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MARINE AIR GROUND TASK FORCE (MAGTF) TACTICAL WARFARE SIMULATION (MTWS)

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Abstract

The Marine Air Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS) is the next generation training system for the U.S. Marine Corps. MTWS is designed to support training of tactical commanders and their staffs in Command Post Exercises, Field Exercises, and exercises involving a combination of live forces and simulated forces. This paper provides an overview of the MTWS system hardware and software, including basic design philosophy, exercise control concept, and combat modeling approach.

1 GENERAL DESCRIPTION

1.1 Purpose

The Marine Air Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS) is a computer-assisted warfare gaming system designed to support training of U.S. Marine Corps commanders and their staffs. MTWS will primarily be used in Command Post Exercises (CPX) in which combat forces, supporting arms, and results of combat are modeled by the system. MTWS will also be used in Field Exercises (FEX), in which all or part of the combat forces are actual military units. In FEX play, the system is used to record and monitor the actions of the live forces, rather than simulating those actions as in CPX play. MTWS can be used to plan tactical operations, and to evaluate the plan under alternative enemy or environmental conditions.

1.2 History

MTWS is replacing the Tactical Warfare Simulation, Evaluation, and Analysis System (TWSEAS). TWSEAS was fielded in 1976 and has been used to support hundreds of exercises at four operational sites: I Marine Expeditionary Force (I MEF), Camp Pendleton, California; II MEF, Camp Lejeune, North Carolina; III MEF, Okinawa, Japan; and the Marine Corps Combat Development Command (MCCDC), Quantico, Virginia. MTWS builds on most of the functional capabilities of TWSEAS, but expands the quantity of game objects that can be represented and provides enhanced combat models. Operating on modern Reduced Instruction Set Computer (RISC)-based processors, MTWS provides a significant upgrade over the militarized computer equipment used in TWSEAS.

1.3 Simulation Functions

MTWS provides a full spectrum of combat models required to support U.S. Marine Corps exercises. The major functional areas are Ground Combat, Air Operations, Fire Support, Ship-to-Shore, Combat Service Support, Combat Engineering, and Intelligence. The system provides limited play in Electronic Warfare, Communications, and Nuclear, Biological, and Chemical Warfare. MTWS uses digitized terrain files for trafficability, cover, and elevation data in the area of operations. Weather conditions can be described, with resultant effects on ground and sea movement, air operations, and visibility. Simulation functions are described in more detail later in this paper.

2 TRAINING CONCEPT

At each operational site, the MTWS system is supported by a Tactical Exercise (TACEX) Team. The TACEX Team consists of system and warfare gaming specialists that assist the user community in planning, set-up, conduct, and evaluation of exercises. User units come to the site with a set of exercise objectives. Together with the TACEX Team, Landing Force order-of-battle, landing plans, initial scheme of maneuver, enemy force disposition, and other game conditions are defined. Using the system, initialization files are built and saved to describe these conditions. Personnel from the user unit are assigned controller responsibilities. The exercise

control personnel play assigned roles, such as subordinate or adjacent unit commanders, or supporting arms staffs. Initial planning for the exercise must identify those roles and the training participants. MTWS is a two-sided game, requiring a human-controlled Opposing Force (OPFOR). Generally, OPFOR is played entirely within the exercise control staff.

Exercise controllers operate the MTWS equipment during the game. The personnel targetted for training (for example, a Battalion commander and staff) do not directly interface with MTWS. In fact, from their point of view, there is no computer system involved. It is the responsibility of the exercise control staff, with the TACEX Team, to ensure an effective training environment is created and maintained. The commander and staff function as they would in the field, employing the tools and resources that are available to them in the tactical environment. They communicate with the exercise control staff over tactical communication nets that have been set up with standard field radio equipment or using commercial telephone or intercom systems.

During conduct of a CPX, MTWS provides information on the tactical situation to the control staff. This information includes status of air missions or landing operations, delivery of supporting arms, detection of enemy forces, assessment of losses, and other data necessary to describe the ongoing situation. The controller can solicit specific information from the system through requested reports. Unsolicited reports (spot reports) are generated within the simulation and sent to appropriate controller stations to inform the controller of significant events that have occurred involving his units of interest. Orders received from the commander and staff are converted by the exercise control staff into commands to the system to direct the forces accordingly.

