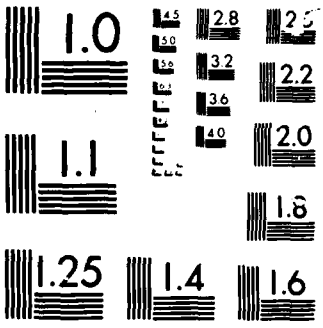
AD-A167 473 THE TERRAIN ANALYST WORK STATION(U) ARMY ENGINEER 1/1
TOPOGRAPHIC LABS FORT BELVOIR VA R B MARTH SEP 85
ETL-R-007

UNCLASSIFIED F/G 15/4 NL



MICROCOPY CHART

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ETL-R-087	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* The Terrain Analyst Work Station		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)* Richard B. Marth		8. CONTRACT OR GRANT NUMBER*(s)*
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer Topographic Laboratories Fort Belvoir, VA 22060-5546		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS see 9		12. REPORT DATE Sep 85 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release.
Distribution Unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Terrain Analyst Work Station
analysis
data base creation
product generation
updating

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

To fight and win the AirLand battle, tactical decision aids (TDA) must be rapidly supplied to the commander. The Army plans to field the Digital Topographic Support System (DTSS) which will utilize automated terrain analysis techniques to exploit digital terrain data to quickly provide TDA's to the commander. The coverage and content of the digital terrain data supplied by the Defense Mapping Agency will be influenced by national priorities and manpower and by the battle itself. Techniques to meet the need for creating, updating and intensifying digital terrain data are being developed on the Engineer Topogaphic Laboratories (ETL) Terrain

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

Analyst Work Station (TAWS) for incorporation into DTSS. ETL scientists have assembled the TAWS using advanced off-the-shelf computer hardware, a government-owned geographic information system (GIS) data extraction hardware and supporting software. The GIS has been designed for data base creation and updating, analysis and product generation. A series of demonstration of TAWS capabilities will be used with the results of laboratory tests to define and validate data extraction, update and revision capabilities needed for the fielded DTSS. TAWS will also support the Corps of Engineers AirLand Battlefield Environment program.

THE TERRAIN ANALYST WORK STATION

RICHARD B. MARTH

US Army Topographic Laboratories
Commander and Director, USAETL, ETL-GS-IB
Fort Belvoir, Va 22060-5546

ABSTRACT

To fight and win the AirLand battle, tactical decision aids (TDA) must be rapidly supplied to the commander. The Army plans to field the Digital Topographic Support System (DTSS) which will utilize automated terrain analysis techniques to exploit digital terrain data to quickly provide TDA's to the commander. The coverage and content of the digital terrain data supplied by the Defense Mapping Agency will be influenced by national priorities and manpower and by the battle itself. Techniques to meet the need for creating, updating and intensifying digital terrain data are being developed on the Engineer Topographic Laboratories (ETL) Terrain Analyst Work Station (TAWS) for incorporation into DTSS. ETL scientists have assembled the TAWS using advanced off-the-shelf computer hardware, a government-owned geographic information system (GIS) data extraction hardware and supporting software. The GIS has been designed for data base creation and updating, analysis and product generation. A series of demonstration of TAWS capabilities will be used with the results of laboratory tests to define and validate data extraction, update and revision capabilities needed for the fielded DTSS. TAWS will also support the Corps of Engineers AirLand Battlefield Environment program.

INTRODUCTION

To fight and win the AirLand battle, the Army must field a combat force that can move quickly and lethally against the enemy. The speed and mobility of this force will depend in part on the availability of up-to-date intelligence information -- information not only about the enemy, but about the terrain and environment as well. Combat commanders need to know as much as they can about the battlefield and need to get this information as quickly as possible.

