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The U.S. Army Topographic Engineering Center (TEC) awarded a Small Business Innovative Research (SBIR) contract in July 1990 to Horizons Technology, Inc. (HTI) for the development of an advanced Terrain-Based Mission Planning Workstation (TMPW). The TMPW will apply terrain visualization techniques with advanced decision aid algorithms and related technologies to support the battlefield commander's mission planning processing needs. The TMPW is intended for use at the brigade, battalion, or lower echelons to provide the commander the capability to visualize a battle area and perform a wide range of analyses using terrain data, current operations/intelligence data, weather information, and planning support templates. Operationally, the system is being designed to support the Army Command and Control System (ACCS) community and is being implemented on the Army's Common Hardware Software (CHS) equipment.

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TERRAIN-BASED MISSION PLANNING WORKSTATION
(TMPW)

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ABSTRACT

The U.S. Army Topographic Engineering Center (TEC) awarded a Small Business Innovative Research (SBIR) contract in July 1990 to Horizons Technology, Inc. (HTI) for the development of an advanced Terrain-Based Mission Planning Workstation (TMPW). The TMPW will apply terrain visualization techniques with advanced decision aid algorithms and related technologies to support the battlefield commander's mission planning processing needs. The TMPW is intended for use at the brigade, battalion, or lower echelons to provide the commander the capability to visualize a battle area and perform a wide range of analyses using terrain data, current operations/intelligence data, weather information, and planning support templates. Operationally, the system is being designed to support the Army Command and Control System (ACCS) community and is being implemented on the Army's Common Hardware Software (CHS) equipment.

The initial six month Phase I effort ended in February 1991 and produced functional specifications and a conceptual design for the implementation of the TMPW. TEC awarded the Phase II SBIR contract in September 1991. This two year Phase II effort expands upon the work performed during Phase I and involves software development and integration. This paper specifically addresses the program status, progress to date and future plans and developments as well as the particular software modules. In addition, the paper addresses potential support to Special Operations Forces and other tactical users.

INTRODUCTION

According to Army doctrine, terrain and weather have more impact on the battle than any other physical factor. Understanding the effects of the terrain and the environment is widely recognized as a force multiplier and an important component in the success of any military operation. Recent advances in computer graphics and display technologies enable the use of advanced computer image generation (CIG) techniques to create realistic terrain perspectives, providing the commander with the ability to "see" the terrain, and rapidly visualize/assimilate battlefield conditions and information.

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The Battlefield Visualization Division of the U.S. Army Topographic Engineering Center at Fort Belvoir, Virginia has the mission to conduct exploratory and advanced development in the areas of terrain visualization and CIG to provide the Army with improved capabilities to extract, fuse, visualize, analyze and display terrain, environment, intelligence, and maneuver information. To support this mission, TEC awarded a SBIR contract in July, 1990 to Horizons Technology, Inc. (HTI) for the development of an advanced Terrain-Based Mission Planning Workstation (TMPW) to support ground force operations and to serve in transitioning existent and emerging terrain visualization, tactical decision aid and mission planning technologies to the field.

PURPOSE

The TMPW's primary mission is to apply terrain visualization techniques in support of mission planning processing needs. The TMPW is intended for use at brigade, battalion or lower echelons and will provide the battlefield commander the capability to accurately visualize the battle area. The battlefield commander can perform a broad range of analyses by using terrain data, weather information data, current operations/intelligence data, and planning support overlays. By using these analyses, the commander can better perceive the impact of the terrain and environment on his mission. The system initially supplements and will eventually replace interpretation of maps and other graphical planning aides by permitting visualization of the terrain. By using the system, planning can be accomplished more quickly and effectively thus increasing the probability of a successful mission.

FUNCTIONAL DESCRIPTION

The primary functional areas of the TMPW are mission planning, graphics support, tactical decision aids, and data management. A detailed description of these functional areas is provided in the sections that follow.

