STRATEGY RESEARCH PROJECT

THE DIGITAL MAP OF THE FUTURE: WILL IT SATISFY OUR INFORMATION NEEDS?

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ABSTRACT

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Emerging digital technology is changing the tools commanders have available to see the battlespace. As part of this move to leverage technologies, the United States Army is moving to a digital map. This move should enhance all leaders' ability to visualize the battlespace. However, digital information is susceptible to distortion. This study reviews the Department of Defense architecture for the production, storage and dissemination of digital terrain products. Using the criteria for quality information as outlined in Field Manual 100-6, Information Operations, the digital terrain architecture is evaluated. In general, the architecture meets the criteria for information quality. There are two areas of concern. The first is precision of the data. Over the next ten years, the digital terrain data will be available at a level of precision previously unheard of. However, the level of resolution may not be sufficient to detect obstacles to maneuver. The second area of concern is usability. Not all Coalition partners will have the systems to process digital terrain data. In addition, there may

be a cultural problem. Training the Army to move from the paper map to digital displays will require the full attention of all leaders for the next decade.

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SEEING THE TERRAIN

Current United States Army doctrine stresses the need for the commander to see the enemy, see himself and see the terrain. The importance of seeing and understanding terrain is certainly not a new concept. The Art of War is the first recognized publication on war. Sun Tzu starts the essay describing the relationship of war to the state. According to Sun Tzu, to analyze war, one must appraise it in terms of five factors. One of these factors is terrain.[1] There are countless historical examples of how terrain has affected and influenced the outcome of battles and engagements. In spite of technological advances that have changed how armies conduct operations, what has not changed is where they conduct them -- on the ground. The Army anticipates the capability to see and strike throughout the depth of the battlespace in the near future. However, Army Vision 2010 still sees a requirement for ground operations in any future contingency.[2] Emerging digital technology is changing the tools commanders use to see the battlespace. The map used by soldiers for the past several hundred years has not changed significantly. While the accuracy has improved and the ability to generate maps in bulk has increased, soldiers in this information age still rely on the paper map. As the speed and computing power of

computers increases, coupled with the ability to transfer information to forces world wide in minutes, the United States Army must take advantage of the digital terrain technologies and move to a digital map. The question that this essay will answer is, "Will the proposed Department of Defense architecture for the production, storage and dissemination of digital terrain products meet the assessment criteria for information quality as outlined in Field Manual 100-6, Information Operations?" One of the conclusions of FM 100-6 is that sources of information are imperfect and susceptible to distortion. Terrain data is simply one category of information on the battlefield. To have value on the battlefield, information must be accurate, relevant, timely, usable, complete and precise.[3]

This paper will present three vignettes about the strategic importance of terrain visualization, and describe the current army doctrine concerning terrain analysis and the value of digitized terrain. This is followed by a description of the proposed architecture and an analysis of the architecture with respect to the quality criteria outlined above. Finally, conclusions of this study are presented.

HISTORICAL PERSPECTIVE

It is fairly obvious that the study of terrain is important to military officers. The relevant question is, "At what level of war is the understanding of terrain critical?" The study of terrain and terrain analysis have generally been associated with the tactical level of war. However, knowing the terrain has affected strategic and operational level decisions as outlined in the following historical examples.

Lack of detailed terrain analysis prior to the Normandy invasion during World War II created major problems for the Allies. Prior to the invasion, the Supreme Headquarters, Allied Expeditionary Force (SHAEF) planners developed timetables that depicted anticipated progress of the forces. As the operation unfolded, it became apparent that the time schedule would not be met. SHAEF planners believed First U.S. Army would be able to occupy the Lessay-Saint Lo-Caumont line by D+14. It was not until one month later that First Army actually reached their goal. One of the reasons for the delay was the effect hedgerows had on the advancing American forces. Hedgerows are separations between farmer's fields that consist of earth and hedges. They range at the base between one to four feet deep and are from three to fifteen feet high. Growing out of this berm are small

trees, vines and brush. The effect of hedgerows on movement "seem to have taken First Army by complete surprise."[4] In a post war survey, only one in one hundred officers questioned stated they knew about the effect of hedgerows prior to the attack.[5] However, the obstacles required the Allies to modify their movement plan and develop special equipment and tactics to move through the hedgerow country.

