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e-maps

APPLICATION OF COMPUTERIZED GEOGRAPHIC INFORMATION TO MILITARY OPERATIONS

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CHAPTER 1

INTRODUCTION

101. Purpose. This pamphlet describes changes in military operations that will improve command and control through the better use of computerized geographic information.

102. Background

a. The exploitation of computerized geographic information is very similar to that of rifled weapons. Rifled weapons were introduced into warfare gradually during the 18^{th}, 19^{th} and early 20^{th} Centuries. A few military leaders saw the potential of these weapons during this long period and employed them to great effect. But when World War I began, the basic tactic for attacking the enemy was the same used as many preceding centuries - line up the infantry shoulder to shoulder and march them forward. It was only when a combination of battlefield stalemate and huge casualty numbers caused mutinies and political unrest that military leaders sought ways to exploit the rifled weapon.

b. For twenty years, computerized geographic information has been making a gradual appearance on the battlefield. And like the gradual introduction of rifled weapons over 200 plus years, the gradual introduction of computerized geographic information tools has not been matched with a refinement of processes or tactics for using digital geographic maps. A few military members who understand computerized geographic information use it and the new tools associated with it but they are a small minority. Most people still think of geographic information as a paper map and use it accordingly. This manual explains how computerized geographic information is different from previous geographic information systems and it discusses new possibilities created by this new technology. The hope is that by this discussion, computerized geographic information will make advances as significant as the understanding and use of rifled weapons.

c. Geographic information is any information that includes a location. A location can be stated as latitude and longitude, military grid reference coordinates, street address, city, state, country or numerous other ways. Probably more than 80 percent of all information includes a location and, therefore, can be categorized as geographic information. An element of information can be categorized as both a piece of geographic information and as a piece of another type of information. For example, the statement that a ship is at 45 degrees north and 20 degrees west is both a piece of geographic information and a piece of operational information. To categorize a piece of information as geographic information is to indicate that it can be displayed on a map.

d. Computerized geographic information is geographic information stored in a computer. To categorize a piece of information as computerized geographic information is to indicate that it can be displayed on a map and used by those software applications that can manipulate data based on location. For example, some computer applications can group data points based on an area in which they are located and then count all points within each area.

e. The term "geospatial information and services" is defined in Joint Publication 1-02, *DOD Dictionary of Military and Associated Terms* and Joint Publication 2-03, *Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations*. The term "geospatial information" is not defined in either publication but Joint Publication 2-03 indicates that geospatial information is that information which provides the foundation information (e.g., roads, rivers and buildings) for battlespace visualization. A detailed discussion of geospatial information and services, geospatial information, and geographic information is located in Appendix A, "Relationship of Geographic Information and Geospatial Information."

f. When geographic information is stored in a computer database, it can be updated quickly and easily transferred from computer storage to map displays. It is also possible to combine geographic data in ways that were previously difficult or impossible. A commander can see a display icon move across his computer map as the vehicle it represents moves across actual terrain. A commander can later replay the vehicle's movement using geographic data stored in a database.

g. For general users, computers have introduced high geographic information accuracies that were previously impossible.

103. Glimpse Into the Future

a. Some global positioning system (GPS) receivers can determine the location of a potential target within one meter. Some weapons, guided by GPS receivers, also have this accuracy. This provides a potential to hit a target with a single round every time. That is, it is possible to hit a target every time provided the location of the target is determined with a position locating system that is as accurate as the weapon's guidance system. If the target location system is not as accurate as the weapon's guidance system (for example, an older GPS system that is accurate to within 100 meters), the weapon will be guided to a location determined by the less accurate target location system. The probable result will be that the weapon will not hit the actual location of the target. Thus, a potential to hit a target every time comes with a potential to miss a target every time. The potential to miss a target can be minimized if those acquiring and processing target locations understand (1) the implications of improved position-location accuracy and (2) the accuracy of systems that provide target locations and weapons guidance.

b. Computerized command and control systems can potentially provide maps that are far more accurate than the current map displays in tactical units. Changes can be reflected on a computer map as fast they are detected by a sensor or reported by a patrol. Rapid revisions of map displays in tactical units require that operators of computerized command and control systems understand the basics of visual information display. When the National Imagery and Mapping Agency (NIMA) prepared all maps used by the military, NIMA's cartographers ensured that maps were well designed with important features highlighted and obvious. Maps were designed with a skillful use of color and symbols. Camouflage experts and cartographers both use shape and color. A camouflage expert uses color and shape to hide important features and draw attention to decoys. A cartographer discards less important information and uses color and shape to draw attention to the most important map features. Operators of computerized command and control map display systems who do not understand the basics of using icons and color can unintentionally mask or hide important data and make less significant data appear important. They can easily camouflage essential information resulting in the opposite of the intended effect. However, knowledgeable operators who understand the basics of a computerized visual display of information can provide an accurate representation of a situation that is far superior to today's representations.

104. Accuracy, Generalization, and Requirements Definition. Users of new computerized geographic information technologies must understand accuracy and the importance of carefully defining requirements for map data.

a. Accuracy is a statement of how closely a piece of data correlates with reality. Absolute accuracy is impossible. There will always be some slight difference between the results of a measurement and the object being measured. Such differences are not necessarily bad; indeed, sometimes they are desirable. Generally, the greater the accuracy, the more expensive the measurement. Since no one has unlimited resources, those making measurements generally use tools and techniques that create data with an accuracy that matches that required for the intended use of the data.

b. While accuracy is often measured in numeric terms, it also applies to determining attributes of an object selected for measurement. A T-72 tank, for example, has many attributes including weight, length, height, speed, color, temperature, quantity of ammunition aboard and the type of soil on its treads. The more attributes selected for an object's measurement, the more accurate its representation can be. Again, the problem of limited assets is very important. If an enemy tank is advancing on a friendly unit at great speed with aggressive tendencies, the only attributes of the tank that are important at that time are those that deal directly with the tank threat before it does damage to a friendly unit. In this situation, the most important characteristics are tank speed and location.

c. Generalization is discarding unimportant data.

d. It follows then that anyone who exploits advances in computerized geographic information must focus on defining requirements. Only then will a user acquire that data which are important and prevent the collection of irrelevant data by intelligence and command and control assets.

105. Uses of Maps. Map usage can be divided into two broad categories: analysis and decision support during mission execution.

a. A basic problem is information overload. Military operations and many other fields of endeavor have long suffered from information overload. Information overload does not stem from an ability to produce information but rather people's limited ability to understand or absorb information. For the military, this limitation is captured in the concept of span of control. Generally, this is considered to be seven subordinate elements, although in some cases it is three, as in three fire teams in a rifle squad.

b. A solution for information overload is to reduce large masses of data to a few important pieces of information. This is performed through data analysis. For example, a single piece of important information can be derived from several pieces of data, or many pieces of less important information can be set aside because they have little significance. Doctrinal manuals have various names for important pieces of information. The Marine Corps Doctrinal Publication (MCDP 1), *Warfighting*, lists pieces of important information as center of gravity and critical vulnerability. MCWP 5-1, *Marine Corps Planning Process* identifies important information as named areas of interest (NAIs), target areas of interest (TAIs), and decision points (DPs).

c. Maps have a specific focus. Every useful map is created for a particular purpose. Just as every attack should contribute to mission accomplishment so should every map contribute in a specific way to mission accomplishment.

d. Maps can be used for analysis. One significant reason to create a map is to provide an aid for analysis of data and information. Large quantities of information are often plotted on a map and then analyzed either (1) to search for a few pieces of important information or (2) to create a new piece of information. The intelligence preparation of the battlefield (IPB) process is a classic example of map analysis. The IPB process starts with a comprehensive collection of information on areas of various types (e.g., marshes, roads and towns) and then develops progressively through these areas creating various overlays until mobility corridors are defined. The process continues as NAIs, TAIs and DPs are defined. The IPB data analysis process reduces thousands of individual terrain features and other factors to a few important abstractions such as centers of gravity, NAIs, TAIs and DPs.

e. Maps can provide decision support during operations execution. Once an operation starts, events can happen rapidly and decisions may be made almost as soon as required information is received. *Warfighting* discusses the OODA loop (the cycle of observe, orient, decide and act). It points out that the ability of a commander to traverse this cycle faster than his enemy can be the key to victory on a battlefield. Maps that support decision-making must be as simple as possible. A map's foreground must display those few icons that represent the most important data (e.g., objectives, key friendly and enemy units, NAIs, TAIs and DPs). A map background must only display enough detail (e.g., roads, rivers, towns, and contour lines) to provide viewers with context for important data icons. Using seven to twelve icons to identify important data, a viewer can quickly spot change. However, if a map intended for decision-making support displays hundreds of icons then important changes may go unnoticed, or worse, be hidden under numerous other icons that represent less significant information.

106. Outline of Manual. This pamphlet explains some ways in which computerized geographic information can be used to improve operations within a framework of (1) maps designed to support analysis and (2) maps designed to support decision-making.

a. Chapter 2, "Theory of Accurate Maps," explains how accuracy can be used as a guide to produce paper maps and computer map displays that support command and control far better than was previously possible.

b. Chapter 3, “Recognizing Common Problems,” explains some basic concepts of computerized mapping by showing problems common with computer maps. The chapter (1) provides a basis for understanding and solving problems what could be unexplainable and unnerving and (2) supports the implementation of concepts explained in Chapter 2.

c. Chapter 4, “Information Collection,” explains how information collection can be changed and improved with computerized mapping.

d. Chapter 5, “Developing a Data Visualization Plan,” explains the development of a visualization plan that supports the scheme of maneuver, fire support plan and similar operational documents.

e. Chapter 6, “Updating Digital Maps in the Field,” explains a great potential benefit of computerizing mapping – creating displays in which the important information is current and accurate.

f. Chapter 7, “Using Digital Maps in Collaboration,” explains considerations bearing on the use of computerized geographic information in collaboration.

g. Appendix A, “Relationship of Geographic Information and Geospatial Information,” explains (1) the terms geographic information, geospatial information and services, and geospatial information, and (2) the relationship between them.

h. Appendix B, “Terminology of Geospatial Information and Services (GI&S),” explains terminology in Joint Publication 2-03, *Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations*.

CHAPTER 2

THEORY OF ACCURATE MAPS

201. Purpose. This chapter explains concepts related to creating and maintaining accurate maps using computerized geographic information.

202. Background

a. Accuracy was discussed in paragraph 104. From that discussion it should be clear that an accurate map contains information that meets a user’s need. Because it is possible to generate an infinite amount of information on any area or object, it is impractical to intend to collect all available information about a particular area or entity. Those who have not thought about (1) the meaning of accuracy, (2) the huge amounts of information available on even the smallest areas and objects and (3) the practical problem of collecting and storing all available information may think an accurate map shows large amounts of information and is always current. Such is a map is impossible to build, is unneeded and, if attempted, may fully absorb many resources with little or no useful return. A map user needs maps that show only what is important to him or her.

b. Mapmaking has long been conducted with this understanding. A military 1:50,000 scale topographic map contains representations of only those features that are important to the conduct of military operations such as (1) contour lines that show the configuration of the earth’s surface; (2) symbols for highways, bridges, buildings, and vegetation; and (3) grid lines to determine location in terms of the military grid reference system (MGRS). All this information helps military map users. If information on less important features such as wildlife habitats, soil types, income distribution, and flood plains is added to military topographic maps, the maps become very cluttered. The result is those features most important for military operations are lost among map representations of features unimportant for military operations.

c. Because paper maps are difficult to change, military organizations use a technique of recording important information on acetate overlays using paper maps as backgrounds. This technique creates accurate maps. If a unit moves, its symbol can be redrawn on an acetate overlay map. If an important bridge is destroyed, an appropriate symbol or notation can be made on an acetate overlay.

d. Data displayed on an acetate overlay is often informally defined. Those using a map for planning and monitoring operations and those maintaining overlays have a common, unwritten understanding of the information displayed on the acetate overlays.

e. Computers can collect, communicate, and post information far faster than people. This ability may significantly shorten a commander’s observe, orient, decide, and act loop (OODA loop) but it requires that data be entered and displayed in a specific and precise format. Information requirements must be well defined and well documented.

f. Military organizations have long had theories and practices for formally defining their information requirements. Essential elements of information (EEIs), commander’s critical information requirements (CCIRs), priority information requirements (PIRs), and intelligence collection plans and tasks are some examples. A new aspect for many military members is defining requirements for information to be kept current on a map.

