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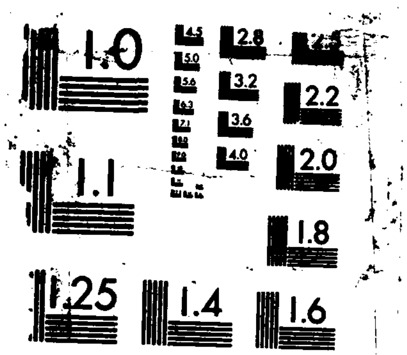

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The Terrain Analyst Work Station (TAWS) project was initiated by the U.S. Army Engineer Topographic Laboratories (USAETL) to develop a prototype system to meet the Army's requirements for providing accurate and timely terrain and environmental information used in making critical military planning and operational decisions. TAWS is designed for use by Army terrain analysts and is being demonstrated in the laboratory and in conjunction with a series of Army Field exercises. During each field demonstration, soldiers are trained in the functional operations of the system and allowed to test its capabilities for digital terrain data extraction, analysis manipulation, and synthesized product generation with minimum supervision by USAETL personnel. Test and demonstration results as well as feedback from various Army elements involved in each exercise are designed to assist scientists and engineers in the development of requirements and specifications for future Army digital topographic support.

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TERRAIN ANALYST WORK STATION (TAWS) DEMONSTRATIONS

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BIOGRAPHICAL SKETCH

MARK A. SITHER, Geographic Systems Laboratory, Geographic Concepts Division, Geographic Information Systems Branch, Geographer, GS-0150-12.

Mr. Sither attended the University of Kentucky from 1972 through 1978, receiving a Bachelor's Degree in geography in 1977 and pursuing the MA Graduate Study as a Graduate Assistant for an additional year. While in school, Mr. Sither spent a period of time as a Planning Intern/Temporary Urban Planner for Lexington-Fayette County, KY. After leaving school, Mr. Sither was employed as a Cartographer, GS-7/9, and Physical Scientist, (Terrain Analyst), GS-11/12, with the Defense Mapping Agency, Louisville, KY, until joining the U.S. Army Engineer Topographic Laboratories (USAETL) as a Geographer, GS-11/12, in 1983. While at USAETL, Mr. Sither provided technical supervision as Contracting Officer's Representative (COR) for contract production of the USAETL report - "Guide to the Collection of MGI Source Material". Mr. Sither has also been a primary participant in the team responsible for development of the Terrain Analyst Work Station (TAWS), a demonstration system incorporating new techniques and methodologies for computer-assisted extraction, storage, manipulation, and presentation of digital terrain information. Mr. Sither is a member of the Association of American Geographers.

ABSTRACT

The Terrain Analyst Work Station (TAWS) project was initiated by the U.S. Army Engineer Topographic Laboratories (USAETL) to develop a prototype system to meet the Army's requirements for providing accurate and timely terrain and environmental information used in making critical military planning and operational decisions. TAWS is designed for use by Army terrain analysts and is being demonstrated in the laboratory and in conjunction with a series of Army Field exercises. During each field demonstration, soldiers are trained in the functional operations of the system and allowed to test its capabilities for digital terrain data extraction, anaylsis manipulation, and synthesized product generation with minimum supervision by USAETL personnel. Test and demonstration results as well as feedback from various Army elements involved in each exercise are designed to assist scientists and engineers in the development of requirements and specifications for future Army digital topographic support.

INTRODUCTION

Within the U.S. Army, as in numerous other organizations, increased demand for complex geographic and environmental information has developed in recent years. In particular, the growth and use of computer technology has become much more widespread. Thus the knowledge-base for use of digital topographic and other environmental data has expanded in such a manner that users within the Army now realize the benefits to be derived. Digital terrain data is used for the provision of accurate and up-to-date information in support of operations' planning and decision-making.