The point of this example is that terrain analysis conducted by the SHAEF planners was inadequate. The hedgerows were not a surprise. However, their effect on friendly force movement was significant. What may have appeared as a tactical nuisance to the planners became a significant issue at the highest levels in SHAEF.

The next vignette describes a modern day failure with respect to terrain visualization. The failures during the Grenada Operation are well known. For the soldiers and Marines on the ground, it was a failure from a mapping perspective. In spite of President Reagan's remarks concerning the construction of the Point Salines Airfield seven months prior to the intervention, information available to the U.S. forces about the island was sadly lacking. The crisis was not anticipated and the mapping community was not prepared to provide standard military

maps. Tourist maps with makeshift military grids overprinted on them were issued. In one case, a location selected as an air drop assembly area based only on a map reconnaissance was in fact an area totally unsuitable for an air drop - a lake.[6]

The lack of standard military maps was also directly responsible for civilian deaths. During operations against Fort Frederick, Navy Corsair pilots bombed a building next to the fort. They had no military maps or other methods of identifying that building as a mental hospital. The result was eighteen mental patients killed during the attack.[7] Grenada was a case where the lack of terrain products resulted in wasted planning effort and unnecessary death.

The following Persian Gulf War example shows how a detailed terrain analysis at the strategic level coupled with a technologic edge proved decisive for CENTCOM. Detailed terrain analysis by the staff was critical in CENTCOM's "left hook" maneuver west of the Wadi al Batin in the Persian Gulf War. General Schwarzkopf was deeply concerned about the lack of Iraqi forces in the area where 3d Army planned to attack. He asked himself, "What does Sadam know about that flank that I don't?"[8] The simple answer was the Iraqi forces could not effectively navigate in this featureless region. They needed roads to

coordinate the movement of tactical formations. In a classic underestimation of their opponent, the Iraqi leadership believed U.S. forces would have the same difficulties navigating and therefore would not consider a major attack in this sector of the theater.[9] However, due to the Army's ability to rapidly produce maps of the area coupled with the Global Positioning System (GPS), navigation in the desert was not a problem for 3d Army. They were able to attack and destroy the Republican Guard Forces from an unanticipated direction.

REVIEW OF CURRENT ARMY DOCTRINE

From the examples above, it is clear that understanding terrain in detail is essential for any force. The Army's doctrinal publications recognize the importance of terrain at all levels of command. This section will review the Army's current doctrine and then look at how the Army views the future with respect to terrain products.

The Army's capstone manual, FM 100-5, Operations, provides some detail on why understanding terrain is important to commanders. The most enlightening section on terrain is found in the chapter entitled the "The Environment of Combat." In the very first paragraph, the essence of the problem is stated. "Successful commanders understand terrain and how it affects

operations. They are able to grasp the potential capabilities and limitations of the space in which they operate."[10] The section describes what tactical, operational and strategic commanders need to know with respect to terrain. The authors of FM 100-5 recognized one of the key issues. "Commanders ensure that terrain information gets down to the level where it can assist in operations planning."[11] Although the discussion of terrain is not extensive, it does point out the importance of understanding the terrain at all levels of war. The treatment of terrain is significantly better than it is in FM 100-7, Decisive Force: The Army in Theater Operations.

FM 100-7 is the Army's manual on how the Army functions at the operational level of war. In this manual, there is acknowledgment of the importance of terrain at the operational level. In a section on "Attack", the manual does conclude that one of the purposes of the attack is to "secure decisive terrain."[12] It also recognizes one of the functions of the intelligence structure of the command. They must maintain current information on several subjects; terrain being one of them.[13] However, there is no discussion of the relative importance of terrain similar to the one found in FM 100-5.

Army Field Manual 5-105, Topographic Operations, provides an excellent description of the organizations, processes and products available from the topographic community. As in the previous manuals, the importance of terrain to war fighting organizations is emphasized. The manual is designed to provide information about the current capabilities but lacks any substantive discussion of the requirements or products for the Army of the future. The final level of doctrinal publications addresses the specifics of how to actually do a terrain analysis.