3 DESIGN PHILOSOPHY

3.1 Operator Control

MTWS was designed with a simple philosophy: the controller, not the simulation software, drives the game. The control staff, under the guidance of an Exercise Director, has the responsibility to ensure training objectives are met. It is imperative, then, that the system enable the controller to obtain any information, to perform any action, and even to "un-do" any simulation result in order to manage the exercise and to create situations that will stimulate command decision-making to achieve training objectives. It is assumed that the control staff has been properly trained and accepts the responsibilities of the position. Can the controller "cheat" by causing an action in the simulation that is unrealistic? Yes. Can the controller obtain information that would not normally be available to a command staff? Yes. Safeguards against such actions would undermine the basic philosophy. Again, it is assumed that the controller takes the assignment seriously and performs his assigned role professionally.

However, to assist the Exercise Director in managing the control staff, MTWS provides a password protection scheme on each controller workstation. The Director can selectively restrict controllers to limited sets of commands and information. This can be done to simplify controller training (teach them only what they need to know for a particular assigned role) or to reduce the possibility of accidental entry of commands that do not fall within the scope of the controller's responsibilities.

3.2 Semi-Automated Forces

A generally recognized problem in wargame control is the difficulty controllers have in managing their assigned game objects and in keeping up with the rapid pace of modern, dynamic combat situations. One approach to reducing the number of actions a controller needs to take is the use of semi-automated forces (SAF). This means the software attempts to make reasonable tactical decisions based on the battlefield situation, relieving the controller of low-level management of the maneuvers and actions of the forces.

In its ground combat model, MTWS provides two levels of control over the actions of ground units. First, the controller can use override commands to exercise explicit, detailed control over various aspects of the unit, including posture, formation, front, movement speed, and response to enemy threat. Alternatively, the controller can allow the simulation to model these tactics. Based on parametric data defined by the control staff, MTWS will perform these actions. For example, a unit will improve its posture over a period of time; given a mission, a unit will assume a default formation for conduct of that mission; the software will compute a movement speed based on the capabilities of the unit's assets, weather conditions, or terrain trafficability; the software will determine a course of action in light of the enemy threat a unit faces. Semi-automated capabilities are available for the convenience of the controller. The controller has the freedom to perform some or all of these actions as overrides or to leave some or all of the actions to the discretion of the software. Remember the fundamental philosophy - the controller drives the game.

4 SYSTEM ARCHITECTURE

MTWS executes on a distributed architecture consisting of three (3) simulation processors, a system control workstation, and up to twenty-six (26) controller workstations (in the delivered configuration). The simulation processors perform the combat models. The system control workstation manages the exercise clock, external system interfaces, and data conversions between the simulation processors and the controller workstations. The system control workstation has two Ethernet ports. One Ethernet connects the system control workstation with the simulation processors. The second Ethernet connects the system control workstation with the user workstations. All computers in the system have been procured from the TAC-3 contract (the system control workstation and the simulation processors are Hewlett Packard 9000/750s; the controller workstations are Hewlett Packard 9000/730s).

The MTWS software consists of three Computer Software Configuration Items (CSCIs), generally corresponding to the hardware architecture: (1) MTWS Application Network CSCI - combat models; (2) MTWS System Control CSCI - system operations, exercise control, data management, and report generation; (3) MTWS Display System CSCI - command entry, spot report output, report request and display, map display, and tactical situation display.

5 DEVELOPMENT APPROACH

MTWS is being developed by the Navy Command, Control, and Ocean Surveillance Center Research, Development, Test, and Evaluation Division (NCCOSC RDTE DIV, Code 44203), San Diego, California, under work agreement to the Marine Corps Systems Command (MARCOSYSCOM, PM, Training Systems), Quantico, Virginia. Prime contractor for the development is VisiCom Laboratories, Inc., San Diego, California. MTWS was developed in accordance with the guidelines of DOD-STD-2167A, Military Standard, Defense System Software Development. Computer-Aided Software Engineering (CASE) tools were used to describe software requirements and system top-level architecture (preliminary design), and to generate initial code structures from the design. The MTWS development team was the first within NCCOSC to use the formal inspection methodology. The system is written in Ada (95%) and C (5%), and consists of approximately 200,000 source lines of code (not counting comments), plus a Government-provided map server product for management and display of digitized maps. The system is currently undergoing Formal Qualification Test prior to delivery to the sites.