CURRENT TERRAIN ANALYSIS/SYNTHESIS METHODOLOGY

Terrain analysis is the process of analyzing military geographic information in order to determine the effects of both natural and manmade features of the environment on military operations. At present, Army Engineer Terrain Analysts manually analyze and synthesize terrain information. However, current manual procedures are cumbersome, slow, and inflexible; thus are not capable of satisfying requirements for rapid creation and revision of terrain information as well as generation and dissemination of synthesized products. Such procedures require the analyst to collect information for a particular geographic area of interest, e.g., maps, charts, photography, reports, and other documentation; evaluate the information for accuracy and relevancy to the project; and then prepare a variety of hard-copy graphic terrain overlays, e.g., surface configuration (% slope), surface materials (soils), vegetation, surface drainage, transportation, and obstacles, as well as associated tabular or textual documents such as highway/road bridge information, climatological data, and other terrain and environmental reports. It may require an experienced analyst several weeks or months to produce the necessary terrain products using traditional methods.

FUTURE TERRAIN ANALYSIS/SYNTHESIS METHODOLOGY

The Army has begun to address problems associated with use of current procedures for generation and dissemination of terrain and environmental information. Use of digital terrain data and implementation of computer-assisted terrain analysis and synthesis techniques in the future will help the Army meet the demand for quick, comprehensive planning and decision-making tools. Numerous automated terrain analysis and synthesis techniques have already been tested and demonstrated in the laboratory. Intervisibility analysis products, e.g., line-of-sight profile, radial terrain masked area, shaded elevation contour, elevation contour interval, slope and area plots, as well as three-dimensional perspective views of the terrain, are produced from digital elevation data. Other terrain and environmental products, e.g., cross-country movement, paratroop drop zones, cover/concealment, helicopter landing zones, and concealment/aerial detection graphics; have been generated from prototype digital terrain data in a fraction of the time required for similar product creation using traditional methods.