The Army's Field Manual 5-33, Terrain Analysis, acknowledges the importance of terrain in the Introduction. It states, "Knowledge of the battlefield terrain is extremely important during all phases and levels of military planning."[14] While acknowledging this requirement, FM 5-33 outlines the organizations that conduct terrain analysis. It also provides the reader with very specific instructions on how to conduct terrain analysis. It predates the proliferation of digital mapping products and assumes standard mapping products are available to the planners. However, as was seen in Grenada and the early days of Desert Shield, this assumption is not always valid.

In summary, the Army's doctrine recognizes the importance of terrain to military operations and provides detailed information on how to conduct the terrain analysis. What the current doctrine does not address in any detail is how the emerging technologies will support the Army of 2010.

EMERGING DOCTRINE

Predicting the nature of future warfare has always been a difficult proposition. However, Joint Vision 2010 provides an unambiguous direction for the United States forces. It clearly states that information superiority is a requirement for the emerging operational concepts of dominant maneuver, precision engagement, focused logistics and full-dimensional protection.[15] The National Imagery and Mapping Agency (NIMA) recently published a Geospatial Information Infrastructure (GII) Master Plan. This plan addresses the importance of information dominance with respect to terrain in the following statement:

> No negotiations can be conducted, no forces can move, no weapons can be brought to bear, no forces can be protected, and no support and supplies can move without a sense of location, an understanding of surroundings, and an understanding of the influence of mission space on the operation.[16]

This thought is reinforced in Army Vision 2010. In a section on information dominance, the message is clear. The Army must create a "disparity between what we know about our battlespace

and operations within it and what the enemy knows about his battlespace."[17] Obviously, part of that battlespace knowledge includes terrain. At the Joint and Army levels, the requirement to know the terrain is clear. How has this been translated into the emerging doctrine at lower levels?

The Army's Training and Doctrine Command (TRADOC) has taken the lead on battlefield visualization. The Terrain Visualization Master Plan published by TRADOC recognizes the importance of accurate and timely terrain information. The executive summary presents terrain visualization as a component of battlefield visualization. Terrain visualization "allows a detailed understanding of the back-ground upon which enemy and friendly forces and actions are displayed."[18] The importance of this statement is provided in the next section that states the Army will move from "hard copy and product based topographic system to a digital, information based system. The information based system provides digital maps . . . which feed battle command systems directly. . . ."[19] The significance of this statement is profound. In the very near future, the Topographic community will completely change the way it provides terrain products and services to the Army. The former Commandant of the Engineer

School, MG Clair Gill, provides some insight on the importance of understanding terrain.

In a speech at the Consolidated Army Topographic, Terrain Analysis and Multispectral Imagery Conference in November 1995, MG Gill described the importance of terrain in several historical case studies coupled with lessons learned from the Combat Training Centers. The conclusion was obvious, but often forgotten. "To visualize and understand terrain is the first step toward dominating the battlefield."[20] He goes on to say however, that we "bombard our leaders with more and more information, but we don't necessarily succeed in giving them better information."[21]

In summary the Army has recognized the importance of battlefield visualization and the role terrain visualization takes. The current doctrine does not reflect the requirement for information dominance leading to battlefield visualization. However, the emerging doctrine provides a clear vision on how information technology - specifically digital terrain products - can provide commanders with the means to achieve information dominance. The next section of this paper will discuss the limitations of our current method of representing terrain: the paper map.

WHY MOVE TO A DIGITAL MAP?

Although maps of various types have been used successfully for several centuries, hard copy maps will be replaced by digital, information-based systems in Force XXI. TRADOC's Concept for Topographic Support for Terrain Visualization outlines the limitations of the hard copy map. The following paragraphs summarize TRADOC's analysis of the current map.

