBC) Operations will require that training ranges integrate capabilities that provide engagement simulation capabilities to replicate sensing and effects of NBC weapons employment and collect data from NBC defensive systems.

To support effective NBC training, training ranges will integrate engagement simulation capabilities to stimulate chemical and biological attack sensors, remote detectors, and replicate chemical and biological signatures. Integrating monitoring and exercise control capabilities will allow reporting and assessment of NBC training actions.

- NBC training range capabilities will simulate detection of chemical agents (in liquid, aerosol, and gaseous forms).
- NBC training range capabilities will replicate chemical employment signals to joint warning and reporting systems.
- NBC training range capabilities will measure the effective donning of protective masks.
- The NBC training range capabilities must facilitate collection of NBC employment data and information acquired by early warning and reporting sensors.

Warfighter Impact If Not Executed - Soldiers cannot train realistically for combat on an NBC battlefield without engagement simulation and replication of NBC attack effects. Commanders are unable to prepare their units to fight on a contaminated battlefield. Immediate action drills do not instill the sense of urgency required to survive an actual attack. OCs and training analysts cannot provide adequate feedback concerning a unit's use of NBC sensors and systems, and gauge its response in reacting to an NBC attack.

Ground-to-Ground (GTG) Engagements

GTG engagements require that training ranges integrate engagement simulation capabilities to replicate employment of ground-to-ground weapons. GTG training range capabilities must be developed to collect data from advanced weapons systems engagements. Training ranges will require fully integrated engagement simulation and exercise monitoring and control capabilities to simulate tactical engagements using new weaponry.

- GTG training range capabilities will replicate the effects of less-than-lethal weapons and lethal weapons.
- GTG training range capabilities will accurately simulate probability of hit/kill (Ph/Pk) characteristics of improved weapons accuracy.
- GTG training range capabilities will accurately simulate Ph/Pk vulnerability characteristics caused by improved protection capabilities of targets.
- GTG training range capabilities will accurately reflect non-lethal weapons capabilities through a probability of disability (Pd) and selective disability function with new protocols for the severity and duration of disability.
- GTG training range capabilities will replicate tactical engagements by advanced weapons.
- GTG training range capabilities will replicate, engagements using kinetic energy weapons, non-line-of-sight bursting, and late flight-line-of-sight guidance systems.
- The GTG training range capability will collect engagement data for a wide variety of weapons systems, including shoulder-fired personal weapons, vehicle-mounted weapons, and advanced terminally guided weapons.
- A hybrid on-board and infrastructure-based engagement simulation capability will provide GTG replication and simulation of engagements for extended range, precision guided systems, shoulder-fired airburst munitions, non-lethal riot/crowd control weapons, and weapons possessing autonomous, countermeasure capabilities. In some instances, the advanced guidance and target seeking sensors installed in weapon systems will require integration of a virtual simulation with a live engagement simulation and with exercise monitoring and control capabilities.

Warfighter Impact if Not Executed - Soldiers and commanders will be unable to effectively train for tactical engagements involving advanced ground-to-ground weapons. Soldiers will be unable to carry out engagements using the full range of advanced lethality direct-fire and bursting rounds and non-lethal weapon capabilities. Soldiers and commanders will be unable to effectively employ weapons with increased Ph/Pk of improved autonomous seekers. Training exercises will not impart the positive effects of soldier protection sensor capabilities and soldier protective coverings.

Ground-to-Air (GTA) Engagements

Ground-to-air engagements will require that training ranges integrate engagement simulation capabilities to replicate sensing and effects of ground-to-air weapons employment and exercise monitoring and control capabilities to collect data from ground-to-air weapons engagements.

- GTA training range integration activities require the capability to conduct realistic engagements between land forces and fixed and rotary wing aviation.
- GTA training range capabilities will replicate shoulder-fired anti-air missiles, ballistic and directed energy weapons with selectable lethality, kinetic energy weapons, and engagements between imaging infrared missiles and countermeasure equipped helicopters.
- GTA training range capabilities will collect data from reconnaissance sensors and engagements between weapons.