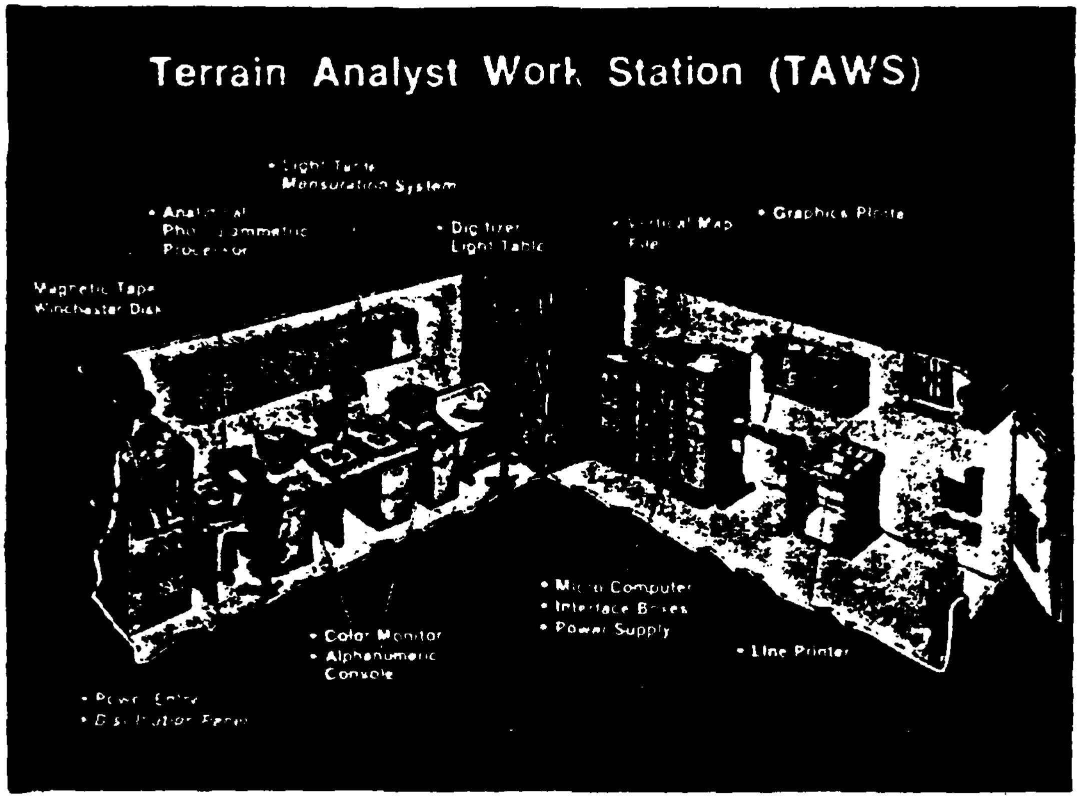

Figure 1. Terrain Analyst Work Station (TAWS)

TERRAIN ANALYST WORK STATION (TAWS)

Research scientists at the U.S. Army Engineer Topographic Laboratories (USAETL) have assembled the Terrain Analyst Work Station (TAWS); a prototype demonstration/research and development system designed to refine automated techniques for digital terrain data creation, analysis, manipulation, and product generation. Although, TAWS is essentially a laboratory system; techniques and capabilities developed and tested in-house and during a series of field demonstrations are being incorporated into specifications for the Digital Topographic Support System (DTSS). DTSS, currently scheduled for initial implementation in the early 1990's, will eventually provide primary field topographic support for the Army. DTSS will enable the terrain analyst to create and revise digital terrain data, and subsequently generate a variety of terrain-related and environmental-related planning and operations' decision aids in either hard-copy or soft-copy graphic and textual format (see Figures 1 and 2).

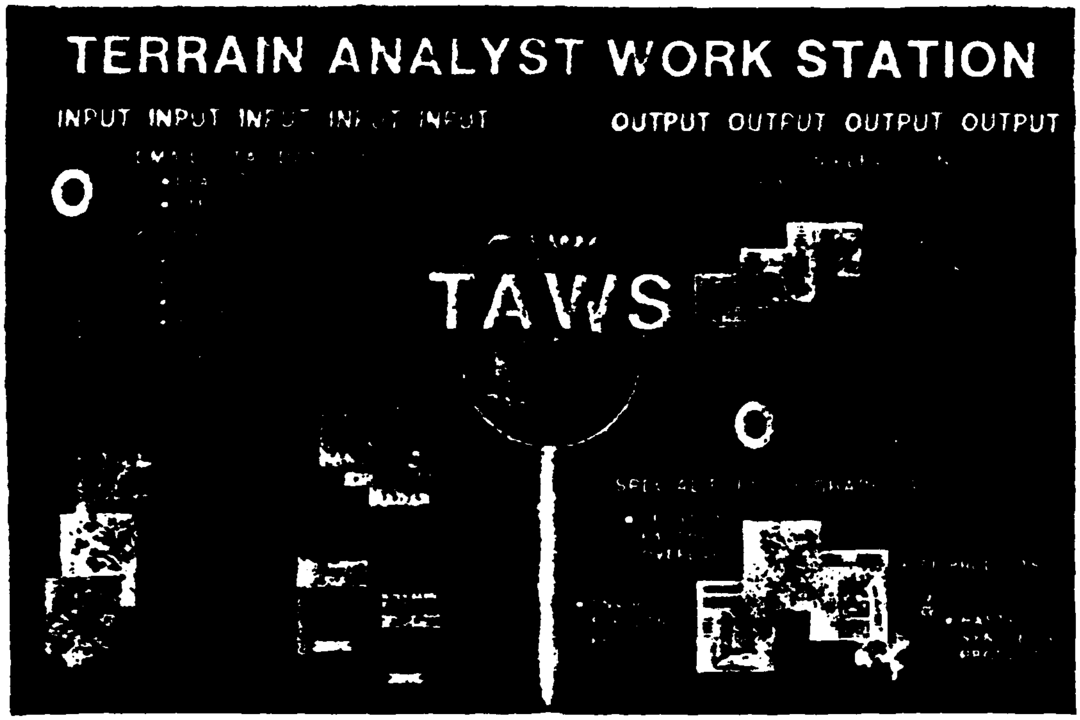

Figure 2. Terrain Analyst Work Station

OVERVIEW OF TAWS' SYSTEM CONFIGURATION

TAWS incorporates recent advances in microcomputer and related peripheral equipment technology; geographic information systems' (GIS) and other geobased data processing capabilities; hard-copy and soft-copy graphics' display; and computer-assisted photointerpretation and photogrammetry. It enables the terrain analyst to test and evaluate techniques which will allow future use of digital topographic and environmental data.