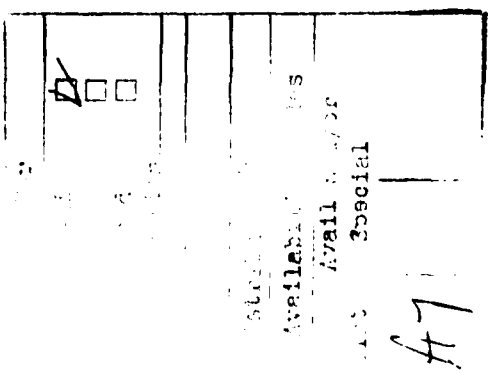
At present, terrain and intelligence analysts manually assemble and analyze such information. Manual terrain analysis is a slow, tedious process at best. Producing a single tactical terrain graphic may require hours of labor from even the most highly skilled analyst.

Digital terrain data bases and automated terrain analysis techniques will help the Army meet the demand for quick, comprehensive information about the terrain. The Army has expressed its needs for digital terrain data to the Defense Mapping Agency (DMA) and plans to field the Digital Topographic Support System (DTSS) to exploit that data in the 1990's. The automated terrain analysis techniques to be employed by DTSS have already been successfully demonstrated in the laboratory on an interactive computer graphics system. Complex terrain products (such as cross-country movement maps and cover and concealment graphics) can be produced from prototype digital terrain data bases -- and can be done in a fraction of the time required by the unassisted analyst.

Digital terrain analysis, however, can only become a field reality if the appropriate data bases exist to support it. DMA is reviewing the Army's Digital Terrain Data Base Requirements to determine its ability to support the Army requirements. Meetings between DMA and DTSS have been held to discuss digital terrain data bases available for DTSS at its initial deployment.

Since US military commitments span the globe, it would be difficult (if not impossible) for DMA to provide the Army with digital terrain information for every area that may eventually be of strategic or tactical interest. Even if complete coverage of the earth were possible, data base users would still find gaps between these general digital sources and the actual lay of the land -- particularly in the battlefield, environments. Modern combat technologies can change the face of the battlefield, making terrain information that was accurate yesterday obsolete in a matter of minutes.

Today's terrain analysts, working with maps, charts and other sources, must take such changes into account. Even after automation, troops in the field will still need to update and revise terrain data to reflect current conditions. The soldiers who man the topographic units of the future must also be equipped to create new terrain data bases should they be called upon to support combat operations in areas for which DMA data are not available.



OBJECTIVE

In response to this need, scientists at the Engineer Topographic Laboratories (ETL) are assembling a Terrain Analyst Work Station (TAWS). This terrain analysis demonstrator will showcase computer-assisted techniques which will eventually allow Army terrain analysts to produce, update and manipulate digital terrain data bases in the field. Although TAWS will essentially be a laboratory system, the incorporation of its capabilities into the planned DTSS will help make that follow-on development a fully functional automated topographic support tool.

The primary function of TAWS will be to perform data extraction, digitization, and mensuration. However, the work station will also incorporate certain data manipulation and product generation capabilities. The system will provide Army terrain analysts with the tools needed to: 1) create topologically valid digital terrain data bases using monoscopic and stereoscopic, multi-sensor imagery, graphics, text, and other military geographic information data sources; 2) edit, update, revise, and intensify existing data bases; 3) merge data extracted from any of the data sources; 4) overlay features on digital elevation data; 5) manipulate, analyze and display, in 2 and 3-D views, digital terrain data; and 6) generate and disseminate Army battlefield tactical decision aids.

HARDWARE

The TAWS incorporates off-the-shelf hardware and builds upon software techniques demonstrated in ETL research efforts. The TAWS computer is a 32 bit microcomputer with 2.0 megabytes of random access memory. It is supported by 264 megabytes of winchester disk storage and a nine track, 1600 BPI tape drive. The input and output devices consist of black and white and color graphics terminals, a color graphics plotter, a line printer with graphics capability. An X-Y digitizing table provides the initial digital terrain data base creation capability. Existing terrain analysis products such as the Planning and Tactical Terrain Analysis Data Bases (PTADB's and TTADB's) are digitized on the X-Y table to form a digital terrain data base. A Light Table Mensuration System (LTMS) is currently being integrated into TAWS for exploiting photographic imagery to generate and intensify digital terrain data. The up-date, edit and intensification capabilities will be added to TAWS when an Analytical Stereo Plotter (ASP) with stereo superpositioning and profiling firmware is integrated into the system in the near future.