203. Blending Base Maps and Overlay Data

a. The primary reason for using acetate overlays with paper maps is that although a paper map is difficult to change, an acetate overlay is easily changed as a situation changes. Though a person can mentally consolidate information on a paper base map with information on an acetate overlay, actual information on the paper map and overlay are still stored on mediums that cannot be physically joined.

b. When a computer is used to create map displays, information on a base map and overlay information can be (1) easily changed and (2) easily consolidated. When a paper map is scanned, a computer graphic (digital) image is created. The image can be easily changed or modified using a computer graphics manipulation program. If a process called “digitization” is used to record the information from a paper map, a database is created that replicates map features such as points, lines, and areas. In a digitization database, features can be easily changed or deleted, and new features can be added.

c. The potential to combine and manipulate formerly separate information formats offers many possibilities. More varied map displays can be created from the same source information to support analysis by inspection. Plans can be produced faster by selecting appropriate data from computer databases. Information can be disseminated faster and more easily than was previously possible.

d. This means that the distinction between base maps and overlay data is different with computer maps than with paper maps but still relevant. With computerized data and maps, the question moves from what can be easily changed (e.g., digital information) or not easily changed (e.g., paper map information) to what information is important (and must be kept current) and what information is less important (and used to provide context for important information).

204. Distinguishing Between Information of Interest and Context

a. Often important geographic information that must be kept current has too few pieces to create a good map. For example, if someone drives from San Diego to Los Angeles, important information is which highway to use and potential problems such as construction or accidents. But a map that shows only a highway, construction sites and accidents is less useful than one that includes general information about major towns and cities near the highway and traces major roads that cross the highway between San Diego and Los Angeles.

b. Less important information placed on a map to make important information more understandable is called context information. Contour lines and lakes on a 1:50,000 scale topographic map are classic examples of context information. These features change infrequently and rarely are individual contour lines or bodies of water so important that the features they represent must be monitored continuously for change. Yet, such context features may make a big difference when seeking to fully understand a situation about an area of interest.

205. Developing Information Requirements for a Map

a. Presently, there are already well-established methodologies for analyzing information as part of military planning. A key is to keep a record of geographic information requirements as they are identified in the process.

b. The Marine Corps planning process and intelligence preparation of the battlefield (IPB) are two such methodologies. The biggest immediate need is to experiment with techniques and procedures to:

(1) Collect and organize requirements for geographic information as the planning methodologies are executed and

(2) Input geographic information requirements into various automated information systems and manage the results of these requirements.

206. Metadata: A Key to Using Existing Data to Meet Information Requirements

a. Given the huge amounts of computerized information in existence and the large amounts of information generated every day, guides and aids are needed to find that information which is important for a particular situation. Metadata is a standard aid for understanding information.

b. Metadata is data about data. It is discussed in detail in paragraphs 405, 409, 607 and 703.

207. Accuracy vs. Situational Awareness. There is conflict between accuracy and situational awareness.

a. Situational awareness comes from knowing the most important information. A mapmaker contributes to a map user's situational awareness by representing only important map features. Unimportant map features are left unmapped. The most important features are made to stand out using techniques such as exaggeration and displacement. The widths of main roads on a map are exaggerated to make them stand out. Icons for important buildings are drawn several times actual scale size to highlight them. If an icon hides part of a line representing a main road, the icon is displaced. These cartographic techniques trade accuracy for better situational awareness.

b. Because of these differences, a distinction is noted between (1) maps (or imagery) designed or processed for the accuracy required for precision weapons and (2) maps designed to provide situational awareness.

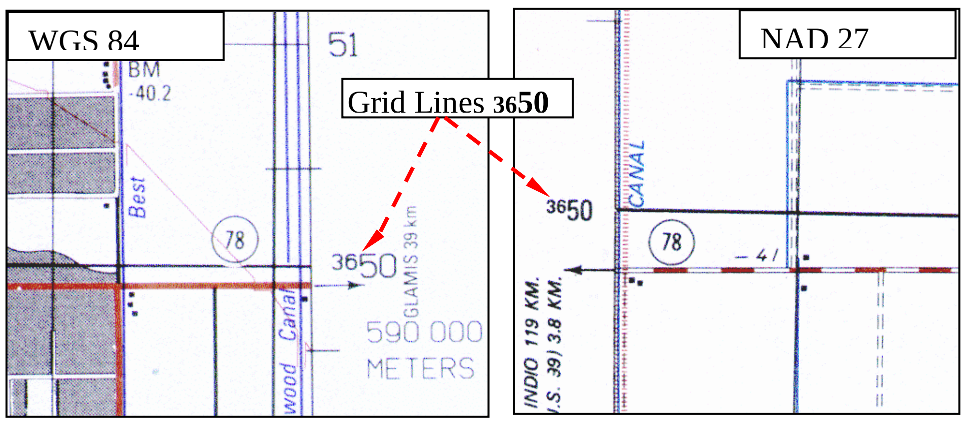
c. Both types of maps and images can and must be used together. Neither is superior; each type has advantages when used in different circumstances.

CHAPTER 3

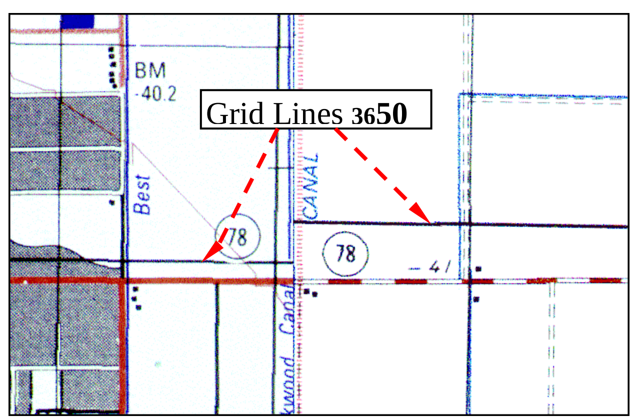
RECOGNIZING COMMON PROBLEMS

301. Purpose. To explain common problems with computerized geographic information.

302. Background. Computerized geographic information can improve the accuracy of maps and speed the transmission of data to those who need it. These characteristics can greatly improve command and control. These same characteristics, however, can also lead to confusing map displays, thus degrading, rather than improving command and control. Those who understand computerized geographic information can minimize confusion through their control of computer map displays. When displays show conflicted data, those who understand computerized geographic information can understand what they are looking at and why it appears confusing. This chapter explains some reasons why computerized geographic information can create confusing map displays.



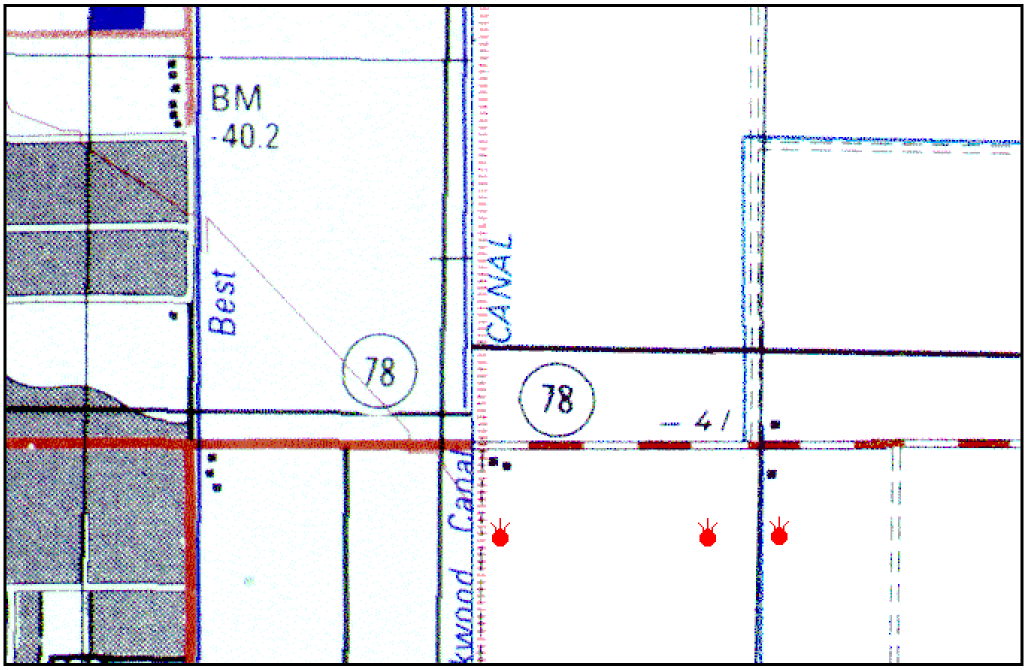
303. Datum Differences. A map that defines location in latitude and longitude, military grid reference system, or some other system, is based on a model of the earth called a ***datum***. To the uninformed, a difference between two datums may appear insignificant. However, in military operations, the difference may be very significant. The maps shown above are adjoining areas. The left map is in WGS 84 datum and the right map is in NAD 27 datum. Note that Road 78 (marked as 78) runs east to west and aligns well. But, the grid lines (marked 36**50**) and highlighted with red dashed arrows do not align. A grid location determined from a paper copy of the NAD 27 map and entered into computer mapping software without regard to datum will not plot correctly on a WGS 84 computer map display.



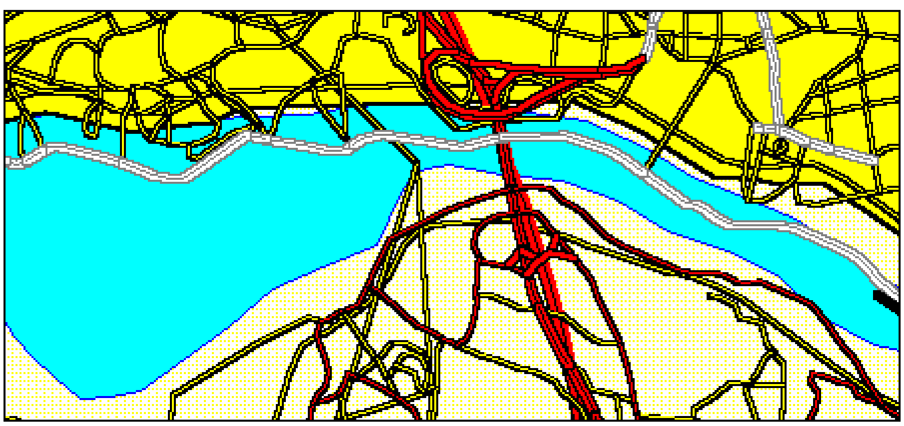
The image at right displays the same two maps with marginal data removed and features on one map electronically aligned and placed adjacent to respective features on the other map. Again, note the straight east to west road 78 alignment and the stepped and misaligned 36**50** grid line.

In the last thirty years, the difference between locations in different datums has resulted in bombs and other ordnance missing their target in combat. In these cases, target locations were determined in one datum while aircraft delivering the bombs measured their location in another.

