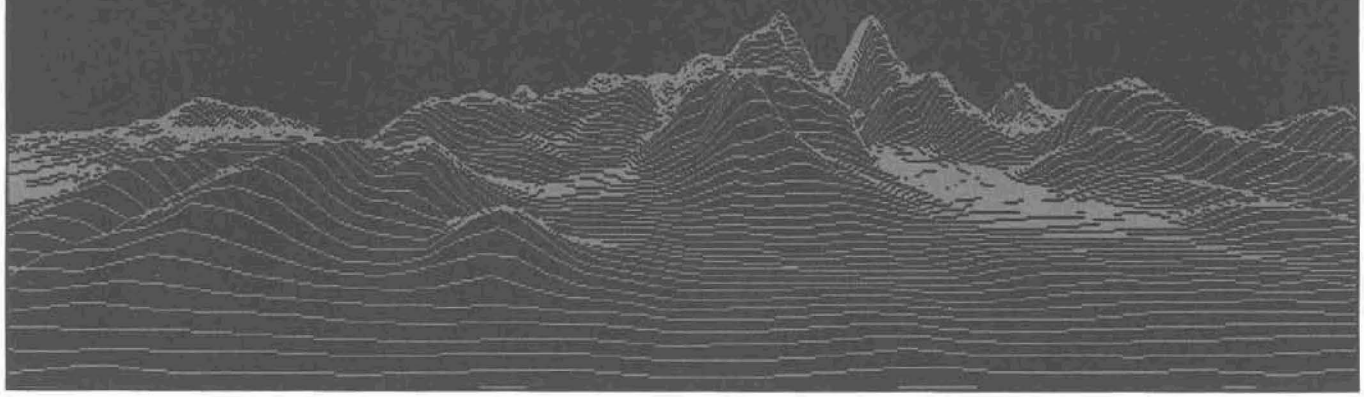
The following information is based on a speech given by Major General Clair F. Gill at the Consolidated Army Topographic, Terrain Analysis, and Multispectral Imagery Conference at Fort Belvoir, Virginia, in November 1995.

Terrain Visualization:
The Challenge for the Whole Team



Among the many challenges we face in today's Army, the most important one is sustaining the ability to decisively win our nation's wars. In the current resource climate, that means we must work hard to ensure that our programs are relevant and battle-focused. This is especially true for many of our Force XXI initiatives. The Army topographic community must share ideas and exchange information to build the team that will provide affordable, battle-focused solutions for terrain visualization and, ultimately, for the battlefield visualization it supports.

Unfortunately, both terms—battlefield visualization and terrain visualization—mean different things to different people. There are many participants, each in charge of some portion of this business. For example, Army Regulations 115-11 and 10-5 name the Chief of Engineers the "Topographer of the Army." The same regulations designate the Deputy Chief of Staff for Intelligence as the central Army staff proponent for Army topography and the central point of contact for Army topographic plans, programs, and requirements. The commander of the Engineer Center serves as the TRADOC commander's proponent for topographic doctrine, concepts, and training requirements.

The following is my perspective of the role that combat engineers have in terrain visualization. It identifies where we will need help from other key members of the topographic support team to collectively provide the best possible support to our ground force commanders.

Leader Development

Within TRADOC, a concept called DTLOMS (doctrine, training, leader development, organizations, materiel, and soldiers) is used to develop solutions to warfighting requirements. All too often, the focus of DTLOMS has become materiel, with the remainder of the solution getting far less attention. This is especially so for many Force XXI terrain issues, given the growth rate of information technology. Topo battalions know all too well the challenges of receiving equipment without the whole supporting DTLOMS.

While technology is essential to our ability to provide topographic support, it may not be our greatest challenge as we focus on the true essence of terrain visualization. From the combat engineer's perspective, our greatest challenge will be leader development. Let's consider a few historical examples.