The Army fielded MICROFIX system has been interfaced to the TAWS computer so that digital terrain products generated on

TAWS can be distributed to units in the field who currently use the MICROFIX. Currently the TAWS-MICROFIX effort is in the developmental stage. Interfacing routines must be changed to take into account MICROFIX version 2.0 changes. Software to scale TAWS products to coincide with changes in map display scales on MICROFIX are also being developed.

SOFTWARE

The TAWS software is an exploratory developmental effort which advances and refines basic research capabilities demonstrated at ETL. A Geographic Information System (GIS) designed for data base creation, analysis and product generation comprises the majority of the TAWS applications software. The TAWS GIS physically consists of a data collection subsystem and a product generation subsystem. Both subsystems support specific analysis functions.

The data collection subsystem consists of photogrammetric, digitizing and verification routines. Additionally, the data collection subsystem has the capability to read and extract information from certain digital sources and output in DMA-specified digital product formats. The photogrammetric routines enable the analyst to interactively compute the camera and control point parameters of selected imagery. The digitizing devices (e.g. ASP, LTMS, X-Y Table). The analyst can digitize in any scale or orientation, and the size of coverage of each data base is also analyst-specified. The data is digitized in arc-node format. Primary attribute information is entered at time of digitization. Secondary or multiple attributes can be entered at any time subsequent to digitization. Editing of arcs, nodes or attributes can be made either at the time of data entry or at a later time by querying the data base for a specific arc, node or polygon, each of which is uniquely identified. Once digitization is complete, each feature in a manuscript can be topologically verified. The analyst invokes verification routines which check for various errors including illegal or missing attributes, arcs and nodes, duplicate or kinked arcs, and slivers and gaps. When completed successfully, the verification routines confirm that a topologically valid manuscript has been compiled.

The product generation subsystem receives the re-formatted, verified data sets from the data collection subsystem. Additionally, several types of digital data can be directly read and incorporated into the product generation subsystem data bases. The product generation subsystem currently handles vector-formatted polygon data sets and will in the near future handle data and consists of storage and control, analysis, and display and plotting routines. The storage and

control routines provide an interface between the vector and raster analysis functions and the cartographic output functions. They also provide the capability to add to, access and manipulate the map data sets. The product generation analysis routines perform a variety of functions, ranging from calculating and outputting tabular information,such as descriptive statistics, to reclassifying map information to complexing or overlaying map data sets. The display and plotting routines produce user-oriented cartographic or display output on the CRT or plotting devices. Product generation is an interactive process on TAWS. The terrain analyst can create a product of interest or use predefined model to generate a product. Figure 1 is an example of an analyst created product. Canopy coverages at operator defined ranges were extracted from the data base and displayed. Figure 2 shows a cross-country mobility product which utilized the Condensed Army Mobility Model System (CAMMS) routines. CAMMS, a Waterways Experiment Station (WES) model, was installed on TAWS by WES and ETL scientists for AirLand Battlefield Environment (ALBE) demonstration. CAMMS determined speeds at which an M60 tank could move, given moisture conditions and a complexed map of soil, transportation, slope, vegetation and obstacle factors.

Ancillary to the GIS, the TAWS supports specialized terrain analysis software used to generate intervisibility products for planning military operations. The intervisibility products are generated from digital elevation matrices compiled on TAWS from DMA Digital Terrain Elevation Data (DTED). Intervisibility products are used to determine areas that are visible, either optically or electronically, from a given site. They compensate for earth curvature and atmospheric refraction and can optionally incorporate vegetation heights in the analysis. TAWS intervisibility products include line-of-sight models, radial terrain masking models, perspective views, multi-site and composite target acquisiton models, and path-loss line-of-sight profiles and areas. Examples of the masked area product and the perspective view product are shown in Figures 3 and 4. The TAWS also contains a data base and associate applications routine of climatic and environmental information used to support the terrain analysis process.