TAWS provides numerous functional tools, among which include those required to:

1) create topologically valid digital terrain data from a variety of source material, e.g., maps, charts, and other hard-copy graphic products, aerial photography and multi-sensor imagery, and miscellaneous textual information;

2) generate two-dimensional and three-dimensional intervisibility analysis displays from digital elevation data;

3) edit and revise existing digital data, either created by the terrain analyst or acquired from other sources;

4) merge digital data created internally on the system, as well as other source data which has been produced elsewhere;

5) overlay digital terrain and cultural feature data upon digital elevation data;

6) produce standard and special-purpose terrain analysis and synthesis products via query, retrieval, and manipulation of digital data; and

7) output natural and cultural terrain feature

information, as well as environmental effects' and climatological statistical data in textual and tabular format.

TERRAIN ANALYST WORK STATION (TAWS) DEMONSTRATIONS

In the preliminary planning stages of the TAWS' Project; it was determined that the requirement existed to demonstrate its capabilities to the intended users of similar systems which were to be developed and fielded in the future. Technology demonstrations would facilitate the transfer of digital terrain and environmental data processing and support procedures/capabilities from the laboratory to the field. Invaluable benefits were seen to be gained from research and development personnel working interactively with the Army personnel for whom they were designing equipment. Hands'-on experience with the TAWS' system within a series of field demonstrations would allow USAETL scientists and engineers the opportunity to receive the necessary feedback required to refine digital terrain and environmental data extraction, analysis, manipulation, and display capabilities to be incorporated into future Army digital topographic support techniques, procedures, software, and equipment.

Field demonstrations of TAWS began in October 1985 with the system and USAETL personnel traveling to Ansbach, West Germany for three weeks of training and supervision of a group of Army terrain analysts. Technology demonstrations have since been held with terrain units at Fort Bragg, NC, Fort Shafter, HI, and Fort Lewis, WA; and an additional field demonstration is scheduled to take place during the Spring of 1987 in South Korea. Each demonstration has required extensive planning and coordination with the particular Army terrain units involved in the exercise, in addition to a minimum of three months of effort in source material acquisition, digital data creation, and other preparation by USAETL personnel in the laboratory. USAETL scientists have spent more than three months outside of the laboratory environment working in conjunction with Army personnel, much of it on a 24-hour per day basis. Terrain analysts and other military personnel have received hands'-on training in all functional capabilities found within TAWS and then have been given the opportunity to operate the system with minimum supervision. Three dozen Army personnel have received operational training and experience in the various digital terrain and environmental data creation, analysis, manipulation, and product generation capabilities currently being developed and incorporated into future systems.

Valuable feedback has been obtained from those who have participated in the series of TAWS' technology demonstrations. Techniques and procedures as well as software and hardware research and development can be oriented more to the actual users' needs and incorporated into future design considerations for digital topographic support systems' software, hardware, and techniques currently under development. Technology demonstrations have shown that digital terrain and environmental data support systems will substantially benefit the terrain analyst in the future.