6 FEATURES

6.1 Terrain

MTWS games can be played anywhere in the world, from 80 degrees north latitude to 80 degrees south latitude. Digitized terrain data is usually obtained from Defense Mapping Agency (DMA) Digital Terrain Elevation Data (DTED) and Digital Feature Analysis Data (DFAD). The system allows the user to enter up to 4 million data points, or roughly equivalent to a 200 kilometer per side square at 100 meter terrain accuracy, o a 1000 kilometer per side square at 500 meter accuracy. The digitized area does not have to be contiguous, but can be initialized as a number of smaller areas.

MTWS models use elevation data to compute line-of-sight, trajectory masking, and terrain gradient affecting speed of movement. Terrain files also provide vegetation cover indexes affecting visual detection from the ground and from the air, and trafficability indexes affecting rate of movement for foot, wheeled, and tracked mobility. Elevation, vegetation cover, and trafficability are computed at intervals depending on the desired resolution of the digitized data.

Natural terrain features are entered by user command. They are not currently obtained directly from DMA data. The user can describe such features as rivers, cliffs, lakes, and swamps. In each case, the user indicates the effect on movement (impassable or movement reduction factor).

6.2 Tactical Display

MTWS employs a mapping system developed by the Navy for command and control applications. This system was predecessor to the Chart 2.0 map server product now identified for the Unified Build, and has very similar features. The user can access and display digital images of paper map products, satellite photographs, or vector shorelines. The user can pan right/left/up/down, zoom in/out, and recenter the maps. Tactical symbology is overlaid on the map image to present a fully integrated display of the combat situation. Symbology includes ground unit symbols, air and surface tracks, ground detections, and manmade obstacles, barriers, minefields, and structures. MTWS provides a number of selectable categories of displayable objects to enable the user to declutter the tactical scene and to view specific objects of interest.

6.3 Parametric Data

MTWS combat models are highly data-driven. Parametric data describes weapon and platform characteristics,

detection ranges, weapons effects, water and ration consumption rates, and other aspects of the simulation. MTWS provides a parametric data editing capability to allow the user to alter model behaviors or to represent new combat capabilities.

A major item of equipment, such as a tank or artillery gun, is represented in parametric data as a platform and associated components, such as the main gun and secondary weapons. The platform component defines mobility characteristics such as movement speed and type (tracked, wheeled, towed). Individual components, such as a radar or a tank gun, are separately characterized and associated with the platform. This approach gives the user the ability to construct a variety of equipment items, having real or proposed characteristics.

Part of the user-editable parametric data files contains identification of troop and equipment allocations (table of organization/table of equipment) for various U.S. and foreign forces. This feature facilitates initialization of an exercise data base by allowing the user to identify the type of object to be represented. All associated assets for that object are then automatically created based on the template stored in parametric data. For example, by specifying a USMC tank platoon, the troops and assets appropriate for that unit are created in the exercise data base.

6.4 Models

A thorough presentation of MTWS model features is not possible in this paper; however, some key capabilities are highlighted in the following paragraphs.

6.4.1 Ground

The MTWS ground combat model provides for the direction, management, and simulation of close combat activities for both simulated and real exercise units. Ground unit representations include formation, front, heading, posture, assigned mission, and asset. Ground movements are affected by such factors as terrain or road trafficability, weather conditions, equipment mobility characteristics, natural and man-made obstacles and barriers, crew availability, and fuel availability. Enemy forces can be detected visually, aurally, or by the use of sensors (ground surveillance radar or ground emplaced sensor). As described earlier, controllers can exercise explicit command over ground units, or can allow the software to perform semi-autonomous actions to respond to the threat environment.