SOFTWARE DESIGN

Although the basic applications software capabilities have been demonstrated in ETL research projects, integrating the component software into a developmental system is an effort of considerable magnitude and complexity. A number of design considerations had to be incorporated to coordinate and implement the software on TAWS. The development strategy

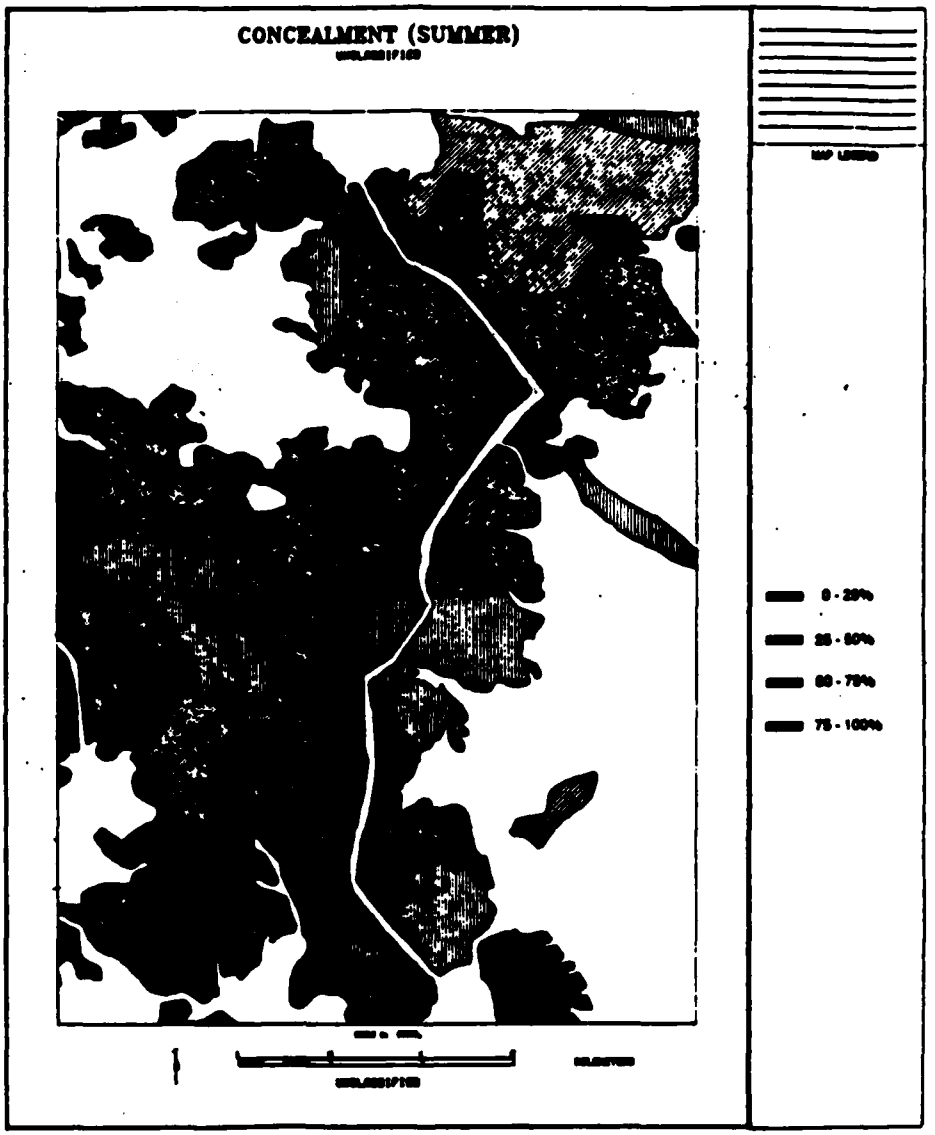


Figure 1.—Concealment

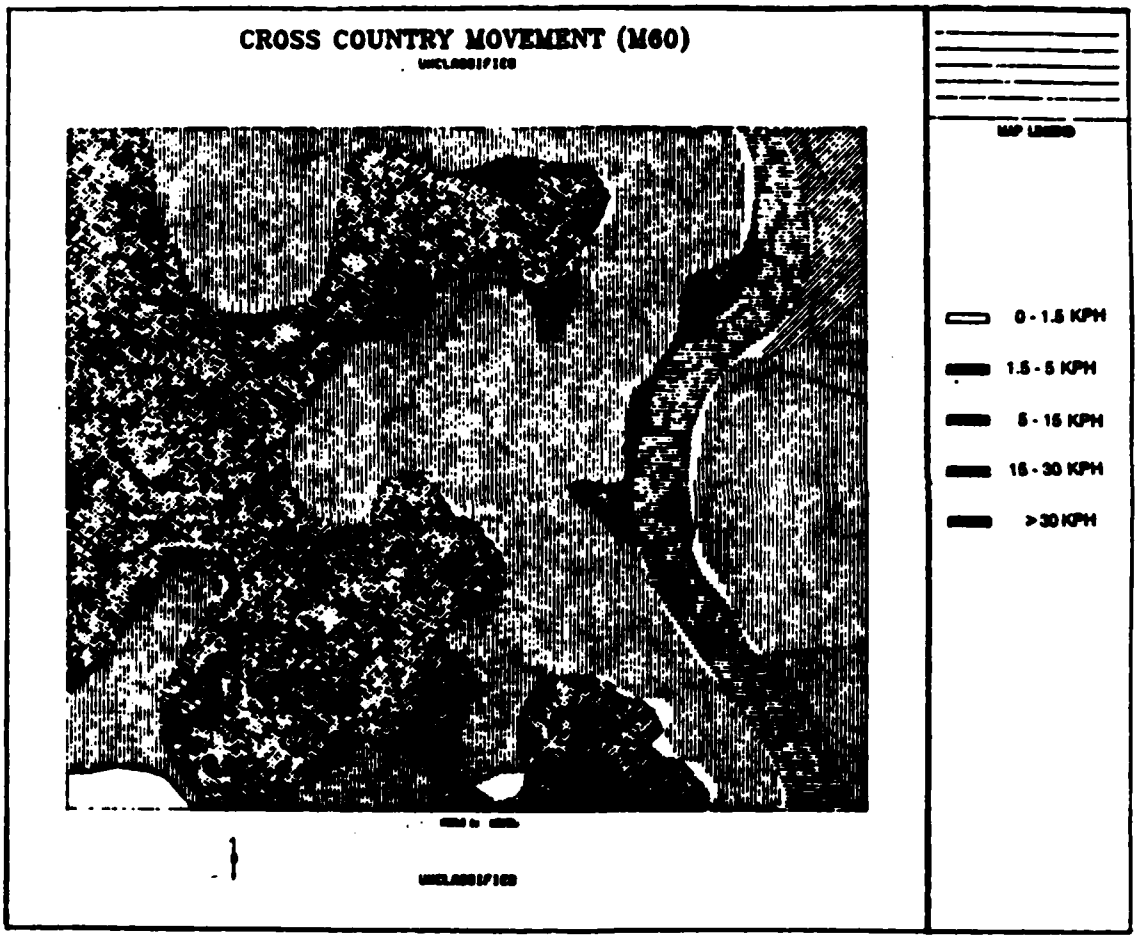
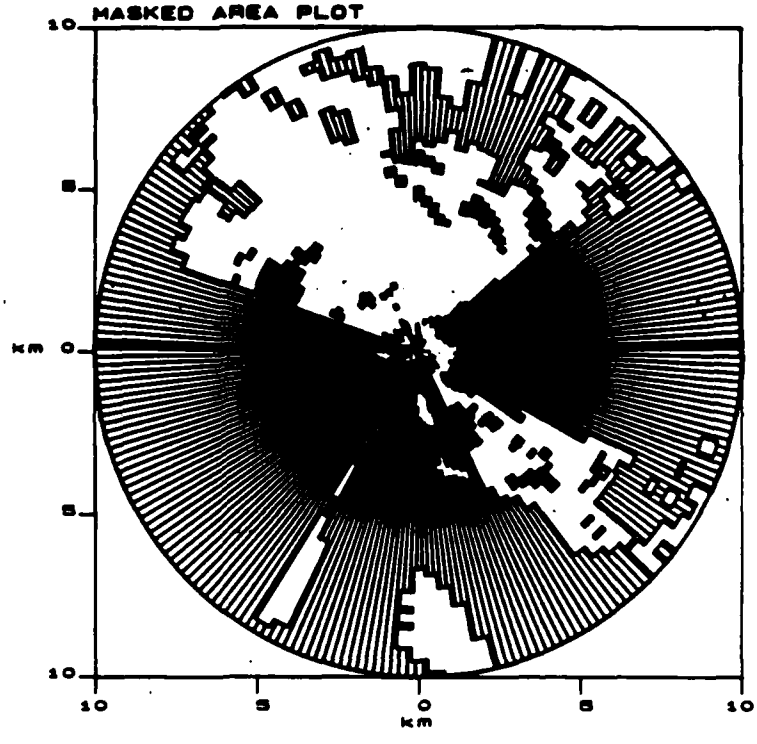