304. Datum Shift. A datum shift occurs when information collected in one datum is displayed against a map that was created in another datum. In the image below, the bursting bomb icons represent the location where three bombs landed. One was aimed at two buildings next to the canal. One was aimed at a truck on the road. The last was aimed a building south of the road. All bomb impacts were offset about the same distance and direction from their intended target. This consistent offset is a telltale indication of datum shift.

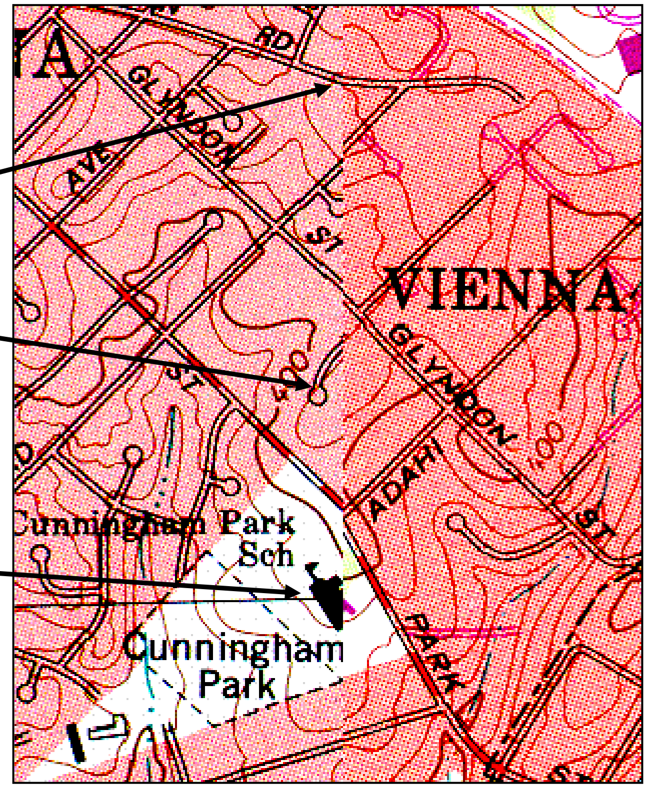


305. Displaying Data of Varying Accuracy. Networked computers can bring together map information of varying accuracy. For the uninitiated, this may cause significant confusion.



In the map image above, city streets appear to be located in a river. Actually, data lines representing the edges (or banks) of the river have been highly generalized. The lesson learned is that with greater generalization comes decreased accuracy. Lines representing streets in the map image are much less generalized and therefore much more accurate. The lines representing the river's edge were digitized from a small-scale (less-detailed) map and the lines used to represent city streets were digitized from a large-scale (more-detailed) map.

306. Conflicts Between Data Assembled at Different Times. The map image below was created by electronically combining digital map images from two U.S. Geological Survey (USGS) maps of Vienna, Virginia, drawn at different times using data collected at different dates.



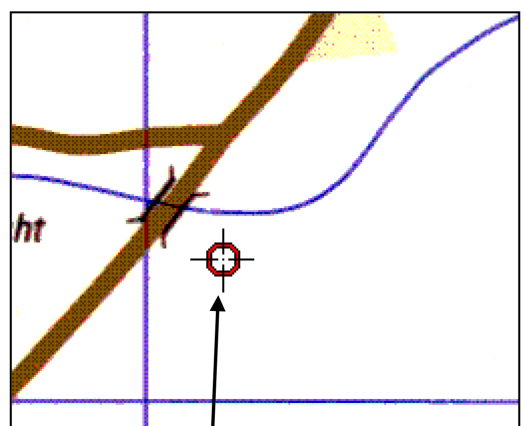
The two images are joined down the center of the map. The newer image is on the left (west) side. The road at the top aligns nicely.

The cul-de-sac and road in the middle of the map are represented only on the newer map image to the left. There is no trace of the road on the right side of the map centerline.

Similarly, the Cunningham Park School building is displayed only on the newer map image and not on the older map (east) image.

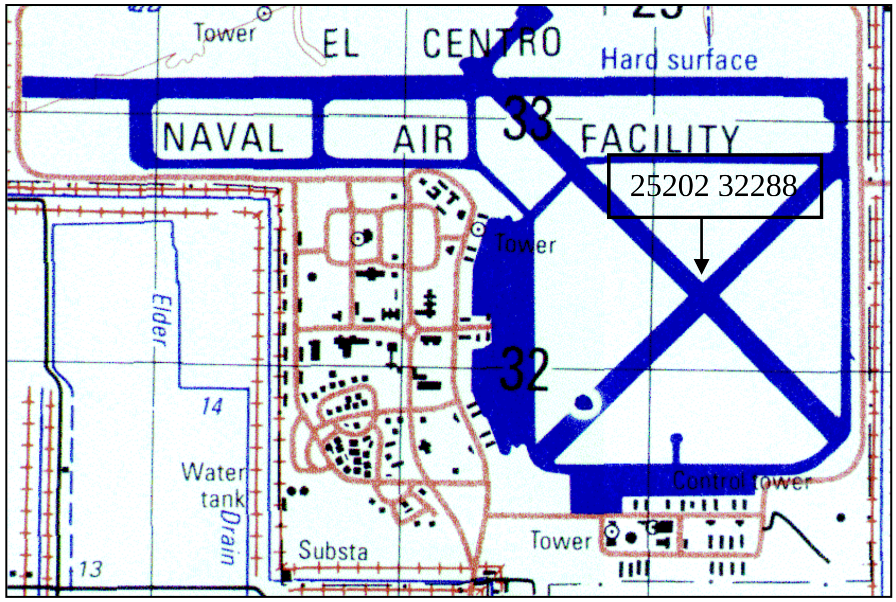
Such discrepancies are inevitable as the transition from paper maps to computer maps slowly unfolds. Because new digital maps, such this example, contain large amounts of accumulated data, the elimination of all map conflicts such may decades, if not centuries.

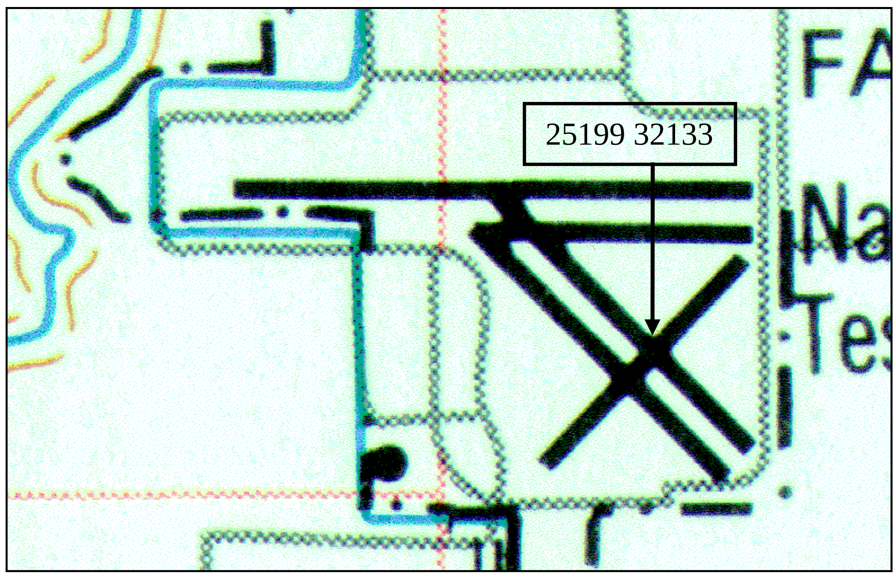
307. Icons Representing Precisely Located Targets. The capability of military forces to determine precise locations has increased greatly in the last few decades. Maps, however, continue to be produced with the same accuracy as before. There are reasons for this. One is that the primary purpose of a map is to aid understanding. Another is that those who make maps for general users need to produce as many maps as possible within allocated funding. This is achieved by making maps with only that level of detail and accuracy required by general users.



The map at the right shows two roads, a stream, and a bridge. The general user needs to know the location of these features with an accuracy that is sufficient to find any of them when traveling on the road. The alignment and accuracy of the road, bridge and stream on the map are sufficient for that purpose.

If the bridge's location is measured precisely (e.g., GPS receiver), the bridge might really be located as shown by the target icon. There is a significant offset of the target icon from the bridge icon on the map. Because a very accurate location is required for a GPS-guided bomb to hit the bridge, a map display might show two separate locations for the same bridge.



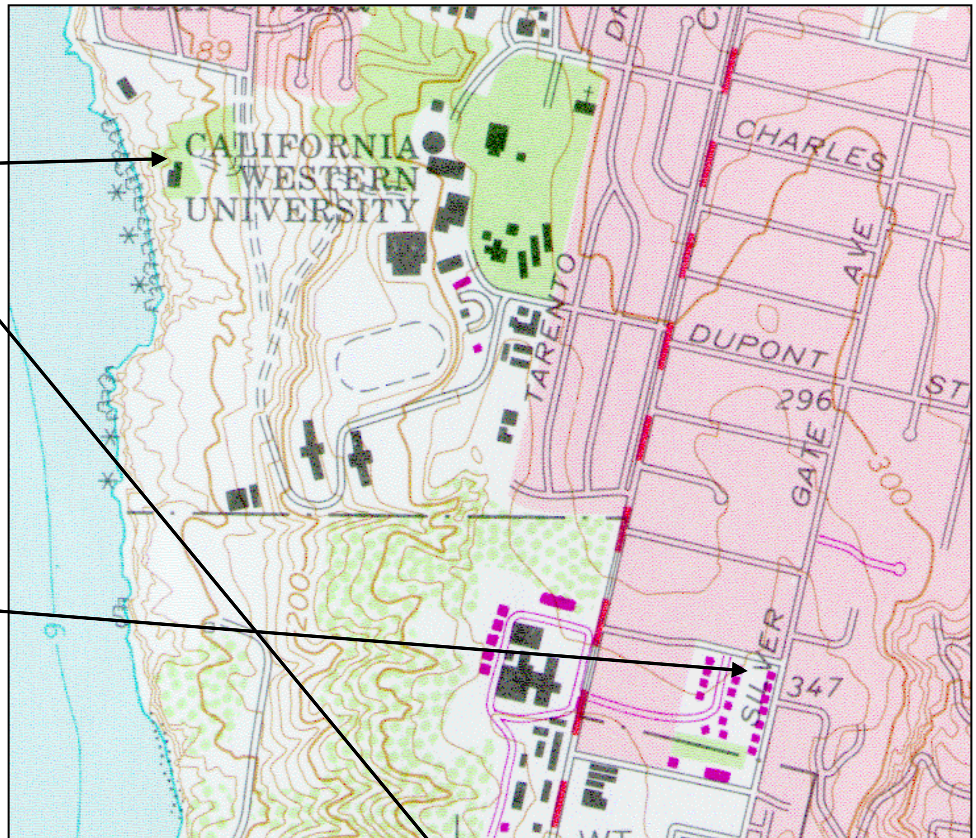


The two maps (right and below right) show the same airfield. The maps have different scales. The top map is 1:50,000 scale. The bottom, 1:250,000 scale. The top map has a horizontal accuracy of 50 meters. The bottom map has a horizontal accuracy of 125 meters. As a result, the location of the intersection of the runways is different on the two maps. On the top map, the location is 25202 32288 MGRS. On the bottom map, the location is 25199 32133. This is a difference of about 155 meters.

Those just starting to understand computerized geographic information may question why a map with two icons for one bridge is acceptable. They may wonder how it can be acceptable for two maps to have different locations for the same runway intersection. The answer is that there is no practical alternative. There are too many places that must be mapped. There are too many features in each place to be mapped. Map users must understand computerized geographic information well enough to see and understand map displays such as those above and use icons appropriately and maps intelligently.