TERRAIN ANALYST WORK STATION (TAWS) TECHNOLOGY DEMONSTRATIONS

TAWS Demonstration #1: October 1985

Location: Headquarters, 1st Armored Division, Ansbach, West Germany
Terrain Unit(s): 518th Engineer Detachment (T)
526th Engineer Detachment (T)
Number of Personnel Trained: 6
Total Time in Training/Product Generation: approx. 2 weeks
Type of Demonstration: Garrison Location
Primary (Direct) Exercise Support: n/a
Secondary (Indirect) Exercise Support: REFORGER '86

Primary Capabilities Demonstrated: Initial Digital Topographic/Environmental Support Outside Laboratory: X-Y Table Digitization/Data Creation; Terrain Analysis/Synthesis Product Generation; Intervisibility Analysis and Product Generation; Environmental Effects' Software Data Generation.

Primary Types of Products Generated:
Terrain Data Creation: TTADB Data; Topographic Map Data
Terrain Analysis/Synthesis Product Generation: Concealment/Aerial Detection; Cross-Country Movement (DMAHTC) and (USAWES); Other Miscellaneous Terrain-Related Products
Intervisibility Analysis: Radial Terrain Masked Area Plots; Line-of-Sight Profile Plots; Perspective View of Terrain Graphics.
Environmental Effects: Climatological Statistics; Almanac Functions: (sunrise, sunset, moonrise, moonset, etc.), Construction Engineering Parameters.

Number of Products Generated:
Terrain Data Creation: Limited Representative Sample Data Creation Only.
Terrain Analysis/Synthesis Product Generation: Limited Representative Sample Product Generation Only.
Intervisibility Analysis: approx. 600.
Environmental Effects: Substantial Statistical Data Generation: approx. 100.

TAWS Demonstration #2: January/February 1986

Location: Headquarters, XVIII Airborne Corps, Fort Bragg, NC
Terrain Unit(s): 283rd Engineer Detachment (T)
Number of Personnel Trained: approx. 12.
Total Time in Training/Product Generation: approx. 2 weeks
Type of Demonstration: FTX - Garrison Location
Primary (Direct) Exercise Support: GALLANT KNIGHT '86
Secondary (Indirect) Exercise Support: n/a

Primary Capabilities Demonstrated: Initial Digital Topographic/Environmental Support For Field Exercise:

X-Y Table Digitization/Data Creation; Terrain Analysis/Synthesis Product Generation; Intervisibility Analysis and product Generation; Environmental Effects' Software Data Generation.

Primary Types of Products Generated:
Terrain Data Creation: PTADB/TTADB Data
Terrain Analysis/Synthesis Product Generation: Concealment/Aerial Detection; Helicopter Landing Zones.
Intervisibility Analysis: Radial Terrain Masked Area Plots; Line-ofSight Profile Plots; Perspective View of Terrain Graphics.
Environmental Effects: Climatological Statistics; Almanac Functions: (sunrise, sunset, moonrise, moonset, etc.); Construction Engineering Parameters.

Number of Products Generated:
Terrain Data Creation: Limited Representative Sample Data Creation Only.
Terrain Analysis/Synthesis Product Generation: Limited Representative Sample Product Generation Only.
Intervisibility Analysis: approx. 150.
Environmental Effects: Substantial Statistical Data Generation, Actual Number of Products Unknown.

<u>TAWS Demonstration #3: May 1986</u>

Location: Headquarters, 29th Engineer Battalion (T), Fort Shafter, HI
Terrain Unit(s): 29th Engineer Battalion (T)
Number of Personnel Trained: approx. 12.
Total Time in Training/Product Generation: approx. 3 weeks.
Type of Demonstration: Garrison Location/Base-Plant Operation.
Primary (Direct) Exercise Support: n/a
Secondary (Indirect) Exercise Support: RIMPAC '86

Primary Capabilities Demonstrated: Base Plant Digital Terrain Data Production Capability; Digitization of Digital Terrain Data using X-Y Table; Photographic Digitization of Digital Terrain Data using Light Table Mensuration System (LTMS); General Terrain Analysis/Synthesis Product Generation, Intervisibility Analysis and Product Generation, Environmental Effects' Software Data Generation.