Figure 2.--Cross Country Movement



Site coordinate:
32U QA0387523428
Site elevation:
531.5 meters
Site antenna height:
2.0 meters
Radial storage file:
1-10.RTM
Radial increment:
3.0 degrees
Elevation extraction:
125.0 meters
Elevation interpolation:
4-point
Target altitude:
2.0 meters agl
Minimum masked zone:
.0 meters
Mode of surveillance:
optical
Map projection:
Transverse
Mercator
Spheroid
International
grd to nth rot ang: 1.8167
Vegetation included [Y/N]:
N

Figure 3.--Masked Area Plot

OBSERVER SITE INFORMATION

SITE ID	1-A	
MILITARY GRID LOCATION	32U	QA050237
TERRAIN ELEVATION	600.	METERS
OBSERVER ELEVATION	602.	METERS

PLOT INFORMATION

AZIMUTH OF VIEW	0	DEGREES
ANGLE OF DECLINATION	0	DEGREES
HORIZONTAL FIELD OF VIEW	60	DEGREES
RANGE LIMIT	20.	KILOMETERS
PLOT GRID INCREMENT	100	METERS
ELEVATION EXAGGERATION	5.	
RANGE LINE SPACING	5000.	METERS

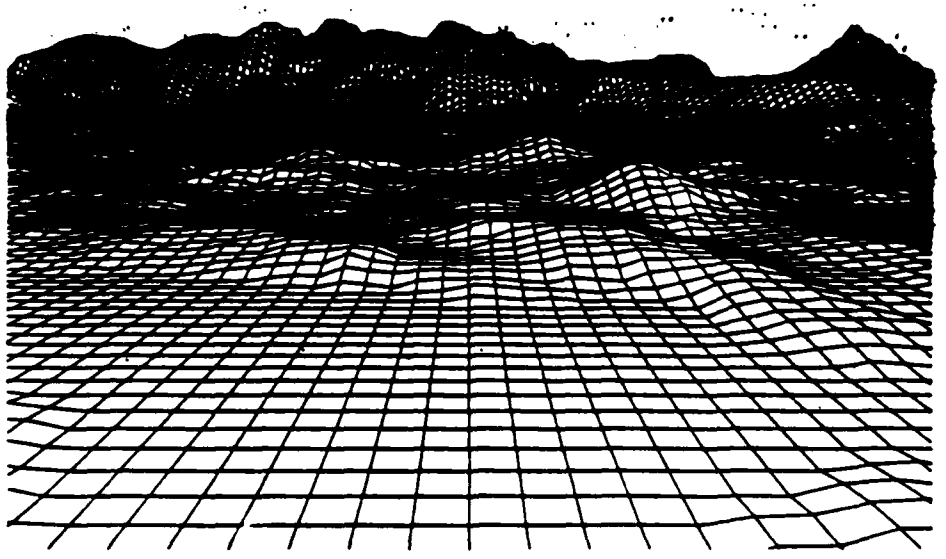


Figure 4.—Prospective Graphic

employs current techniques of systems analysis such as following a top-down design, utilizing both manual and automated configuration management tools, and segregating the development, test, and user-accessed sectors of the system. The software design goals of TAWS are to develop a modular, portable, device-independent and user-friendly system. To achieve the first goal, all software was segregated into functional groups and structured into modular programs. This will facilitate any future software enhancements and program maintenance. The goal of portability will utilize a variety of software tools. First, the selected operating system is UNIX (trademark of Bell Laboratories), commercially available through a number of venders and currently supportable by most micro and minicomputer systems. To minimize system dependencies, most of the applications software will be written in ANSI Fortran 77. All assembly level and machine-dependent code will be isolated in program libraries and reduced to low-level primitives. The goal of attaining software portability is dependent upon creating device-independent code, the third goal. To achieve device-independence, all calls to specific I/O devices will be isolated in libraries, and device-specific graphics calls within the applications modules will be eliminated. All applications programs will contain the ACM-SIGGRAPH "Core" standard graphics calls. The goal of building a user-friendly system will be attained through software development techniques which will isolate the user from the operating system and guide the user through the system. Creating concise and easy to follow user documentation, coupled with providing on and off-line training materials should minimize both the time required to learn the use of the system and the effort required to effectively utilize this powerful terrain analysis tool.