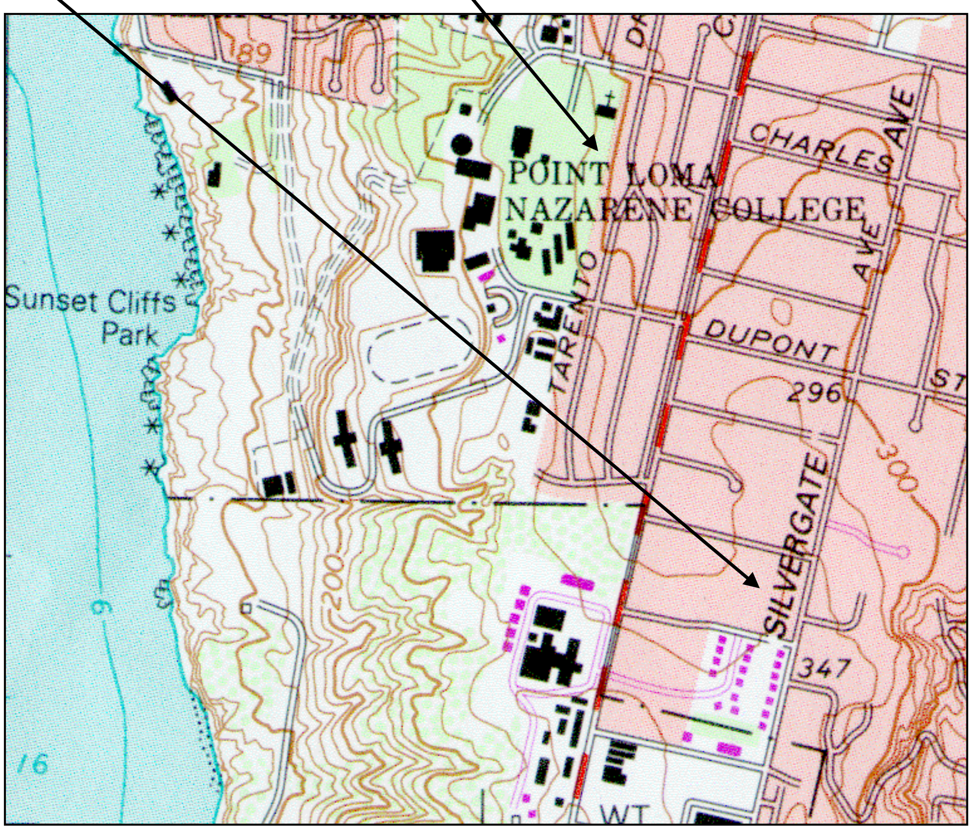
308. Mixed Data from Different Maps. Before computers were used easily for mapping, paper maps were the heart of geographic information. Now, widespread computer use has established databases as the heart of geographic information. The capability of computers to store and subsequently display database information as electronic map displays means that data from two or more maps of the same area, created years apart, can be easily combined. This capability has advantages such as facilitating change detection. But, if two or more maps use different methodologies to identify identical features, then a single feature may have two names or characteristics when the maps are combined. The map images located on the next page provide an example of this. The map data are real.

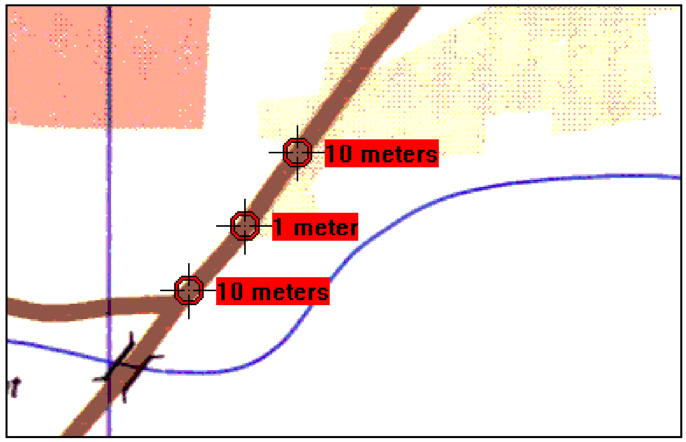
Note the different names for the same university - college. In the upper image, the name is "California Western University." In the lower image, the name is "Point Loma Nazarene College."



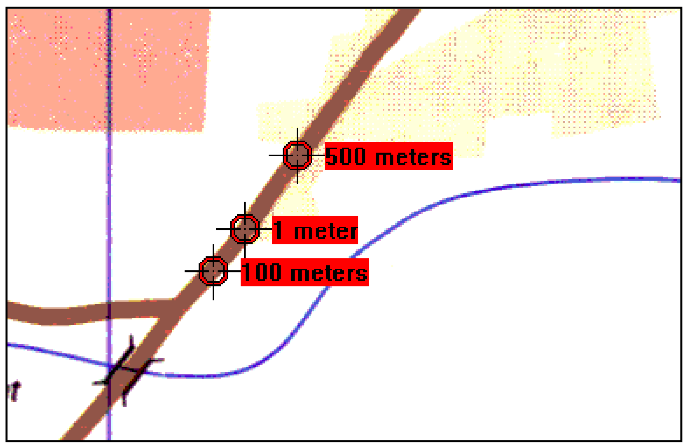
Note that one street has two different spellings of the same name. In the upper image, the spelling is "Silver Gate Ave" (with a space between Silver and Gate). In the lower image, the spelling is "Silvergate Ave" (with no space).

If data were entered into a database based on the name of the university or the spelling of Silver Gate Ave (both in the upper map), a user of the lower map image would have trouble retrieving information related to those features. The database would not recognize the different school name and street name spelling.



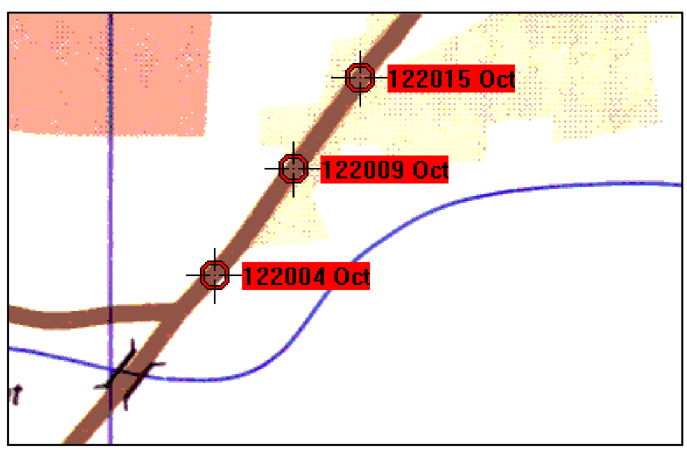


309. Displays of Data of Mixed Accuracy. The multitude of data collection assets being fielded produces a potential for assets of different accuracy to produce different data results from one data source. This may result in a computer map display showing simultaneous multiple locations for one object. The map image at right shows an example of how this might appear. There are three icons for one or more vehicles on a road. The data next to each icon represent the accuracy of the collection asset. The challenge is to determine whether there are one, two, or three vehicles. Because there is little difference between the accuracy of the collection assets and because the collection assets are very accurate, the three icons probably represent three different vehicles.

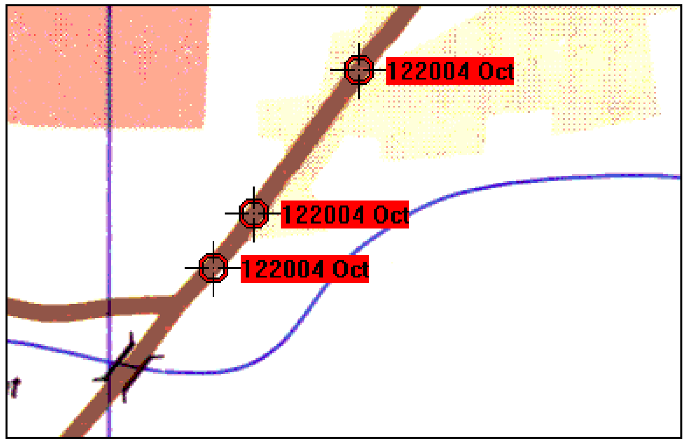


In the figure at right, the accuracy of each collection asset is again noted next to each vehicle icon. This time two collection assets are relatively inaccurate. This suggests that the three icons represent two or more vehicles.

310. Displays of Data of Collected About the Same Time. Collection assets can also produce multiple locations for one object at slightly different times. The times when data are collected may aid in determing whether a group of icons represent multiple vehicles or one vehicle.



In the map at right, the icon times are a few minutes apart in progression from southwest to northeast. This suggests one moving vehicle.



In the map at right, icon times are identical. This suggests that a different vehicle created each icon.

Identifying the time when data are collected may be a problem because computer systems can attach a time tag at several different points during the collection and processing of data. The first opportunity to attach a time tag is when data are collected (i.e., the collection assets detects the reported object). A second opportunity to attach a time tag occurs when data are transmitted. A third opportunity occurs upon receipt of data by another system. Thus, a time tag does not automatically state when a data element was created.

311. Conclusion. Computerized geographic information enables map displays to be created by combining data from a variety of sources. These maps have a potential to be very accurate and timely to a degree that was previously impossible. But this same capability can also create curious and ambiguous map displays such as were shown in this chapter. Understanding how ambiguous displays are created will enable computer map users to benefit from new capabilities without being unnerved by inevitable problems such as were discussed here. Further, since potential enemies will seek advantages whenever and wherever they can, we must expect future foes to understand our collection assets and to create circumstances that provide us with ambiguous and confusing map displays from raw data sensors. As always in warfare, there is be no substitute for the situational awareness that results from understanding process and equipment limitations.

CHAPTER 4

INFORMATION COLLECTION

401. Purpose. To suggest how computerized geographic information may affect information collection and its use by military units.

402. Background

a. Skillful military users of global positioning system (GPS) equipment, computerized geographic information software and similar tools can improve:

(1) Situational awareness and

(2) The accuracy and timeliness of fires.

b. Situational awareness can be improved markedly because:

(1) GPS and other precision locating systems enable general users to determine location far more accurately than was previously possible.

(2) The traces of linear features such as roads and the edges of areas such as lakes and swamps can be determined very rapidly and accurately using GPS equipment and other data systems that store or report locations of people or vehicle movements at specific and frequent time intervals.

c. However, there is a conflict between accuracy and situational awareness.

(1) Situational awareness comes from knowing the most important information. A mapmaker contributes to a map user's situational awareness by representing only important map features. Unimportant map features are left unmapped. The most important features are made to stand out using techniques such as exaggeration and displacement. The widths of main roads on a map are exaggerated to make them stand out. Icons for important buildings are drawn several times actual scale size to highlight them. If an icon hides part of a line representing a main road, the icon is displaced. These cartographic techniques trade accuracy for better situational awareness.

(2) If the potential of terminally guided weapons is to be fully realized, the accuracy of target data stored in computer databases cannot be compromised. Thus, while an icon representing an important bridge or building may be displaced on a map display used by a commander, the actual database location of the bridge or building must remain unchanged when used for targeting.

d. Also, there is a need to pay close attention to certain technical matters that do not concern general users. The most important of these technical matters is the datum.

e. Before widespread computer usage, it was difficult to quickly disseminate large quantities of geographic information. Specifically, it was very difficult to create and disseminate map updates.

f. This chapter explains methods to overcome problems created by (1) mapping techniques such as generalization and displacement and (2) the potential capability to update maps. In practice, these methods blend together.

403. Check Datum of Data. Of all attributes of geographic information, none causes users more problems than failing to know the datum of the map data in use. In the last twenty years, datum problems have repeatedly led to targets missed by bombers and U.S. forces disputing boundaries. Because of the ease with which geographic information can be used by computers and rapidly moved over networks, users should not assume that all the available computerized geographic information is in the same datum. This was usually true when the primary source of geographic information was paper maps. It was difficult to move information between data sources (i.e., paper maps) and it was difficult to mix data in different datums.