- A hybrid GTA engagement simulation and exercise monitoring and control capability will replicate and simulate engagements between systems equipped with countermeasures and counter-countermeasures.

Warfighter Impact if Not Executed - Air defense weapon system crews and commanders will be unable to train with their ground-to-air weapons. Air defenders will be unable to employ advanced weapons against conventional aircraft and aircraft using self-protection or aircraft self-healing capabilities. Observer Controller (OCs) and training analyst workload to provide meaningful training feedback on air engagements will increase, and this may result in them providing anecdotal feedback vice objective and accurate engagement results.

Air-to-Air/Air-to-Ground (ATA/ATG) Engagements

Air-to-air/air-to-ground engagements will require that training ranges integrate engagement simulation capabilities to replicate air-to-air weapons employment. The tactical application also drives exercise monitoring and control capabilities to collect data from aerial offensive and defensive systems and aerial engagement simulation systems.

- ATA/ATG training range capabilities will replicate air-to-air engagements, self-healing aircraft defensive measures with adjustable Ph/Pk (incorporating "hit but healed" capability), and a variety of weapons systems including air-air missiles, directed energy weapons, and electromagnetic weapons. ATA/ATG FCS training capabilities must collection of performance data from these engagements.
- Additional ATA/ATG exercise monitoring and control requirements include position and event reporting about nap-of-the-earth flights, aerial vehicle position location, and acceptance of data from advanced pilotage sensors and instruments.

Warfighter Impact if Not Executed - Aircrews and commanders will be unable to employ air-to-air/air-to-ground weapons. Aircrews will be unable to exercise engagement skills using the full range of advanced non-lethal to lethal weapons, masked targeting seekers, or aircraft self-healing capabilities. Variations in lethality will affect probability of hit and kill (Ph/Pk) to an extent where engagement results will become unrealistic and provide poor preparation for real-world missions. Observer Controller (OCs) and training analyst workload to provide meaningful training feedback on air engagements will increase, and this may result in them providing anecdotal feedback vice objective and accurate engagement results.

Smart Fire-and-Forget Systems (SFFS) Engagements

Future Smart fire-and-forget systems will require that training ranges integrate capabilities that provide engagement simulation capabilities to replicate sensing and effects of smart weapons employment. SFFS training also requires exercise monitoring and control capabilities to collect data from smart weapons engagements.

The looming SFFS training problem presents a critical need for a paradigm shift in engagement simulation. The capabilities of new weapons and defensive systems require that a hybrid weapon system/training system solution be developed that is capable of replicating and simulating engagements between missiles that react to target defensive measures and targets that recognize and react to threat countermeasures.

- SFFS training range capabilities will simulate terminal guidance of fire-and-forget weapons.
- SFFS training range capabilities will replicate engagements between smart munitions and smart targets. SFFS TES/exercise monitoring and control capabilities will replicate hit avoidance technologies, multi-role system capabilities, and scalable defensive measures.
- SFFS training range capabilities will facilitate collection of performance information on engagements between smart weapons and smart targets. The training support system will collect data from these engagements while simulating the characteristics of attack and defense during training exercises.

Warfighter Impact if Not Executed - Soldiers and commanders will be unable to employ weapons with terminal guidance capabilities. Soldiers will be unable to use smart weapons against targets that employ smart defensive reactions. Observer Controller (OCs) and training analyst workload to provide meaningful training feedback on SFFS engagements will increase, and this may result in them providing anecdotal feedback vice objective and accurate engagement results.

Intelligence Operations and Communications

Command and Control (C2) interaction between units and the development of systems that push C2 to lower echelons during intelligence operations and communications requires that training ranges integrate capabilities to collect data from intelligence gathering sensors and battlefield tactical Command, Control, Communications, and Computers (C4) systems. Intelligence operations and communications operations training capabilities provide Observer Controllers (OCs) and training analysts the ability to monitor and track intelligence gathering activities and communications during combat training center training.