6.4.2 Air

MTWS models the following types of air missions: air reconnaissance, combat air patrol (CAP), airborne early warning, escort, transport, medical evacuation, tanker, ferry, deep air support, close air support, and armed reconnaissance. Both fixed wing and rotary wing aircraft can be represented in the system. Aircraft launch and recovery can be affected by weather conditions or air base status. Aircraft availability for further missions is affected by aircraft turnaround time and maintenance factors. Air defense play includes surface-to-air weapons free/tight tactics and vectoring of CAP aircraft to intercept an enemy track. Airborne radar or passive electronic support measures can be used to detect other air or surface objects.

6.5 Ship-to-Shore

The ship-to-shore model in MTWS is a component that makes the system unique compared to other simulations of similar scope. Amphibious landing plans and contingency plans can be prepared and rehearsed in the simulated environment prior to deployment. The controller can identify beaches for surface assaults or landing zones for airborne assaults, amphibious shipping from which pre-loaded landing craft are launched, transport areas, rendezvous points, and lines of departure. Assault forces and cargo can be serialized for surface-borne or airborne transport ashore. Serials can be assigned to scheduled or non-scheduled (on-call) waves. The system represents the variety of operational options, including over-the-horizon, underway launch, beaching, and causeway offloading. In the late stages of amphibious operations, general unloading is provided to expedite movement of remaining units and cargo ashore.

6.6 Fire Support

The MTWS fire support capability includes ballistic weaponry such as artillery, mortars, multiple rocket launchers, surface-to-surface missiles, and naval gunfire, as well as guided weapons such as surface and air launched cruise missiles and cannon-launched guided munitions. Fire missions can be scheduled, predefined for on-call initiation, or called for immediate fire. Split battery operations can be performed.

MTWS provides representation of control measures, including Coordinated Fire Lines, Fire Support Coordination Lines, Fire Support Areas, unit boundary lines, phase lines, Airspace Coordination Area, No Fire Areas, Restricted Fire Areas, Restricted Fire Lines, and Reconnaissance Area of Operation. Control measure violations are reported to the controllers as advisory

messages only. The system does not prevent the controller from conducting a desired mission.

For counter-battery operations, the system models use of Counter-Fire Radars and crater analysis to estimate back-azimuth to the firing battery. Ground-based supporting arms can be suppressed by air-to-surface fire, by direct fire engagement, or by receipt of indirect fire.

6.7 Combat Service Support

MTWS models consumption of ammunition, fuel, water, and rations during the exercise to create opportunities for Combat Service Support (CSS) play. The controller can plan and coordinate resupply operations from beach supply areas or other supply points using ground, air, or water transportation assets. The controller also has the option to cause immediate resupply of a unit when appropriate for game execution.

CSS operations can be performed to send out repair teams to repair damaged equipment or to evacuate damaged equipment that cannot be repaired in the field. Ground, air, or water evacuation of human casualties can also be conducted.

6.8 Combat Engineering

MTWS enables the controller to construct, instantaneously or over time, structures, obstacles, barriers, minefields, roads, and bridges. Bridges can be defined to span specific natural or man-made barriers. Combat Engineering (CE) operations are also provided for clearing minefields and removing obstacles and barriers. The duration of an operation performed over time is based on availability of the assigned CE unit, the size of the unit, and the type of activity to be performed.

6.9 Nuclear/Biological/Chemical

MTWS provides a limited nuclear, biological, and chemical (NBC) warfare capability. NBC weapons can be delivered by air or surface fire. Use of nuclear weapons causes casualties and damage based on the initial blast effect, and on a residual radiation area created by the blast. This area moves and expands in the direction of the wind. Employment of persistent biological or chemical weapons creates a contaminated area that affects exposed troops in the area or who later enter the area. The intensity of contaminated areas and radiation areas decreases over time.

Units can be placed in NBC readiness by employing Mission-Oriented Protective Posture (MOPP) gear. Effects of exposure to NBC contaminated areas are neutralized by use of MOPP gear, but troops fatigue more rapidly, especially in conditions of high humidity and high temperature.