404. Check Scale of Data. Just as a commander has critical information requirements and priority intelligence requirements, so too every mapmaker has unique requirements. Every mapmaker focuses on producing a map that is useful for a particular purpose. Towards this end, detailed roads, rivers, and other linear features are drawn with as few points as possible. A map user can see this by comparing one river on small-scale and large-scale maps. On a large-scale map such as a NIMA 1:50,000-scale map, the Mississippi River has numerous twists. These twists are progressively simplified with each smaller scale map created of the Mississippi River until on a map of the entire United States all river twists are removed; the Mississippi River appears with only a few gentle curves. This progressive removal of twists in a river is called generalization. When all maps were made of paper, it was easy to determine generalization; it varied directly with map scale. This easy determination was removed when computer vector and raster maps were created. When viewing a computer map display, users may have difficulty determining map scale; if it cannot be easily determined the map may be used incorrectly.

405. Check for Metadata. Metadata are data about data. A book footnote is a type of metadata. Footnotes state data sources and either state or suggest data accuracy. Good map metadata lists, among other things, a map's scale, its creation date, and the organization that produced the map. Good metadata is important because potential problems may arise when computerized geographic information is easily and rapidly transmitted through computer networks. It is now easy to (1) disseminate inaccurate geographic information and (2) bypass safeguards used when NIMA maps are prepared and distributed to the military. While electronic mapping has provided a potential to determine locations far more accurately than was possible previously, it has also provided a potential for map inaccuracy previously unimaginable. Metadata use is essential to prevent the inadvertent use of inaccurate maps.

406. Compare Imagery and Maps. NIMA revises its maps on average about once every four years. This means that on average about one third of NIMA map information covering urban areas is incorrect. This is not a new circumstance. Now, what is new is that aerial and satellite imagery can be compared with maps much easier. Programs such as ArcView and Command

and Control Personal Computer (C2PC) can display both imagery and maps. Using this capability, electronic maps and imagery of an area of operations can be entered into a computer mapping system and compared. Some programs require that a user switch between images. Other software allows a simultaneous display of a map and an image with a capability to adjust (or fade) either as the other brightens. This capability enhances the rapid identification of changes and improves situational awareness.

407. Check for Datum Shifts. Of all possible mapping problems, none is potentially more serious but easily spotted than a datum shift. This may occur in a base camp when readings from a GPS instrument set to WGS 84 datum is checked with readings on paper maps and computer maps. If there is a consistent and noticeable difference between numerous GPS instrument readings and the paper and computer maps, the maps may not be in WGS 84 datum. Remember, the fact that a map states it is in WGS 84 datum is no guarantee that it actually is. A great deal of recent geographic information is mislabeled regarding datum information.

408. Use of Digital Images. Usually digital images are not computerized geographic information. However, because a digital image is a separate object or file and may represent a particular feature or place, it may be assigned a geographic location (i.e., be georeferenced). Once a digital image is georeferenced, it can be incorporated into geographic database and displayed by most mapping software.

409. Reconnaissance. The introduction of computer maps and GPS has significant implications for reconnaissance. First, information now collected by reconnaissance units may be much more accurate than was previously possible. Second, reconnaissance units must expand their activities to include checking and verifying the geographic accuracy of important targets or areas of interest. Is a bridge really at the coordinates stated? If a bridge's location is determined using a small-scale computer map, its actual ground position may be hundreds of meters from its computer database location. Other reconnaissance geographic considerations include:

a. Locations of critical facilities.

b. Important structures that have been removed.

c. Fields of observation blocked by new structures.

d. New structures that may serve as observation posts or provide better sites for communications antennas.

e. Traces of new or improved roads.

f. Characterization of roads in disrepair or abandoned.

g. Altered rivers, streams and other watercourses.

h. Areas where local alliances have changed.

i. Locations of obstacles and minefields.

j. Metadata collection.

410. Use of GPS to Plot Roads and Other Linear Features and Areas. The capability of GPS receivers to determine and save a sequence of points can be used to record the trace of a road or other linear feature, or the outline of an area. A GPS device can be mounted on a vehicle or carried by an individual. Data collected by a GPS device can be saved with a data recorder or transmitted to a headquarters needing the information. When using GPS devices to collect a trace of linear objects or an outline of an area, it may be necessary to discard many points. GPS devices can collect several measurements in one minute. If a GPS device moves slowly or down a long straight line, many collected points will add no value to the data collection while filling limited space on a computer hard drive. Discarding data points is called generalization. When done skillfully, generalization does not detract from the precision of information while greatly increasing its usefulness.

411. Exploiting Precision Location Devices

a. Understanding the accuracy of devices that collect geographic information is very important because some are markedly less accurate than others. GPS devices and laser range finders are accurate data collection devices.

b. Weapons designers use the accuracy of geographic information collection devices by incorporating them into weapons. For example, a GPS-guided bomb is very accurate. However, if a GPS-guided bomb is targeted with geographic information data from a collection device that is less accurate than the bomb's GPS device, there is a strong chance the bomb will be guided to a point other than the target. An unfortunate aspect of GPS and similar precision location systems is that the chance of hitting a target is markedly increased when accurate target location information is used but when less accurate or inaccurate target location information is used, the target will be continually missed no matter how many rounds or bombs are delivered.

c. This means that:

(1) Locations of potential targets must be determined using geographic information collection systems with the same or better accuracy as the weapons to be used.

(2) Using a weapon with a very accurate guidance system against a target that is located with a relatively inaccurate target location system will likely result in the target being missed.

(3) Metadata that indicates data accuracy is necessary for computerized geographic information.

412. Managing Data on Vector Overlays

a. Reasons for Vector Overlays. Accumulated geographic information data is best exploited by displaying it. Generally, after new data is stored in a geographic information database, it is displayed as vector points, lines or areas. Vector points must be assigned an appropriate icon. Lines and areas must be assigned an appropriate color, width, fill pattern, etc.

b. Creating Vector Overlays. Displaying too much geographic information may hide important features or targets in a sea of less significant information. Often it is best to place the most important information on one overlay or layer and use a series of supporting overlays. Putting all available data on one overlay can reveal at a critical moment in an action that the most important information is difficult to see on the overlay.

c. Updating Overlays. As information is updated, it should be placed in appropriate overlays or layers. Sometimes, existing overlays can be reused. However, at other times, it may be best to create a new overlay or overlays using new information. Users of information displays are well advised to produce too many rather than too few overlays. It is easier to combine overlays or simultaneously display several overlays than to separate information displayed on one overlay into several overlays.

CHAPTER 5

DEVELOPING A DATA VISUALIZATION PLAN

501. Purpose. To discuss development of a data visualization plan in support of the execution of an action plan. Also discussed are some considerations that bear on a data visualization plan.

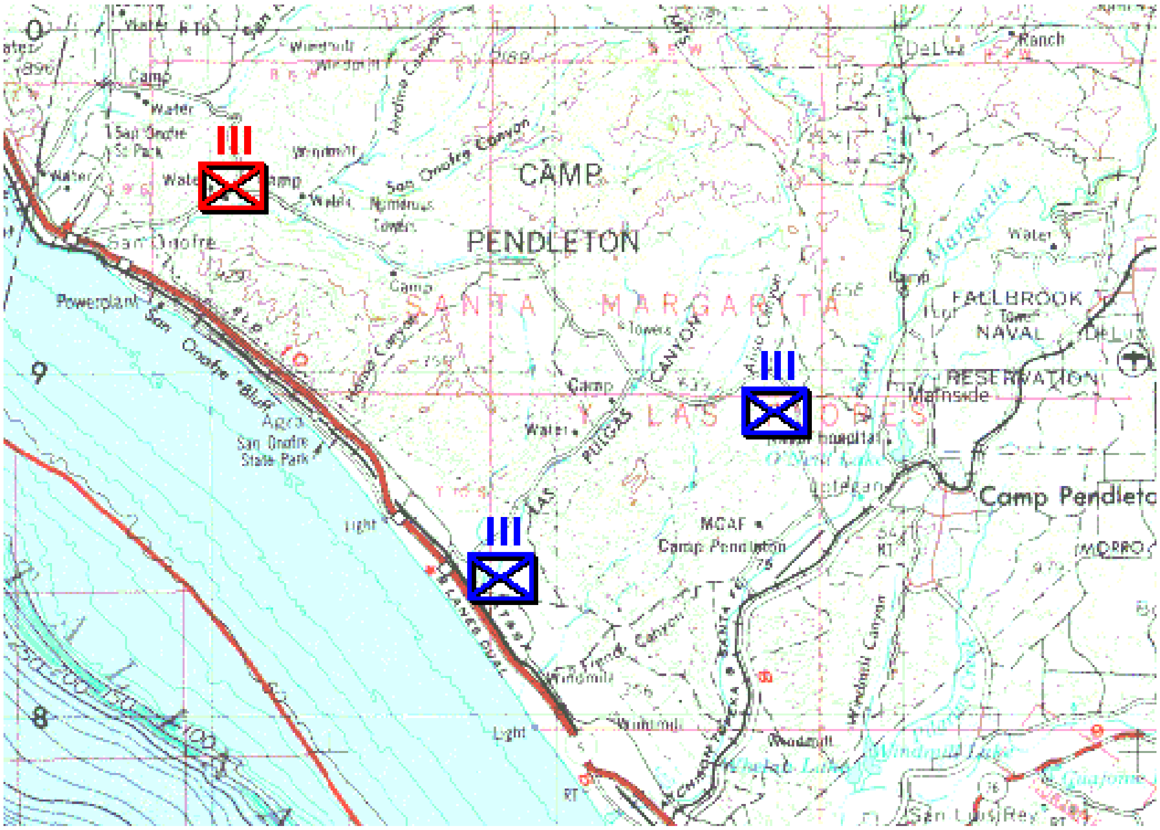
502. Background

a. Computerized command and control systems often include a capability for many different map displays of information. Previously, paper maps limited the capability to customize map displays. Paper map colors could not be changed. Paper map icons or feature lines could not be enlarged or brightened to highlight them. Today's computer map displays can easily change color, enlarge icons or highlight features or objects. Less important features can be removed to minimize map distractions. Preparations for an attack have long included development of a (1) scheme of maneuver and (2) fire support plan. These plans are a means to exploit a wide variety of methods for attacking units to maneuver and use fire support for mission accomplishment.

b. To fully exploit the flexibility of map display systems in computerized command and control, users must develop a plan of data visualization that complements and reinforces other plans such as those for maneuver and fire support. A visualization plan should exploit the wide variety of ways in which information can be displayed. Its aim should be to present information so the most important information is readily apparent. To shorten the observe, orient, decide and act loop (OODA Loop), an effective data visualization plan is essential.