On the eve of the Battle of Austerlitz, Napoleon walked the battlefield and decided how he would use terrain to his advantage. He even had his engineers shape the terrain by digging some

By Major General Clair F. Gill



Photo by Jim Ray

Leader training includes visualizing the terrain with the help of computers such as the Digital Topographic Support System/Multispectral Image Processor.

ditches and moving some berms. Though outnumbered, the French Army literally routed the Russian Army the next day. Much of the battle unfolded just as Napoleon had envisioned.

About 50 years later at the Battle of Gettysburg, Major General Meade, the Union commander, sent Brigadier General Warren to assess the importance of an area that Meade considered key terrain. Warren, an engineer, went to a point on the battlefield where he could see the ground and assess its impact. He confirmed the need to get forces to a hill called Little Round Top to protect the flank of the Union Army and deny that key terrain to the Confederates.

A third example involves a heavily outnumbered armor force desperately defending the Golan Heights in the 1973 Yom Kippur War. A few Israeli tanks defended the Golan heights and effectively bought time for reinforcements to arrive. One of the keys to Israeli success at the tactical level was that often a few Israeli tanks arrived at key terrain 30 minutes before the Syrians.

These examples show a common thread. In all three cases, a warfighter visualized the impact that terrain would have on the outcome of his fight. Each saw the potential in a situation. Each understood that impact in terms of the warfighting tools with which both he and his enemy had to work. And each acted quickly enough to influence the outcome of the fight. In today's combat training centers, we revalidate these lessons over and over again—that to visualize and understand terrain is the first step toward dominating the battlefield.

These examples clearly demonstrate that while terrain visualization is a new term, it is far from a new concept. If we keep this perspective, then leader development, not materiel, becomes our central focus for terrain visualization. To develop leaders who understand the art of war, given the tools and environment at their disposal, we must have leaders who understand terrain in the first place. The topographer must provide effective support to help that warfighter become familiar with a piece of ground before he walks on it.

Whether looking at a computer screen or actually standing on the ground, terrain visualization occurs only when you realize how you will use that terrain to accomplish the mission. If you don't understand what you see, or if you don't know how to use your warfighting tools to defeat the enemy in that environment, you won't accomplish terrain visualization, and you may not accomplish your mission.

Combat Engineer Role

As combat engineers, we have an especially important role in terrain visualization because of our mission. Terrain is a source of friction in war, and engineers—whether supporting mobility, countermobility, survivability, or sustainment—are either the lubricant or the sand in that friction. To be an engineer requires a basic, fundamental understanding of terrain because we are the ones who will shape the battlefield. And we support every other battlefield operating system when we do this.

So how will we grow leaders to truly visualize the impact of terrain on mission accomplishment across the enduring battlefield functions? And, given such mastery, how will we harness our materiel solutions to maximize our leaders' ability to exploit the terrain when they cannot walk the terrain ahead of time? Here lies the real challenge. We bombard our leaders with more and more information, but we don't necessarily succeed in giving them better information.

Consider the three-dimensional "fly through" that almost anyone can demonstrate on today's computers. Is this a good terrain visualization tool? In Vietnam, commanders were provided a similar view of the battlefield by flying them around in helicopters at various altitudes. Commanders didn't always understand what they saw from above the battlefield, but that doesn't mean we shouldn't view the terrain from that perspective. It simply means that we need to develop both the view and the leader simultaneously. We must ensure that the leader understands what he sees and knows the limitations of his view and how to use that information to win. In other words, computer models are only as good as a warfighter's ability to apply them to win. Pretty pictures don't always equate to terrain or battlefield visualization.

"Our engineers must be terrain visualization experts so they can help the maneuver commander use the terrain to his advantage to win."

We recently eliminated the topographic engineer specialty and proclaimed that every engineer would be a topographic engineer. The focus of that change should be that every engineer must become a terrain visualization expert—but not necessarily a technical expert on how to use new technology to provide more terrain information. While we cannot escape the fact that our terrain visualization experts must master the information tools at their disposal, we cannot afford to make that mastery the object of our leader development. We need to focus a level above—on combined arms warfighting operations.