6.10 Casualty and Damage Assessment

The MTWS casualty and damage assessment (CDA) model partitions weapons effects into four categories: point assessment, both guided and unguided - weapons that are launched or fired against a specific point target such as a tank or vehicle; area assessment, both guided and unguided - weapons that are launched or fired at a location with the intent of affecting all objects in the vicinity of the target location. For point assessments, a probability of kill is used based on the targeting accuracy of the firing weapon (probability of hit), and the destructiveness of the ordnance together with the hardness of the target (probability of kill given a hit). For area assessments, impact point locations are computed based on the accuracy of the firing weapon or guidance system. Damage caused by area assessments is computed considering the mean area of effectiveness of the ordnance, proximity of the target object to each impact point, and hardness of the target.

For weapon systems, MTWS categorizes damage as catastrophic kill, mobility kill, or firepower kill. Landing craft and aircraft losses are categorized as destroyed only. Troop casualties are categorized as wounded - routine, wounded - priority, wounded - emergency, and killed in action. The presence of wounded personnel reduces the combat effectiveness of the unit.

6.11 Weather

The controller can define "global" weather conditions in a base weather zone. Attributes of the base weather zone include temperature, visibility, cloud cover, precipitation, humidity, sea state, and wind speed and direction. Up to five (5) circular weather zones can be created to describe "localized" weather conditions: temperature, humidity, visibility, etc. The local weather zones move at the speed and direction of the "prevailing winds"; i.e., the speed and direction of wind in the base weather zone. Weather conditions can affect a number of models in the system, such as ground and water movements, air launch and recovery operations, visual detections, water consumption rates, and air reconnaissance effectiveness. While simplistic, this approach enables the control staff to create a variety of conditions to impact the tactical environment.

6.12 Physiological/Psychological Factors

During an exercise, simulated units in MTWS can alternately grow weary or become rested based on periods

of activity or inactivity, respectively. Fatigue can also be affected by weather conditions, availability of water, and use of MOPP gear. The fatigue level of a unit can affect movement and effectiveness of fire.

During combat, a unit may decide to initiate a withdrawal when a user-assigned casualty limit is reached (when ground combat logic is under control of the software, rather than under controller override). The casualty limit is defined as the portion of initial combat power the unit is able to lose before initiating withdrawal.

Ground units may be suppressed by direct fire, indirect fire, and air-to-surface delivery. While suppressed, the volume of fire from the unit is reduced.

7 FUTURE CAPABILITIES

Following initial delivery of the system to the U.S. Marine Corps, a number of enhancements are being considered for incorporation into MTWS:

a. Position Location Reporting System (PLRS). MTWS will interface to PLRS to obtain near-real time position information on actual units in the field. This information will enable the exercise control staff to monitor the movements of forces participating in field exercises.

b. Marine Tactical System (MTS). The MTS communications protocol and message standard will be implemented to enable MTWS to interoperate with Marine Corps tactical automated command and control systems. During an exercise, MTWS will model the evolving tactical situation and stimulate the command and control systems to support operator training, operational test and evaluation, and the ongoing mission of command staff training.

c. Unified Build Map Server. The current map server product will be replaced by the Unified Build map server. This will provide MTWS with similar "look and feel" to other Navy command and control systems in service and under development.

d. Aggregate Level Simulation Protocol (ALSP). Basic connectivity and "ghosting" of surface and air entities has been developed in MTWS and successfully demonstrated in ALSP confederation testing at the National Simulation Center, Ft Leavenworth, Kansas, and at the Warrior Preparation Center in Germany. MTWS will participate in the Ulchi Focus Lens '94 (UFL-94) joint exercise in August 1994 as an ALSP confederation listener only. Modifications to MTWS are in progress to enable the system to interface with the confederation for air-to-air, air-to-surface, surface-to-air, and naval gunfire interactions.

8 SUMMARY

When delivered, MTWS will be a state-of-the-art tool for conduct of tactical command staff training. It will stand as an example of the application of modern software engineering practices and open systems architecture concepts to warfare simulation. Its modeling breadth and flexibility will enable the U.S. Marine Corps to represent and exercise a wide variety of combat scenarios to prepare leaders who are ready to face the military challenges of today's world.

AUTHOR BIOGRAPHY

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