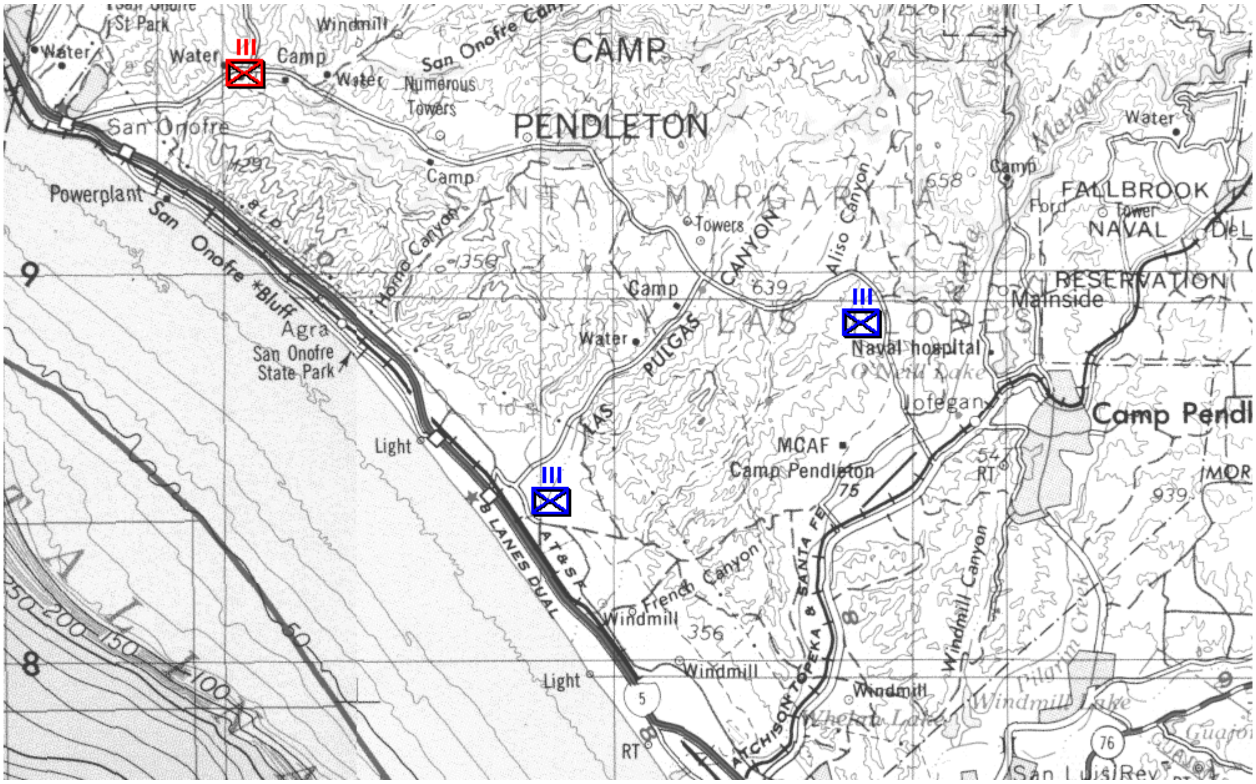
503. Glimpse Into the Future. When techniques of intelligence preparation of the battlefield (IPB) are implemented with computerized command and control software, important information can be highlighted better than was previously possible. For example, to easily draw the attention of watch officers and commanders to an electronic map display of an attacking enemy force, less important map information can be presented in gray and muted colors while a large, flashing and brightly colored icon can represent the attacking enemy force.

504. Data Visualization Techniques. There are several basic techniques used in a visual presentation of information.



a. Use strong colors for symbols that represent important information. In the map above, an enemy infantry regiment and the two friendly infantry regiments are the important map objects; they stand out because they are represented with standard military symbols and strong colors.

b. Use a background or base map with only enough detail to frame and enhance understanding of the important information displayed against it.

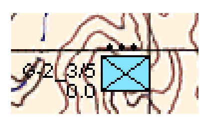


c. Muted or gray map colors (i.e., grayscale base maps), as used in the above map, highlight important information while diminishing the presentation of background or context features.

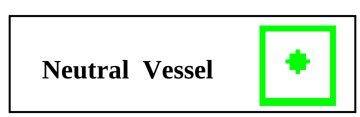
d. To be most effective, a mapmaker should focus first on the foreground – the objects of greatest importance on the map. After these objects are identified and represented, an appropriate background can be selected or composed. If several background raster maps are available, the map that best highlights the important foreground information should be chosen. If vector data are used for a background, they should be varied in color and line width to indicate relative importance. The most important linear objects should be represented by the widest lines.

e. Use appropriate symbols. Examples are *DOD Interface Standard (Common Warfighting Symbology)* MIL-STD-2525B and dot symbols. Examples of standard symbols are:

(1) MIL-STD-2525B Symbol. The image at right is the symbol for an infantry platoon. The text to the left of the symbol provides a unit designation.



(2) Navy Tactical Data System (NTDS). The image at right is a sample of NTDS data.

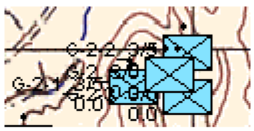


(3) Dot Symbols. These are particularly useful when a large number of incidents are represented over a base map with the intent of finding patterns by map inspection.

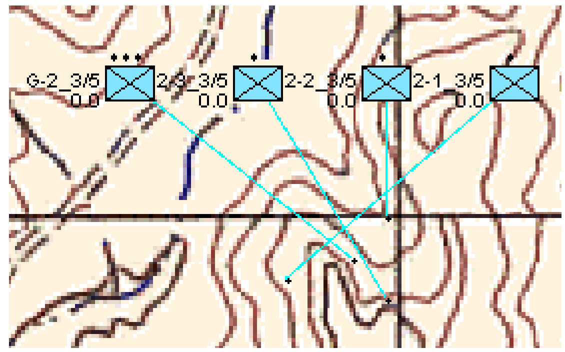
f. Prevent clutter and the information overload that accompanies clutter by representing only necessary detail. Standard techniques for preventing clutter and information overload include:

(1) Filtering. Filtering is performed with database or mapping software. Software provides a method for selecting a specific data feature (e.g., all tanks, roads or lakes).

(2) Decluttering. Many mapping programs use a decluttering tool to clarify cluttered map presentations. The figures below display a map before and after a declutter tool is used.

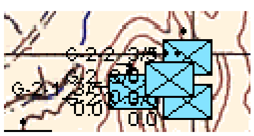


Before declutter

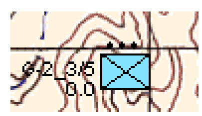


After declutter

(3) Hiding Selected Objects. This mapping software feature hides or filters out selected individual rather than entire object categories. The figures below display a map before and after hiding individual features. The figure below left displays a platoon headquarters and its squads. The figure below right displays only the symbol for a platoon.



Before hide



After hide

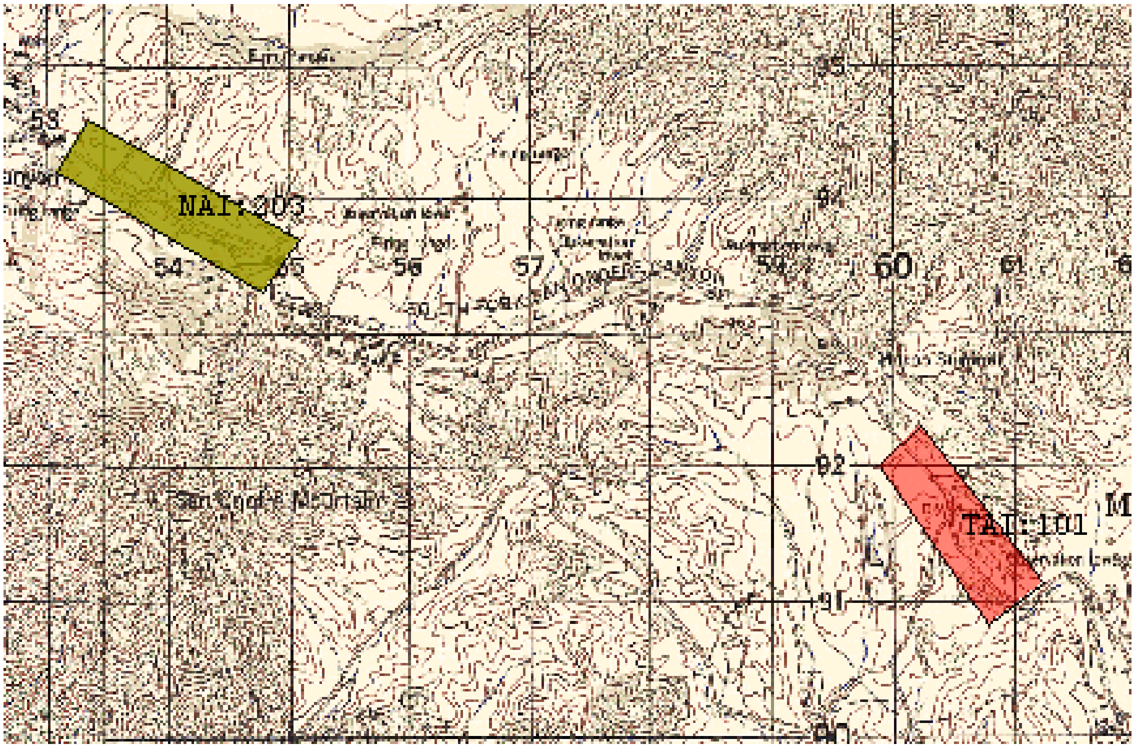
(4) Aggregating Objects. Aggregation is similar to hiding. The primary difference is that the hide feature filters out user-selected individual objects. When objects are aggregated, software selects the objects to be hidden based on user criteria. Some examples are:

(a) A user specifies that a map display only those units larger than a company.

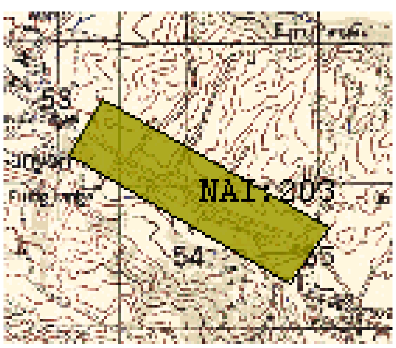
(b) A user specifies that all units in 2d Battalion, 4th Marines will be aggregated and represented by a single icon located at battalion's headquarters.

(5) Varying Tint of Vector Overlay Objects. Most mapping software programs include features that permit users to vary the tint of an object. Tint has two components, color and transparency.

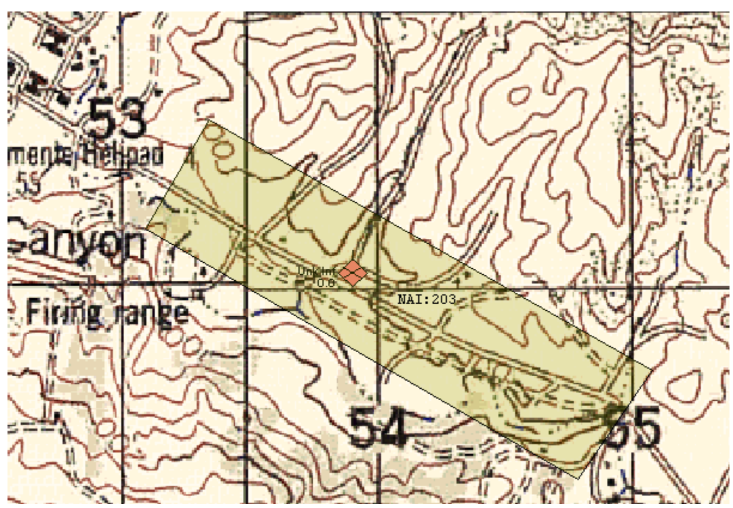
(a) Color can be varied as shown in the figure below. One area is yellow-green and the other is orange-red.



(b) Transparency can also be varied. In the figure below left, the vector NAI feature obscures most of the area it covers. However, by increasing transparency as shown in the figure below right, the map displays most of the detail beneath the NAI.