Mission Planning

The mission planning module represents the major function of the TMPW in that all the other modules support it. The mission planning module is used for either offensive or defensive operational planning. This module is divided into six different subfunctions. The six subfunctions are: determine required map coverage, identify area of operations, preliminary battle area analysis, assign areas of responsibility, analyze unit sectors, and prepare operations order/operations plan (OPORD/OPLAN).

Determine Required Map Coverage: This subfunction will allow the operator to select the required map coverage and scale. The map coverage is based on the Maneuver Control System's (MCS) Electronic Map (E-MAP) data. Once the required map coverage and scale have been selected, the corresponding map and associated

digital data will be loaded into system RAM. The map area selected will concurrently be displayed on the monitor.

Identify Area of Operations: After the map has been displayed, the operator will be able to display the control graphics contained in the operations overlay or create one if none are available. The operator will retrieve the saved overlay from the hard disk or create his or her own, by using the graphics utility function, if a saved overlay is not available.

Preliminary Battle Area Analysis: In this subfunction the operator will be able to display thematic overlays contained in the database on the electronic map background. The thematic overlays that may be displayed include surface configuration (slope), vegetation, surface materials (soils), surface drainage, transportation, and obstacles. This information is derived from the Defense Mapping Agency's (DMA) Interim Terrain Data (ITD) digital data product. The capability will exist to create changes in the overlay data by use of a "change" graphical overlay. This overlay will be independent of the terrain database and will be created by the operator. The overlay will consist of symbology that represents changes to the terrain features. If ITD data is unavailable, the system will notify the user that the data does not exist.

The operators will have a variety of decision aids at their fingertips to perform multiple analyses. The analyses will be used to assess the effect of the terrain and weather conditions on the mission. The weather data is based on historical data and is incorporated in the mobility Tactical Decision Aids (TDAs). The effect of terrain and weather will be based on the five military aspects of terrain. These five aspects are; observation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach (OCOKA). The results of the analyses may be displayed on the map background. The data obtained from the preliminary analyses may be used to create an operational overlay by accessing the graphics utility module.

Assign Areas and Responsibility: In this subfunction, the operator will be able to place symbols representing available units on the terrain and give them tactical tasks to accomplish. Courses of action can be developed to accomplish the tactical tasks by constructing or inputting an operations overlay to show how subordinate units will be utilized and controlled. The courses of action will be based on the preliminary battlefield analyses. Decision aids will also be available to the operator for additional input. By developing courses of action, the operator can assess a variety of solutions to tactical problems and plan accordingly.

Analyze Unit Sectors: After deciding how the subordinate units will be deployed, the operator can analyze every sector to assess its suitability. The electronic map and overlays are used to measure the impact terrain and weather have on the assigned sectors. Based on the analyses, the operator can evaluate the

ability of the subordinate units to perform the assigned tasks and make adjustments if necessary. Adjustments may be in the form of repositioning or reorganizing the subordinate units.

Prepare OPORD/OPLAN: After the final modification to the operations plan has been made, the corresponding electronic overlay for the OPORD/OPLAN will be prepared. The overlay will then be sent to the printer and will be printed in the form of a screen dump.

Graphics Support

The graphics support module will enable the operator to generate two or three dimensional maps and terrain displays of the specific area of interest. This module is divided into three different subfunctions. The three subfunctions are; electronic map display, terrain perspectives and graphics utilities.

Electronic Map Display: The electronic map display will support the standard map scales of 1:50K, 1:250K, and 1:1M. The electronic map display will be based on E-MAP data produced by the MCS and will have a declutter option. The capability will exist to overlay tactical decision aids and mission planning overlays, in any combination, as well as symbology per U.S. Army FM-101-5.

Terrain Perspectives: Three dimensional terrain perspectives, from any point and orientation within the area of interest, will be generated from DMA's Digital Terrain Elevation Data (DTED). Future modifications to the TMPW include generating terrain perspectives using a progressive refinement technique. The progressive refinement technique will allow the operator to construct three dimensional scenes starting with an interactive wire mesh followed by a series of steps allowing the operator to selectively add more realism to the scene. Realism will be added by the augmentation of color, sun shading, and the draping of SPOT/Landsat imagery draped over the elevation data. Symbology, tactical decision aid overlays, and other graphics overlays may be displayed in any combination on the elevation data as well as the electronic map display with the option to selectively declutter. The operator will have the capability to print, in color, the perspectives and overlays as a "window dump," which will represent a reasonable reproduction of the window contents.