- Training range capabilities will facilitate collection of sensor data from airborne target acquisition and intelligence sensors and emitters.
- Training range capabilities will facilitate collection of data from ground target acquisition sensors and emitters.
- Training range capabilities will facilitate collection of information from voice and digital communications occurring on the live training environment battlefield.

Warfighter Impact if Not Executed - Soldiers and commanders will be unable to effectively use data from ground and airborne target acquisition and intelligence sensors. Soldiers and commanders will be unable to effectively integrate and use data from advanced C4 ground and space-based communications systems to provide battlefield situational understanding. OCs and training analysts will be unable to provide meaningful training feedback on the employment of advanced C4 ground and space-based communications systems.

What is the objective training range live and simulation-based integration strategy?

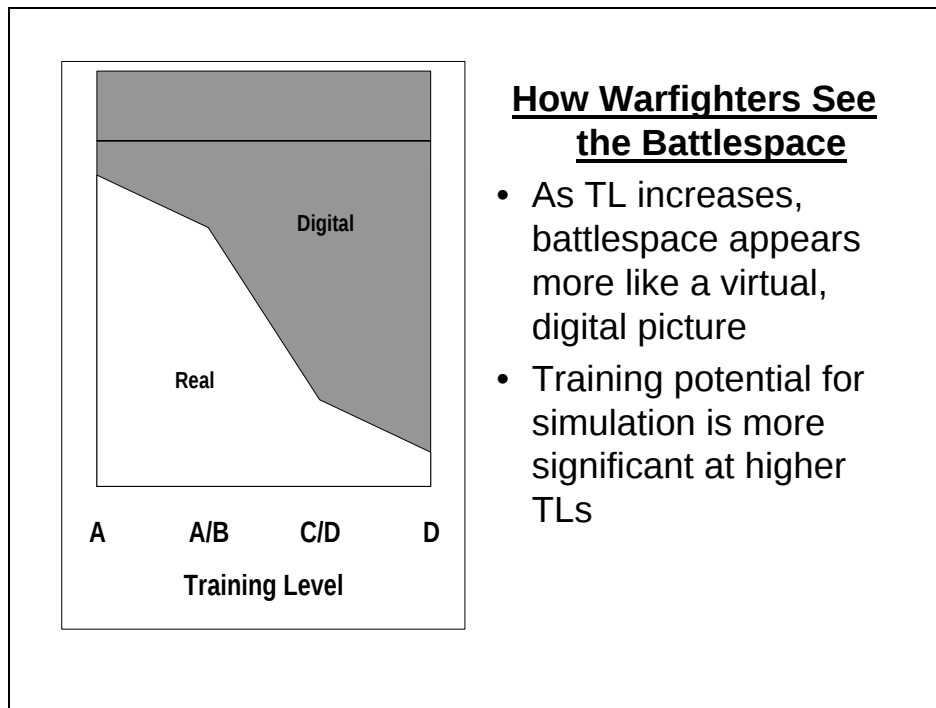
Army training is, and will continue to be, a continuous process that begins by preparing individual soldier to practice military skills, then progresses through increasingly complex unit and collective training opportunities that prepare multiply organizations at several echelons to perform major military operations. The jobs of trainers and analysts in both live and simulation venues are very similar except that safety and real-world conditions make for a more demanding exercise control chore with field-based training. Training ranges assist Commanders and tactical operations staff, units, and soldiers to practice and hone critical warfighting skills through direct interaction with terrain, weather, cultural features, the enemy, indigenous populations, and the soldiers' cognition and behavior as they operate their real warfighting systems. Live-fire and live force-on-force training is superior to other simulation venues in terms of engendering confidence in self and buddies, instilling leaders and soldiers with confidence in weapons and equipment, and engendering safe operations. As valuable as live training opportunities are, real-world training space has limitations that might be mitigated by the use of advanced simulation. At present there is only a rudimentary concept of how to use simulation to exploit real-world training more fully, and no detailed strategy for integrating live and simulation-based training for the Objective Force.