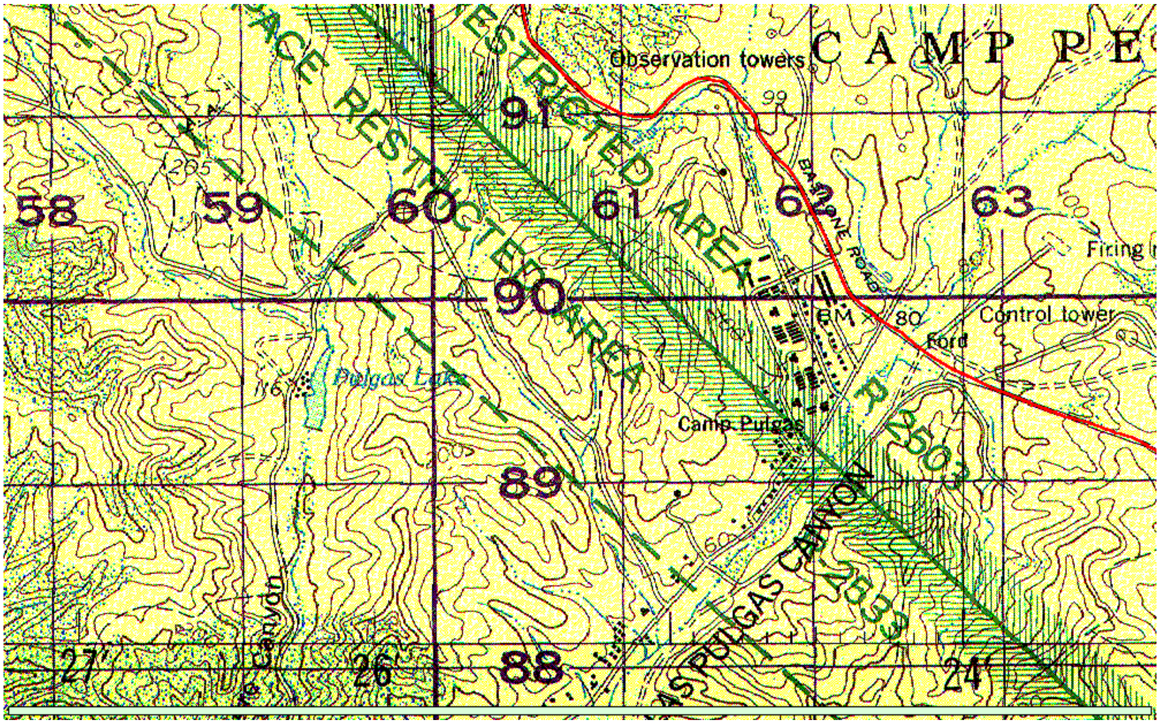


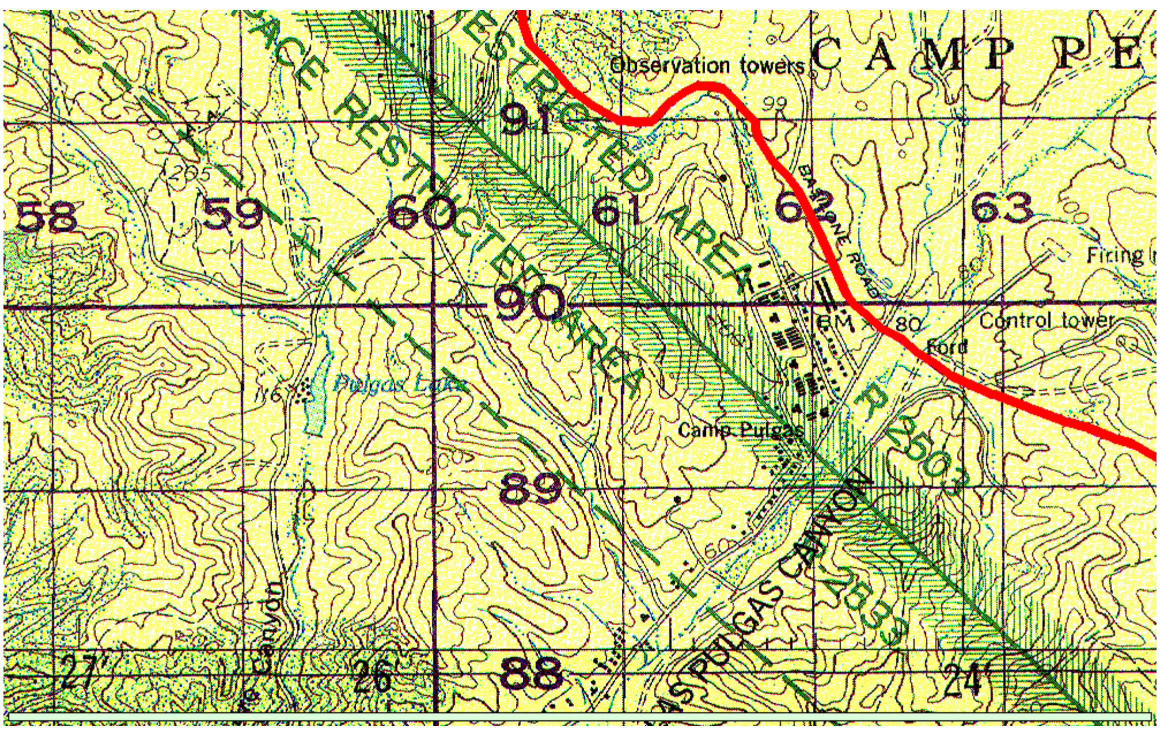
Little transparency



Generous transparency

(6) Varying Line Width. Thicker lines on a map usually represent more important features. In the first figure below, Basilone Road is represented with a thin red line (i.e., a vector map overlay feature). Using mapping software, the Basilone Road line can be thickened (i.e., increased in width) to highlight its importance in upcoming action. The second figure below shows a thicker Basilone Road line.





505. Process

a. Identify Important Features. The key to creating effective customized map displays is to identify and accentuate important features while de-emphasizing less important map display information that provides only background or context. Intelligence preparation of the battlefield (IPB) and MCWP 5-1, *Marine Corps Planning Process* provide methodologies for identifying important information. These methodologies also provide a guide for determining which map information should be displayed as background or context and which information is unimportant. Named areas of interest (NAIs), target areas of interest (TAIs), and decision points (DPs) identify important aspects of an anticipated action or situation.

b. Develop Coloring Scheme. Colors are used to identify various types of map features. Red icons may be reserved for enemy identifiers with a set of larger than normal icons used to represent particularly important enemy units. Background terrain may be colored with (1) varying shades of gray (i.e., grayscaled) or (2) muted shades of blue, green or red.

c. Implementation. A color scheme must be implemented.

(1) As colors are adjusted to match a data visualization plan, ensure that the meaning of map features are not accidentally changed. For example, changing a green wooded area to dull blue might inadvertently create the impression that the wooded area is a lake.

(2) Strengthen Icons, Lines, and Polygons. As action unfolds, a computer map user's eye must be drawn to important features. If an icon representing an enemy unit appears on a map, a watch officer should be able to see immediately if the enemy unit is near key terrain. If key terrain is represented by icons, lines, and polygons that standout or are highlighted from the map background, it will be easier to determine the proximity of a hostile element and key terrain features.

(3) Represent the information generated by the IPB process.

(4) Prepare overlays representing anticipated actions.

(5) If an operation has various phases, prepare overlays that can be displayed in a phased manner.

CHAPTER 6

UPDATING DIGITAL MAPS IN THE FIELD

601. Purpose. To explain updating of digital maps using computerized geographic information.

602. Background

a. National Imagery and Mapping Agency (NIMA) revises its maps every six to ten years. Thus, on average, NIMA's maps are four years old. Given the cost and effort required to maintain all the maps for which NIMA is responsible, six to ten years is the best revision time that can be hoped for. Computerized geographic information and associated software provide the potential means to have current and accurate maps to meet users' needs despite NIMA's limitations.

b. The key to this potential improvement is shifting the primary location of geographic information from paper maps to computer databases. When geographic information is stored on a paper map, it is difficult to change information because a paper map is difficult to change after it's printed. However, computer databases are easy to change. If a building is torn down, its record can be removed from a database or be annotated to note that the building no longer exists. Computer maps based on an updated database will show the building is torn down or will display an icon indicating the building is removed.

c. The basic technique of using forces operating on the ground to gather information in the field for subsequent use in revising or supplementing maps is not new. The major difference now is that with computer-based information, a potential exists to disseminate revised important information within seconds of its discovery. This compares to days or even years in the past.

603. Glimpse into the Future. The basic approach for updating digital maps such as NIMA provides is to overlay new data on a digital map or to modify the map locally. The potential result is a map as current as the latest information available in the field. Additionally, the capability of computer networks to rapidly disseminate information makes it possible for adjacent, higher, and supporting or supported units to have a high level commonality of understanding of a situation that was impossible before the introduction and use of computer mapping. The capability to determine locations with GPS devices, laser range finding equipment, imagery interpretation techniques and other modern technologies enables military members in the field to collect geographic information to an accuracy previously impossible to all but a few specialized topographic units.

604. Focus on the Important. This is the key to producing useful, current and accurate maps through the exploitation of computer mapping.

a. It is important for those who realize this potential to understand that an infinite amount of information can be generated on any area, regardless how small. Although rarely mentioned, this concept has long been understood and reflected in military doctrine and techniques. For this the reason commanders develop their critical information requirements (CCIRs) and priority intelligence requirements (PIRs). All commanders and their staffs must focus on collecting and updating geographic information that is important for mission accomplishment. If a category of information is interesting but not particularly important, it should be checked and updated only if time allows. If a category of information is unimportant, it should be ignored.

b. Those who do not have experience in maintaining databases tend to underestimate the amount of time and effort required to update a database. A commander who requires the collection and processing of unimportant information may (1) inflict information overload on his organization and (2) risk not learning important information because subordinates are collecting and processing less important or unimportant information.

605. Process

a. Those without practical experience in maintaining large quantities of detailed information will underestimate the time and effort required to update and change information without accidentally entering erroneous information. Any organization maintaining computerized geographic information needs (1) a process that is easy to understand and (2) detailed step-by-step procedures for implementing this process. The process of planning and delivering fires by artillery is a good example. The easy-to-understand process (1) begins with a forward observer seeing a target and calling for fires; (2) proceeds with calculating firing data and the firing of rounds; and (3) ends with the observer providing an assessment of the effect of rounds on the target. This process is supported by detailed procedures: (1) calling for fires, (2) plotting and checking target locations and trajectories in fire support coordination centers, (3) entering data into a fire direction computer, (3) putting correct data into the guns' fire control systems and (4) placing the right rounds and powder into the guns' firing chambers.

b. Maintaining and using computerized geographic information has a similar process: (1) identify important geographic information (i.e., the information to be collected), (2) address which organic elements of a unit will collect the needed information, (3) determine to whom and how new information will be reported, (4) determine who will verify it (some reported information may not be true and accurate), (5) determine who will enter or update information in the database, and (6) determine who will check the entry of information.

c. A suggested outline for this process follows:

(1) Acquire available and relevant geographic information. Sources include NIMA, commercial map companies, military agencies and civilian government agencies.

(2) Assemble information in appropriate elements of a command and control system to create one or more geographic information databases.

(3) Define geographic information and mapping priorities.

(4) Perform reconnaissance using means that do not require fieldwork (e.g., study aerial imagery).

(5) Update geographic information databases using information determined in subparagraph (4) above.

(6) Prepare geographic intelligence tasking for units performing field reconnaissance.

(7) Perform field reconnaissance.

(8) Enter field reconnaissance information into geographic information databases.

(9) Assess the information in the databases.

606. Controlling Changes. It is important to have a system to control changes because reported information that appears to be true is not always so. Militaries have long fooled their enemies by placing dummy equipment and personnel where enemy observers or remote sensing devices would detect them. Further, members of ground forces sometimes locate items of tactical importance and fail to characterize them properly. Military forces with an established system for controlling changes in geographic information can minimize their vulnerability to enemy deception or inadvertent misreporting. Indeed, most command and control systems now include procedures ensuring the proper verification of changes in information. The key is to define appropriate actions extending these procedures to include computerized geographic information.