Graphics Utilities: The graphics utilities necessary to create and edit overlays will be available on the TMPW. The utilities include a library of symbols that are used in tactical planning. These symbols will be in accordance with U.S. Army FM 101-5. The system will have the ability to move individual symbols on the display by using the mouse buttons. Other utilities available on the TMPW include coordinate transformation software and the on screen display of coordinates relative to the corresponding background.

Decision Aids

The TMPW will have a library of tactical decision aids that will be used by the mission planning module in support of planning tasks. The tactical decision aids will be thematic overlays or product overlays with respect to the Army's OCOKA guidelines.

Thematic Overlays: The thematic overlays that will be available to the operator include: transportation, railroad, drainage, soil, vegetation, and slope overlays.

OCOKA Overlays: The OCOKA overlays that will be available to the operator include: masked areas, driver visibility, concealment, obstacles, bivouac sites, drop zones, helicopter landing zones, helicopter survivability zones, avenues of approach and mobility overlays.

Data Management

The data management module controls all of the data accessed by the mission planning and decision aid modules. The standard databases will be read only, so that inadvertent changes cannot be made by the operator. The data management module is comprised of two subfunctions. The two subfunctions are database management and data transformations.

Database Management: The database management subfunction controls the storage and retrieval of data from all databases. The standard terrain databases used by the TMPW include E-MAP (Electronic Map Data), DTED Level I and Interim Terrain Data (ITD). Updates to the standard terrain databases will be supported through the creation of update overlays. Examples of updates are anything that can change as a result of military operations such as minefield locations or transportation barriers. Other overlay and graphic control files critical to battlefield analysis may also be created and updated by the operator. These overlays include operations, intelligence, and logistics overlays.

Data Transformation: The data transformation subfunction provides the capability to transform standard data formats to internally used data formats. The transformations for the standard data sets used by the TMPW will be part of the system's resident software.

STATUS

The Phase I effort for the SBIR contract ended in February 1991, producing functional specifications and a conceptual design for the implementation of the TMPW. The Phase II effort is currently under way and expands upon the work performed during Phase I. The Phase II effort involves software design, development and integration.

The hardware for the TMPW consists of a Hewlett Packard (HP) 9000 series 425t model computer with a 19 inch 1280x1024 color monitor and two 400MB internal disk drives, HP PaintJet XL color graphic printer, 4mm Digital Audio Tape (DAT) drive, 1/4 inch Cartridge Tape Drive and a CD ROM drive. This hardware is compatible with the Army's current Common Hardware suite.

The TMPW is being developed using the Unix operating system. The Graphic User Interface for the TMPW is based on X-Windows with the OSF/Motif graphics widget set. This is consistent with the Army's plan to standardize their Soldier Machine Interface (SMI) around X-Windows. Although some preexisting code has been written in the C programming language, the remainder of the software is being developed in the Ada programming language. The software for the TMPW is device independent and will be portable to other computer platforms.

The TMPW program is scheduled to be completed by May of 1993.

CONCLUSION

The completion of this SBIR effort will result in a fieldable software prototype implemented on the ACCS-CHS platform. TEC plans to revisit many of the agencies and Army schools which assisted in the development of the TMPW functional specification to demonstrate and improve the baseline capabilities developed under the SBIR program. TEC will assist potential users and developers in the transfer and integration of the TMPW technologies into their respective systems. Currently, the Special Operations Forces community is looking at the TMPW to see if this technology can be incorporated into the Special Operations Forces Planning and Rehearsal System (SOFPARS).

Future enhancements that are being considered include obtaining data from other sources such as the Terrain Information Extraction System (TIES), implementing a relational database for textual information and implementing networking software for communications with other systems.

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