Maps consist of a geographical representation of the earth's surface on paper or acetate. Points, lines or areas represent the information depicted on a map. Features on a map are denoted by various colors, different symbols or marginal notes found in the legend. To facilitate understanding, the amount of information that can be depicted on any one map is limited. Several factors influence the selection of information used on any map sheet. First, the volume of data that can be depicted on a map is extremely limited. Much of the information available must be filtered out of the product in order to ensure readability. Second, the map must be drawn with great precision and accuracy. This requirement also limits the amount of information that can be portrayed. Third, frequently the area of interest is at the intersection of several different map sheets that may not be based on the same horizontal datum. Fourth, once

the information has been placed on a map, it is expensive and difficult to extract that information or combine it with other information. An example of this is an overlay from a higher headquarters based on a map scale that is different from the using unit. Transposition of boundaries from an overlay to a different scale map is extremely time consuming and invariably leads to errors. Finally, the map is not dynamic. Updating and disseminating changes to a static map (like a destroyed bridge over a large river) within a force is not easy under the best of circumstances.[22] The hard copy map has served the Army well in spite of the limitations listed above. However, with a CONUS based contingency Army that is expected to conduct operations world wide on short notice, the old way of doing business will not enable commanders to achieve that information dominance our doctrine depends on. The next section will outline the future architecture for mapping products.

THE EMERGING ARCHITECTURE

The GII, produced by the National Imagery and Mapping Agency (NIMA) in October 1997, provides the direction for the Department of Defense with respect to digital mapping. The plan "documents a broad range of initiatives needed to manage the transition from standard hard copy products to an information-based environment

capable of supporting global readiness . . . "[23] The GII Framework is composed of user services and a set of data (to include terrain) with known accuracy. This section will describe the three types of information found in the Framework: Foundation Data, Mission Specific Data Sets (MSDS), and Qualified Data Sets.

The first source of information is known as Foundation Data. Foundation Data forms the base of the Framework.[24] It is the starting point for the generation of all terrain products and analysis. The primary developer of the Foundation Data is NIMA. Foundation data is generated by national resources and is available for dissemination to all military users.

The Foundation contains information with a large number of important characteristics. First of all, it is available with near worldwide coverage. As its name implies, it is a foundation for all types of analysis and is therefore mission independent. Foundation Data will be used in both war and Military Operations Other than War (MOOTW). It will contain relatively stable background information or have an in-place maintenance program if updates are required (such as navigation safety information). Foundation Data will consist of standard coverages of known accuracy and quality and will use a common horizontal datum

(World Geodetic System 1984) and known vertical datums. This last feature is critical for all military units across the battlefield. Without a common horizontal datum, adjacent maps do not join together with any consistency and navigation at the edges of these maps creates fire control problems for forces. There is an area in South Korea where adjacent maps did not use the same horizontal datum. An interesting and potential fatal consequence of this datum change is that the same town is depicted on two different map sheets with two different military coordinates. In a tactical engagement using indirect fire around that town, fratricide is not only a possibility, but also a probability unless it is clear to all which datum is referenced.

In addition to the above, the Foundation also contains several other types of information. Stereoscopic imagery will be available for terrain analysis. Digital Terrain Elevation Data (DTED) to level 2 will be part of the foundation. The level associated with DTED determines the accuracy of the information. The smaller the spacing between the data points, the greater the resolution. Level 2 DTED means that the spacing between data points is 30 meters which is approximately equal to the contour information on a standard 1:50,000 scale military map.[25] The significance of DTED in the Foundation is far reaching. DTED

supports three-dimensional visualization of the battlespace for the war fighter. Other types of information that are included in the Foundation are hydrographic/bathymetric information, geophysical data such as gravity and magnetics, and navigation safety information.

The next set of data is the Mission Specific Data Set (MSDS). This data set forms the next layer of the Framework. As the name implies, this data set is developed to satisfy specific, validated area requirements. This is done by enhancing the data in the Foundation data set. MSDS may include higher resolution imagery, elevation or depth information and any changes that have been detected or identified affecting the terrain within the Area of Operations. This data will come from a variety of sources to include national assets, host nation support and in theater observations. An example of Mission Specific Data is the inclusion of detailed imagery and maps of an area in a foreign city to support a NEO operation. One of the key considerations in fulfilling the MSDS is the standardization of specifications for data inclusion into the set.[26]

The next part of the architecture is referred to as Qualified Data. Qualified Data "includes other data sets of known accuracy that have not been integrated, or deconflicted,

with Foundation Data or MSDS."[27] Examples of Qualified Data include national and international government databases which meet the requirements established by NIMA. These requirements will include accuracy, currency, resolution, content and format standards. The GII Master Plan identifies another growing source of Qualified Data. This is private industry associated with the geospatial field. If DoD needs information that is not readily available through its own sources, it will consider commercial sources with known accuracy and quality.