When we describe our need for future training range capabilities, we invariably encounter real-world constraints that will inevitably limit use of training land to a discrete subset of the total training requirement associated with the wide potential range of Army missions along the entire spectrum of military operations. At the low-end of the spectrum, are missions like disaster relief and humanitarian assistance. On the high-end are missions like global war. Until recently, we structured Army Forces for operations on the high-end of the spectrum, sequenced training events to prepare those Forces to address other requirements across the full-spectrum. But, in response to the events of the past decade, Army Transformation will include more responsive, agile Forces that can transition from peace-time operations full-blown war, and back again, without a breach in momentum for retraining or gaining additional resources. It seems

contradictory, but it will take deliberate training preparation so that these “*agile*” Forces can operate without retraining, so that they can stand ready and capable of accomplishing their ultimate mission, to fight and win at the highest end of the spectrum of warfare. Together, these factors, the complexity of the operational environment, missions that span the operational continuum, and the need to rapidly project power anywhere in the world, mandate technological changes to complement the limitations of our out-dated training ranges.

When we consider training range operational issues, we are mainly concerned with how the land is used to support military operations training. In describing the progression of training events, in order of their ascending complexity, four training levels (TL) are defined:

- Category A: Individual/Operator - The objective is to train and sustain individual operator and maintenance task skills.
- Category B: Crew/Team - The objective is to train and sustain combat ready crews and teams. This category builds on individual skills acquired from Category A.
- Category C: Functional - The objective is to train and sustain commanders, staffs, and crews/teams in each functional area to be used in their operational role.
- Category D: Force Level/Combined Arms and Battle Staff - The objective is to train and sustain combat ready commanders and battle staffs to use their operational systems in their operational role.



In contemplating future training strategies, the use of simulation (*virtual* and *constructive*) is often cited to be the method-of-choice for overcoming economic and environmental constraints. We accept that integrating simulations that complement land's inherent training support capability can overcome land's inherent limitations; the all important question is how. The above figure suggests a possible guideline for shaping the strategy.

For the upper level of TL–C and throughout the entire range of the TL–D operational role the Warfighter's interaction with the battle is through a man-machine interface to electronic information systems that convert the battlefield picture into a virtual, digital battlespace. Live real-world training opportunities at these levels, heavily supplemented by simulation-based training

applications, can offer the best opportunities for training those interpersonal leadership and command skills that cannot be easily imparted solely in the simulation-based training environment. The potential for using simulation to complement live training opportunities at these TLs is obvious and great.

TL-A requires a more intimate relationship between the soldier and the real-world. Soldiers may have such things as weapons, target acquisition, fire control, navigation aids, and communication devices that provide an electronic perspective on the battlespace. In some occupational specialties, most of the soldier's operational tasks involve interaction with electronic devices. But, with most soldiers, their primary warfighting experience involves complete immersion in the real-world, and face-to-face interaction with fellow soldiers. Close human encounters and sensory interactions with the real-world are very difficult to impart in a simulation-based training experience, and would probably not be important, soldier-shaping learning experiences. But, using simulation-based applications to replicate the soldier's electronic battlespace perceptions and certain operational characteristics of their weapons could potentially be the most critical solution for overcoming environmental, legal, regulatory, and other limitations on live training.

Potentially, the most important training range operational issue is that the exercises must use closely integrated simulation applications to enhance the realism and value of resource intensive live training opportunities. These applications do not currently exist. Most application concepts that have been discussed and considered for live and simulation-based integration tend to support technology demonstrations with little training value. But, future forces may not be able to prepare properly for combat unless training venues are closely integrated to portray the threat in a realistic and safe way during live training exercises. Together, these factors, coupled with the complexity of the operational environment, missions that span the operational continuum, and the challenges of preparing units to rapidly project power anywhere in the world, mandate technological changes to our out-dated training ranges that will integrate simulations in live training opportunities. Developing this type of technology could be the single, revolutionary training support opportunity that creates a true breakthrough concept of how and what to train Armies.