We need technical experts, but even more we need leaders who know how to view terrain and apply what they see to win battles. These same leaders must then articulate what the battle commander needs to know to understand terrain. The tempo of Force XXI operations will make such mastery extremely important. We must have leaders who can decide and act more quickly than ever, and those leaders will need battle-focused decision aids if they hope to have any chance of coping with the operations tempo of 21st century warfare.

Engineer Center Role

As the Army topographic community continues to make impressive strides in providing greater resolution of the terrain to warfighters, the Engineer Center will provide a parallel effort to identify and develop the leader skills necessary to use that information effectively. Some of our effort will, in turn, drive the requirements for materiel solutions. The focus will be on developing solutions to meet battle-command requirements, not the other way around.

In practical terms, our engineers must be terrain visualization experts so they can help the maneuver commander use the terrain to his advantage to win. We must keep that perspective as we develop our terrain visualization support to battlefield visualization.

Our early experience with advanced warfighting experiments and the experimental force indicates that leaders and their soldiers in the field are getting overwhelmed with so-called "good ideas" that lack focus. They are drowning in new technology, new media, new jargon, and massive amounts of information of all types. In that type of environment, we must help warfighters sort the wheat from the chafe.

Army topographers can make a good start to this end by doing two things: learn to speak the warfighter's language and avoid bombarding him with highly technical language, endless "topospeak," and unique acronyms. Then we must become experts on our doctrine for tactical decision making

and the staff processes that support it. With that expertise, we will acquire the ability to provide battle-focused information about terrain and not simply offer a smorgasbord of computer graphics and data that result in information overload.

Modeling and Simulation

Another area where the Army needs our help is in modeling and simulations, which are rapidly becoming critical to the Army's future. We will use these systems as both combat and training development tools to develop and evaluate doctrine, to train all echelons of the force, and for mission planning and rehearsal.

The requirements for dynamic terrain modeling and the consistent portrayal of terrain and its impacts present major challenges. Both require detailed terrain data and well-developed, empirically sound models. We cannot afford to develop a system or capability on a simulation and then find that the system does not work because the simulation was fundamentally flawed through its terrain database. Nor can we afford to develop tactical decision aids or mission planning and rehearsal systems that provide results that are inconsistent with reality.

If the modeling and simulation community doesn't capture the terrain's very real impact on operations when they develop our simulations, the risks are great. That is why TRADOC tasked the Engineer School to solve several key modeling and simulation terrain problems. We will examine the way we develop and manage terrain requirements for modeling and simulations. At the same time, we will formulate a means for validating terrain models so that we get reliable, consistent results across the full range of applications. We will call on members of the topographic support team to help us with this important task. As we succeed, we will improve the terrain piece of modeling and simulations. We will also put in place the means for reinforcing future leaders' appreciation of terrain's real impact on operations every time they use one of these systems.

The Players

As noted earlier, the combat engineer is just one player in a large talented cast. We cannot succeed in the business of terrain visualization without a great deal of support from each team member. Fortunately, our team is abundantly resourced with the talent and spirit to make terrain visualization a reality.

The Defense Mapping Agency (DMA). Since 1972, DMA has provided our Commanders in Chief around the world with mapping, charting, and geodesy support. When DMA was formed from the mapping elements of all the services, we were a Cold-War, paper-map-oriented force. Technology, weapons systems requirements, and our national strategic focus have certainly evolved since then, and DMA is working hard to refocus to the new realities. As the TRADOC proponent for terrain visualization, the Engineer School is vitally interested in evolving joint doctrine for which DMA has the lead. We must figure out key doctrinal issues including—

- The need for a global geographic information database.
- The requirement for global coverage of minimum essential terrain information.
- The need for a rapid, terrain-data-generation support capability for contingencies.
- How to exploit the strengths of both DMA at the national level and the topographic elements at the theater level to sustain battlefield visualization terrain databases.