Another type of Qualified Data is that data collected by the users. Information concerning changes to maps and other topographic products may be reported by commanders in the field. However, before it is considered as Qualified Data, it must meet established standards. In any event, before the data is useful, the analyst must understand the limitations of the data he is working with. NIMA recognizes this as an important aspect of the Framework.

A part of the Framework that overlaps the three types of data is called Metadata. Metadata is information about the quality, currency, sources used and lineage of the information in the Framework. It will help users understand the limitations of the data they have. The GII Master Plan states, "Metadata

conveys data quality and lineage and supports the intelligent application of geospatial information."[28]

The next part of the Framework is Framework Services. Framework Services provide the interface between the geospatial information and the user. As stated in the GII Master Plan, "Framework Services supports the access and exploitation of Framework information."[29] In addition to providing the Framework information in soft or hard copy, Framework services will also include technical assistance, and training programs to enable users to take full advantage of all of the products available from the Foundation.[30]

Once the geospatial data is obtained, cataloged and stored for use, mechanisms must still be in place to disseminate and analyze the data. The Engineer Center has a well-articulated plan for the dissemination of terrain data found in the Framework. The draft plan is entitled "Operational Concept for the Dissemination of Digital Terrain to Warfighting Entities." Although a full description of the concept is beyond the scope of this paper, the highlights are presented below.

The key organizations in the dissemination of digital terrain data are the command's topographic engineer units. These units will have accounts with NIMA to access geospatial data for

their commands. They will also maintain the Terrain Data File Server for their commands. This file server will hold the Foundation Data set for the command and control systems that will use this data.[31] Data will be provided to the units in hard copy prior to deployment, or transmitted to the topographic units using web-based technologies.[32]

Once a unit is deployed to a theater for a specific mission, two activities commence. The command's topographic unit in possession of the Foundation Data set will provide that data to the command and control systems as a background for planning. At the same time, NIMA and topographic units will provide Mission Specific Data to subordinate topographic units and the C2 systems of the command. The purpose of this data is to enhance the Foundation, provide higher resolution information and document any changes in area of operations. At the same time, the topographic units will provided tailored Foundation Data to the warfighting entities in the command.[33]

The final step in the process of using digital terrain is the analysis of the information leading to enhanced battlespace awareness. The topographic community has developed several superb systems to support the terrain analysis mission. Description of these tools is also outside the scope of this

paper, but they are a combination of COTS and GOTS systems that have either been fielded or are under development.

The architecture described above is designed to enhance a commander's ability to visualize, and dominate terrain. The GII Master Plan and the Army's concepts of how to accomplish the storage, dissemination and analysis of digital terrain data seem to nest well. The next section will analyze how well the proposed infrastructure will do in moving the Army to a digital terrain based environment.

ANALYSIS OF THE GII

This section will evaluate the Geospatial Information Infrastructure and the Army's doctrine with respect to the criteria listed in the introduction.

ACCURACY

The first area is accuracy. Does the terrain data convey the true situation?[34] The GII meets the criteria of accuracy. The use of a standard datum, the World Geodetic System 1984 (WGS 84) will ensure a level of consistency and accuracy previously unknown in the Department of Defense. Geodetic datums "define the reference systems that describe the size and shape of the earth."[35] There are over one hundred and ten different datums in use today worldwide.[36] The location of each point on the earth as

represented by latitude, longitude and height above or below mean sea level is different for each datum. The significance of the adoption of one datum by Department of Defense is that there is a unique coordinate on the earth for each location. Obviously, one datum will rectify the problem stated above concerning that Korean town found on two different map sheets. One datum is also a significant step in preventing fratricide. If two elements or services are looking at the same target using the same, universally accepted datum, then the likelihood of fratricide due to map differences is significantly diminished.