TAWS DEMONSTRATIONS

In March 1985, the 1st Armor Division (1AD), Ansbach FRD invited ETL to demonstrate TAWS at their facilities. An October 1985 garrison demonstration was coordinated between 1AD and ETL. The terrain analyst of the 518th Engineer Detachment will be trained to use the baseline TAWS capabilities by ETL and WES personnel. The terrain analyst will then generate the products they desire to support the REFORGER 86 exercise with the assistance of the ETL and WES scientists. The 1AD personnel will be interviewed after the demonstration for comments about the TAWS.

Coordination for a second demonstration has been initiated with the 18th Airborne Corps at Fort Bragg, North Carolina. The second TAWS demonstration will also be a garrison demonstration and coincide with the second quarter FY86 Gallant

knight exercise. The LTMS will be added to the baseline TAWS for this demonstration and feedback on its potential for field use will be obtained.

A third demonstration is currently being arranged with the ALBE community and the US Army Development and Employment Agency (ADEA). TAWS will support an ALBE technology demonstration at Fort Lewis, Washington in the fourth quarter FY86. The TAWS will be in a shelter for this demonstration and an analytical stereo plotter will have been added to TAWS.

Future demonstrations will be arranged as time and funds permit. The 29th Engineer Battalion has expressed an interest in a first quarter FY87 demonstration. The TAWS will support the ALBE demonstrations until the ALBE support equipment is available.

FUTURE DEVELOPMENTS

The current method of creating a digital data base from DMA paper products (Planning and Tactical Terrain Analysis Data Base, PTADB and TTADB) is time consuming. Advances in scanning digitizers have produced smaller, less expensive machines capable of digitizing the line work of the PTADB and TTADB products. ETL will investigate the potential use of these digitizers.

Advances in the TAWS GIS are also planned. The GIS capabilities will be expanded to handle different data formats (Standard Linear Format, vector and raster) and to transfer data between the formats. The elevation data manipulation routines will be incorporated into the GIS, Investigations into the exploitation of digital imagery data by the GIS will be initiated in the future.

END

FILMED

6-86

DTIC