607. Documenting Changes (Metadata). When entering new or changed computerized geographic information into a database, it is important to document the change by entering its information source, quality, timeliness, etc. This is metadata. As *Warfighting* points out, ambiguity and confusion are inevitable in military operations. Good metadata is one of the best tools to resolve ambiguity and eliminate confusion.

608. CPX and Other Training. Because maintaining and revising computerized geographic information involves many elements of a unit, it is important that CPX and similar training be conducted on collecting and updating computerized geographic information. For a unit to fully realize the potential of computerized geographic information to improve situational awareness it must be able to accurately collect and revise geographic information when people are tired and other matters are pressing.

CHAPTER 7

USING DIGITAL MAPS IN COLLABORATION

c. Purpose. To explain considerations bearing on the use of computerized geographic information in collaboration.

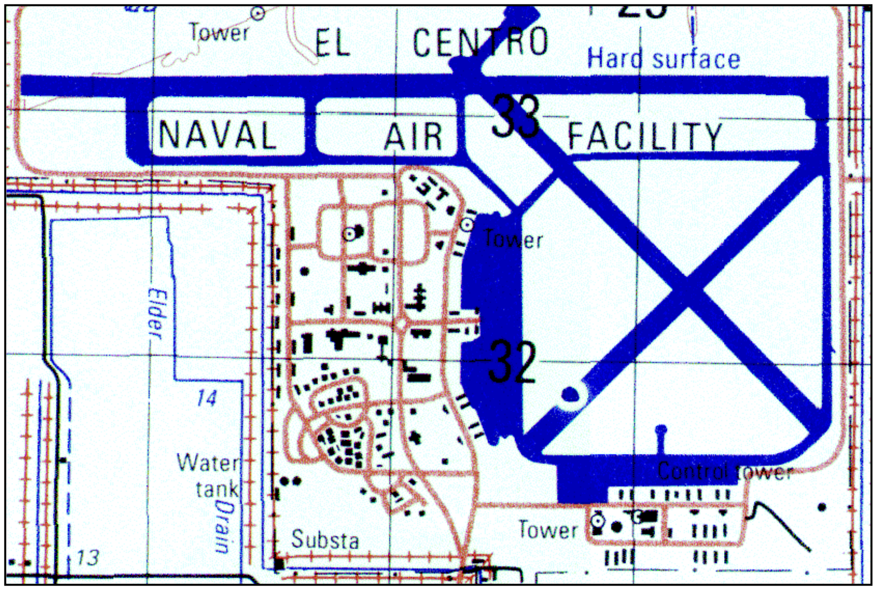
d. Background.

(1) Collaboration is important in military operations because it is one of the principal ways in which limited assets are focused on the most important objectives. Collaboration is basically two or more individuals (1) developing a common picture of a situation, (2) deciding on a course of action, and (3) then working together during the execution of that course of action.

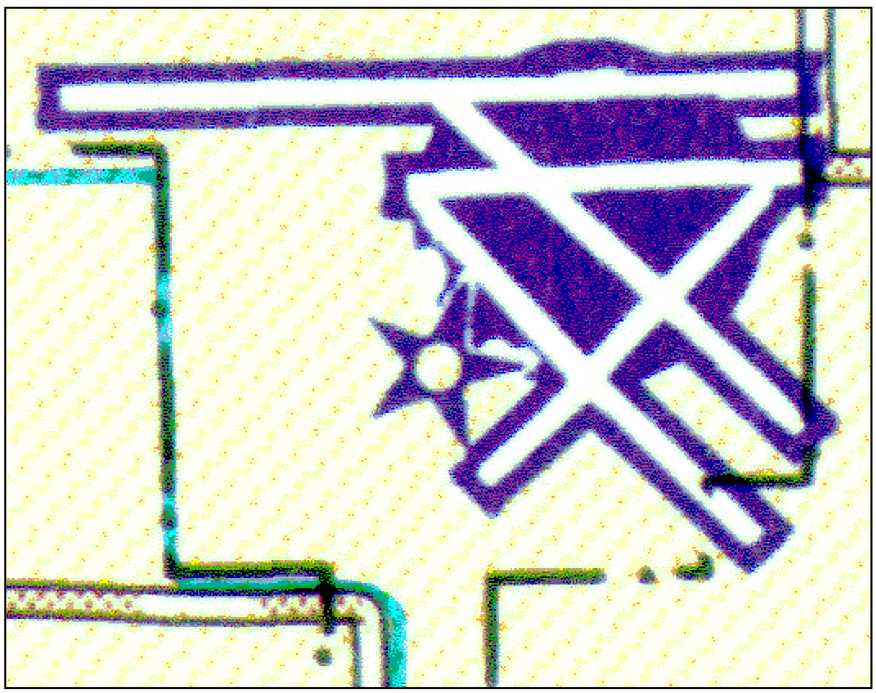
(2) The introduction of computerized geographic information can improve collaboration in several ways. First, computer map (digital) images and related information can be exchanged between distant elements using electronic communications much faster than exchanging the same information in paper form. Therefore, the use of computer information can increase the tempo of operations by speeding decision-making. Second, information can be accessed much more rapidly when it is in a computer database than when it is recorded and filed on paper.

(3) But the use of computerized geographic information also holds the potential to obstruct collaboration. The airfield images on the next page demonstrate a potential problem of misusing computerized geographic information.

The map at right and the map at lower right show the same airfield. When placed together on a single page, the differences between the maps are obvious. However, if the two maps are displayed on computer screens in combat operations centers that are miles apart, the differences may go unnoticed or be considered unimportant.



The differences between these maps are very significant. If a user of the top right image discusses the runway intersection, a user of the map at right will have an ambiguous situation - which runway intersection is being discussed?



e. Procedures. The following guidelines will help reduce the opportunities for digital maps to cause confusion during collaboration:

a. Examine metadata for a computer map to determine (1) its data source or information used to produce the map, (2) the accuracy of the information, (3) if data was used from an existing map, (4) the scale of that map, (5) the information used to produce that map and (6) the date of that map's information.

b. Establish a common map for the collaboration. The information gathered in the first step is important because its absence may mean that important information is not displayed. For example, an apparent absence of marshes drawn on a map may not mean there are no marshes and that tracked vehicles will have good traffic-ability but rather that marshes were not included on the map.

f. Summary. Decision-making can be improved through collaboration with computer maps and other forms of computerized geographic information. However, the characteristics of computerized geographic information that hold the promise of better collaboration (e.g., access to more information) also hold a threat of causing confusion and leading to misunderstandings.

APPENDIX A

RELATIONSHIP OF GEOGRAPHIC INFORMATION AND GEOSPATIAL INFORMATION

1. Purpose. To explain (1) the terms geographic information, geospatial information and services and geospatial information, and (2) the relationship between them.

2. Terms

a. **Geographic information** is any information that includes a location. The location can be stated as latitude and longitude, military grid reference coordinates, street address, city, county, or numerous other ways. Probably more than 80 percent of all information includes a location and can therefore be categorized as geographic information. An element of information can be categorized as both a piece of geographic information and as a piece of another type of information. For example, a statement that a ship is located at 45 degrees north and 20 degrees west is both a piece of operational information and a piece of geographic information. To categorize a piece of information as geographic information is to indicate that it can be displayed on a map.

b. **Computerized geographic information** is geographic information entered and stored on a computer. To categorize a piece of information as computerized geographic information is to indicate that it can be displayed on a map and used by software applications that manipulate data based on location. For example, some computer applications can group and count data points located in a specific area.

c. The Department of Defense uses a "**geospatial information and services**" term. It is defined in Joint Publication 1-02, *DOD Dictionary of Military and Associated Terms* as:

> The concept for collection, information extraction, storage, dissemination, and exploitation of geodetic, geomagnetic, imagery (both commercial and national source), gravimetric, aeronautical, topographic, hydrographic, littoral, cultural, and toponymic data accurately referenced to a precise location on the earth's surface. These data are used for military planning, training, and operations including navigation, mission planning, mission rehearsal, modeling, simulation and precise targeting. Geospatial information provides the basic framework for battlespace visualization. It is information produced by multiple sources to common interoperable data standards. It may be presented in the form of printed maps, charts, and publications; in digital simulation and modeling databases; in photographic form; or in the form of digitized maps and charts or attributed centerline data. Geospatial services include tools that enable users to access and manipulate data; it also includes instruction, training, laboratory support, and guidance for the use of geospatial data. Also called GI&S.

d. Although the term **geospatial information** is used in the Department of Defense, it is not defined in Joint Publication 1-02 or Joint Publication 2-03, *Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations*. Without defining the term, Joint Publication 2-03 says of geospatial information:

> Digital geospatial information forms the foundation for battlespace visualization. When geospatial information is coupled with threat analysis, meteorological and oceanographic environmental intelligence, the friendly situation, and the logistics situation, the commander can more quickly grasp the view of the battlespace. This dominant view of the areas in which joint forces conduct operations allows commanders at all levels to react quickly to evolving situations, and allows for friendly forces to operate inside the decision cycle of adversaries… Geospatial information provides the necessary framework upon which all relevant strategic and tactical information is layered.

e. Geographic information includes geospatial information and other "relevant strategic and tactical information" that include location.

APPENDIX B

TERMINOLOGY OF GEOSPATIAL INFORMATION AND SERVICES (GI&S)

1. Purpose. To explain the terminology in Joint Publication 2-03, *Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations*.

2. Background

a. Computers have radically altered what was formerly called mapping, charting, and geodesy. Before widespread computer use, paper maps were the heart of geographic information. Today, paper maps are still important but geographic data stored in computer databases is now the heart of geographic information. Because of this radical change, the name "geospatial information and services (GI&S)" has replaced mapping, charting, and geodesy.

b. This radical change to mapping and geographic information is the basis for a new language used by military forces for drawing information from National Imagery and Mapping Agency (NIMA). Some terms in this new language are explained:

3. Categories of Geographic Information[1]

a. Foundation data is the basic data NIMA provides to military forces. It includes:

(1) Elevation and bathymetric data. Digital terrain elevation data (DTED) provides elevation data. Digital bathymetric database (DBDB) provides ocean floor depths. These data provide a three-dimensional view of the world. DTED is used in creating three-dimensional map displays.

(2) Foundation feature data. Key nature or manmade features are represented in vector files as a point, line, polygon or text. The location given for each feature is only as accurate as its data source.

(3) Spatial imagery. This is imagery that has been geo-positioned (i.e., processed so the location of features on a map can be determined by examining its respective imagery).

b. Mission Specific Data Sets (MSDS). This is NIMA data that supplements foundation data. MSDS examples include:

(1) Hardcopy (paper) maps. These are topographic line maps, joint operations graphics and coastal charts.

(2) Digital data (softcopy) maps. These are usually stored on compact disks (read only memory) (CD-ROM). This category includes arc digitized raster graphics (ARDG), compressed arc digitized raster graphics (CARDG), vector maps, DTED, DBDB, and digital nautical charts.

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1 See Joint Publication 2-03, *Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations* pages I-1 through I-4 for a more complete discussion.

(3) Textual data. This includes gazetteers, notices to mariners, country studies and flight information publications.

c. Other Information or Products. These are additional materials prepared by NIMA.

4. User-Produced or Acquired Data. Operational forces are not restricted to the categories of data listed in paragraph 3 above.

a. Some additional information is collected and produced by military units using their own elements (e.g., ground or air reconnaissance).

b. Other additional information may be acquired from (1) governmental agencies other than NIMA (e.g., Central Intelligence Agency), (2) other military services, (3) military services of other nations, (4) commercial sources, or (5) local agencies such as city planning departments.

c. Other additional information is the result of processing data from NIMA or other sources.

d. Joint Pub 2-03 identifies this procurement, production, and updating of geographic information as “exploitation” and “value-adding.”

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