In addition to the consistency achieved with the WGS 84 datum, accuracy is also improved. WGS 84 was developed as a replacement for WGS 72. The models in WGS 84 use the latest data and technology available as of 1984. The important point is that "WGS 84 earth gravity model and geoid are considerably more accurate than their WGS 72 counterpart."[37]

Another aspect of accuracy is the requirement to update the database as changes occur. The GII Master Plan states that the Foundation Data Set must be "relatively stable or have an in-place maintenance program to ensure currency."[38] While the actual structure or organization for maintaining the database has not yet been established, the recognition of the requirement to

maintain and update the database should ensure current, accurate information.

RELEVANCE

The next area of analysis is relevance. Does the terrain data "apply to the mission, task or situation at hand?"[39] Based solely on the structure of the Framework, the terrain data is relevant. By design, the Foundation Data coupled with Mission Specific Data Sets will provide the warfighter the information needed to accomplish the mission. The Foundation consists of a baseline of information about an area. For a specific mission, MSDS is layered on top of the Foundation to "densify" the product which will enable commanders to conduct the specific analysis required.

TIMELINESS

The next area involves timeliness of information. Is the terrain data "available in time to make decisions?"[40] The GII MP meets the timeliness criteria. Once the Framework is completed, Foundation Data will enable planners to initiate planning even if the area of interest is not covered by large scale mapping products. This is critical for a CONUS based contingency force. Two of the three examples cited above specifically addressed the

lack of terrain products when a crisis started. The necessity to use tourist maps ends once the GII is fully implemented.

If large numbers of hard copy maps are required, NIMA anticipates a significant timesavings with the Foundation. NIMA estimates that it will take between 600 - 1000 hours to enhance Foundation Data to produce a Topographic Line Map (TLM). These are the 1:50,000 scale maps all military personnel are familiar with. However, if the TLMs have to be generated without the Foundation Data, it would take 1800 hours.[41]

As the information is received by the topographic units and incorporated into the local databases, updates will be available to maneuver battalions and below instantaneously. The technical means to accomplish this dissemination is beyond the scope of this study. However, the digital terrain information will ride on the same communications backbone as other friendly and enemy information down to armored vehicle commander as part of the Army Battle Command System (ABCS). This quantum leap forward will enable commanders to maintain terrain information dominance in a highly dynamic situation. However, it is recognized that due to the scarcity of means required to move data at the tactical level, "this is the most complicated portion of the process of digital terrain data dissemination."[42]

USABILITY

The next area is usability. Is the terrain data in "common, easily understood formats and displays."[43] The usability issue has several facets. The first centers on the capability of the topographic community or staff officer to generate useful terrain information using the GII and data processors. The Terrain Visualization Master Plan states that this man-machine interface is the most important element of terrain visualization. As was mentioned above, hard copy maps are relatively unsophisticated in what they portray. The opposite is true with digital terrain products. The high level of sophistication of the processors, displays and databases provides the means for both analyst and commander to understand terrain as they have never done before. The difficulty is that analysis is more complicated and requires special skills and training. Although the information may be readily accessible, training of operators to understand what they are looking at will take time. The Army published an annex with the GII MP. One of the concerns is the time required to convert to digital maps. The estimate is that it will take well over a decade to accomplish this transition. However, the plan also acknowledges that digitization will "not eliminate the need for 'fail safe' paper maps and overlays."[44] This statement implies

that not only must soldiers be proficient with the new technology, but they must also continue to exercise their map reading skills.

Once digital terrain data is available for analysis by topographic units, will it be in usable form? Will the leaders understand what they are seeing on the displays and use it in a meaningful way to make decisions? The question of understanding not only involves extensive training for all leaders, but also doctrinal changes on how digital terrain products can be used. For example, with data that is currently available, an operator of a multispectral imagery processor can determine if an area is saturated with water. If the decision-maker does not understand that the capability exists to conduct this type of analysis, he may make a decision on an attack axis through an area totally unsuited for mounted maneuver.

The third facet of the usability issue is the audience. The digital terrain information found in the Framework may not be useful at all to coalition partners who do not have the capability to store, process or manipulate digital terrain data. The GII MP recognizes this difficulty. Canada, Australia, and the United Kingdom have participated in the development of the GII MP.[45] However, the United States has conducted operations

with several other nations during the past decade. The demands to share this information will require topographic liaison teams with the connectivity to the tactical digital networks the United States forces will use.