Primary Types of Products Generated:
Terrain Data Creation: TTADB Data
Terrain Analysis/Synthesis Product Generation: Cross-Country Movement (DMAHTC); Cover/Concealment; Construction Resources; Bivouac Sites; Helicopter Landing Zones; Paratroop Drop Zones; Division Tactical Operations' Center Locations.
Intervisibility Analysis: Radial Terrain Masked Area Plots; Line-of-Sight Profile Plots; Perspective View of Terrain Graphics.
Environmental Effects: Climatological Statistics; Almanac Functions: (sunrise, sunset, moonrise, moonset, etc.); Construction Engineering Parameters.

Number of Products Generated:
Terrain Data Creation: Substantial Digital Terrain Data Was Created From Portions Of Several TTADB Factor Overlays.
Terrain Analysis/Synthesis Product Generation: Substantial Representative Sample Product Generation
Intervisibility Analysis: 29th ENG BN (T) Demonstration Support: approx. 75.
RIMPAC '86 Exercise Support: approx. 36.
Environmental Effects: Substantial Statistical Data Generation, Actual Number of Products Unknown.

TAWS Demonstration #4: November 1986

Location: Headquarters, 9th Infantry Division, Fort Lewis, WA
Terrain Unit(s): 537th Engineer Detachment (T)
Number of Personnel Trained: 4
Total Time in Training/Product Generation: approx 3 weeks.
Type of Demonstration: CPX - Tactical (Mobile) Shelter/ Field Location.
Primary (Direct) Exercise Support: BOLD VENTURE '87.
Secondary (Indirect) Exercise Support: n/a

Primary Capabilities Demonstrated: Initial Test of Tactical (Mobile) Shelter; Initial Test of Tactical (Mobile) Shelter and TAWS in Field Location; Digitization of Digital Terrain Data using X-Y Table; Photographic Mensuration and Digitization of Digital Terrain Data using Light Table Mensuration System (LTMS); General Terrain Analysis/Synthesis Product Generation, Intervisibility Analysis and Product Generation, Environmental Effects' Software Data Generation.

Primary Types of Products Generated:
Terrain Data Creation: TTADB/PTADB Data
Terrain Analysis/Synthesis Product Generation: Cross-Country Movement (DMAHTC) and (USAWES); River Crossing Sites (Fording Sites); Tactical Bridge Erection Sites; Cover/Concealment; Construction Resources; Bivouac Sites; Helicopter Landing Zones; Paratroop Drop Zones; Concealment/Aerial Detection; Highway/Road Bridge Locations and Highway/Road Bridge Information Table Printout.
Intervisibility Analysis: Radial Terrain Masked Area Plots; Line-of-Sight Profile Plots; Perspective View of Terrain Graphics.
Environmental Effects: Climatological Statistics; Almanac Functions: (sunrise, sunset, moonrise, moonset, etc.); Construction Engineering Parameters.

Number of Products Generated:
Terrain Data Creation: Digital Terrain Data was Created from Substantial Portions of Several TTADB and PTADB Factor Overlays.
Terrain Analysis/Synthesis Product Generation: approx. 35.
Intervisibility Analysis: approx. 100.

Environmental Effects: Substantial Statistical Data Generation, Actual Number of Products Unknown.

TAWS Demonstration #5: Spring 1987

Location: Republic o' Korea (South Korea)
Terrain Unit(s): 359th Engineer Detachment (T) (Reserve)
Number of Personnel Trained: 4 - 6
Total Time in Training/Product Generation: approx. 3 weeks.
Type of Demonstration: FTX - Tactical (Mobile) Shelter/ Field Location.
Primary (Direct) Exercise Support: TEAM SPIRIT '87
Secondary (Indirect) Exercise Support: n/a

Primary Capabilities To Be Demonstrated: Tactical (Mobile) Shelter: Field Location; Digitization for Revision of Digital Terrain Data using X-Y Table; Photographic Mensuration and Digitization for Revision of Digital Terrain Data using Light Table Mensuration Systems (LTMS); General Terrain Analysis/Synthesis Product Generation, Intervisibility Analysis and Product Generation, Environmental Effects' Software Data Generation.

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