We have long had a productive partnership with DMA's Defense Mapping School. DMA will provide much of the expertise to make our training evolve with the rest of our DTLOMS. We must continue this worthwhile partnership to ensure that our topographic support soldiers are fully versed in the new technologies and support concepts. We want them to be just as credible and effective as their predecessors have been on division and corps terrain teams throughout the Army.

We also must work together to produce a leader-development training package that will help our leaders and soldiers come to grips with the essentials of datum shifts, global positioning system strengths and limitations (to include accuracy), and the strengths and weaknesses of the digital systems we put in place. The Engineer School will take that package, translate it into basic warfighting terms, and then export it to every other school in TRADOC.

Corps of Engineers. We are fortunate to have the backing of an enormous pool of talent in the Corps of Engineers laboratories. These topographic support experts have consistently produced outstanding materiel and software solutions to meet both current and future operational requirements. As we pursue our terrain visualization objectives, we will need the backing of these

experts more than ever. They will furnish the materiel piece of our DTLOMS so that we can provide combat engineers with needed digital reconnaissance tools and our terrain teams with the capability to build and sustain terrain databases in the theater. We also need their help in solving the many challenges of database management and communications necessary to provide a common, up-to-date picture of the battlespace, both vertically and horizontally, throughout the theater.

Topographic Units. Commanders continue to receive outstanding support from topographic units. They have done a superb job of tackling how they will support operations with new systems in the midst of major changes in almost every aspect of their business. We need their input when we capture battle drills; tactics, techniques and procedures; and possible fixes to doctrinal issues.

Intelligence Community. We will continue to build our partnership with the intelligence community. We want to learn as much as we can about providing digital support from the people who developed the All-Source Analysis System. We will continue to have a common interest in solving the enormous database management and communications challenges for both the terrain and intelligence databases. We will continue to work on key doctrinal issues, such as the terrain visualization aspects of deep targeting, and including terrain visualization requirements in the collection management process.

Most of all, we must continue to work together to ensure that the warfighter knows the strengths and limitations of our terrain information collection systems. We need special emphasis on what can be done with a map or image and how the addition of an underlying digital terrain database affects terrain and battlefield visualization. We must accomplish this with full understanding of the immense pressure that fog, friction, fatigue, and operations tempo have on the commander in the course of operations. Our success in the area of mission planning and rehearsal systems will depend on this fundamental understanding.

The Warfighter. There are many others on the team, but one member has a greater vote than all of the rest. As we continue to provide information technology to support battlefield visualization, we need the warfighters' input. In short, he must tell us what works and what doesn't, and we need to listen.

The warfighter also must demand that his terrain expert, the combat engineer, fully support the terrain-related portions of tactical decision making. That support includes—

- Identifying priority areas for terrain information collection and terrain team work effort.
- Working closely with the intelligence staff to collect key information.
- Providing a solid analysis of the terrain impact on the courses of action.
- Conducting a risk assessment when lack of terrain information results in uncertainty about what the real impact of terrain may be.

The Engineer School will continue to work closely with the Battle Command Battle Lab and the battlefield visualization crew at the Combined Arms Center to ensure that engineers are fully integrated into the staff estimate process and that our DTLOMS are indeed battle-focused.

Closing

I think I have found the combat engineer's niche in the topographic arena. It rests on fundamentals. The combat engineer's business is terrain, pure and simple. We own the ground. Everything topographic, then, has a single purpose: to help us acquire complete ownership of that ground before we get there. That is the reason why every engineer must be a terrain-visualization expert.

If we don't apply our knowledge about terrain to translate the battle commander's terrain visualization requirements into something tangible we can provide, then who will? This is the measure of relevancy I have been speaking about.

The Engineer Center will continue to focus its topographic support on the sharp end—the battle commander's requirements. And we will focus our DTLOMS to that end as well. In so doing, we hope to give the rest of the Army's topographic team the right focus against which they can apply their considerable talents. Together we will achieve our terrain-visualization objectives.

Major General Gill is the Commander of the U.S. Army Engineer Center and Fort Leonard Wood and the Commandant of the U.S. Army Engineer School.

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