COMPLETENESS

The next area of analysis is completeness. Is all of the terrain data required by the decision-maker available?[46] It is clear that if every terrain feature on the earth was part of the Foundation, the database would be enormous and prohibitively expensive. The question is really "complete with respect to what?" When compared with the mapping failure of Grenada, the GII meets the criteria of completeness.

How much of the earth does the GII Foundation Data Set cover? The GII MP calls for DTED data from 60 degrees North and South by 2000.[47] This is a great start in developing the Foundation Data and covers virtually all of the world where the Army has operated in the past few decades. While the Foundation consists of more than just DTED, Joint Publication 2-03, JTTP for Geospatial Information and Services Support to Joint Operations, states, "Foundation data will be available on a near-global basis to support strategic planning."[48] While not sufficient by itself for generating TLMs, it will provide military planners the with a

basic map to be filled in with MSDS. Although no specific time lines are provided in the plan, it is clear that the GII will be much more extensive than any previous DoD terrain database.

PRECISION

The final criterion for evaluating terrain data is precision. Does the terrain data "have the required level of detail?"[49] Initially, it seems that the data will not have the level of precision to preclude a situation that occurred with SHAEF planners during the Normandy invasion mentioned above.

The Engineer Center hosted a conference at Fort Leonard Wood, Missouri, in May 1997 on the Map of 2010. During the conference, a NIMA representative stated that the Foundation Data will have a resolution of five meters.[50] Is this good enough? It is better than currently available, but will not be sufficient in the long term. Looking back at the hedgerow problem and a modern day example - a terrain feature known as the Colorado Wadi at the National Training Center - is enlightening. Even with five meter resolution, the significance of both of these obstacles would not be apparent to planners using only digital terrain products. Although this information can be filled in with MSDS, it will not be part of the Foundation. As is evident in any training exercise involving mounted forces, it does not require a world

class obstacle to stop a mounted force. Just a small terrain anomaly that no one noticed during the planning.

CONCLUSIONS

This study has examined the importance of understanding terrain at both the operational and strategic levels, reviewed the current and future doctrine and examined how the Department of Defense and the Army will leverage emerging technologies to achieve information dominance and battlespace awareness using digital terrain products. Several conclusions emerge from this study.

The first is the necessity for operational and strategic planners to understand the detailed characteristics of battlespace. Generalized terrain characterizations such as "rolling farm land" may sound good in a briefing. However, strategic and operational successes are contingent upon tactical success. Historical examples have shown that understanding the details of the terrain at what may seem to be the tactical level is essential for high level commanders. Planners can not focus on just the big picture when it comes to terrain, because the big picture will not stop or delay forces. Specific terrain features that may not appear on a map, however, will.

Both the current and emerging doctrine recognize the importance of terrain in achieving dominant situational awareness. The general requirements are comprehensively documented and the specific Corps of Engineer organizations and equipment to support the commanders in Army Vision 2010 are well thought out.

Finally, the Geospatial Information Infrastructure will provide the forces with information that, in general, meets the criteria for information quality as outlined in Field Manual 100-6, Information Operations. There are two areas of concern.

The first is a short term problem regarding the precision of the information. As stated above, the move to accumulate and store DTED that covers most of the world at level 2 will be a great step forward. However, even this level will not provide the detail required to fully appreciate the effects something like the hedgerows or the Colorado Wadi have on maneuver forces. Lacking a level of precision that includes the above two examples (one meter accuracy), commanders will continue to go into battle believing they know the terrain when there may just be a terrain surprise the tactical forces can not deal with effectively. The emerging technology in data acquisition should resolve this problem over the next decade.

The other issue is usability of the digital terrain information. This will be the biggest challenge for the Army. It is not necessarily a technological challenge. Rather, it is a cultural challenge. The hard copy map has been the starting point for developing battlespace awareness for centuries. Hard copy maps are relatively easy to use, virtually indestructible, easy to carry and easy to get. The information edge that digital terrain data will provide leaders in the Army is undeniable. However, actually making the move away from the map will require the full attention and effort of all leaders at all levels for the next decade.

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ENDNOTES

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