THE ECONOMICS OF PORTABLE TRAINING SIMULATION SYSTEMS

by

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ANTEKNA, INC.

The involvement of the United States Navy with complex multiple emitter EW training systems has been both extensive and long term. We know this at Antekna, because during our six year corporate history the Navy has provided millions of dollars to support the development and deployment of three large scale electronic warfare training simulation systems, the 7B1/1 and the 10A3/1 and 10A3/2, using our modular standard product concept. As our largest customer, the Navy's commitment to excellence in training achievement through the use of sophisticated RF and video simulators is exemplified by the high level of interest in our concepts and technology. Our commitment to meet the Navy's training needs is illustrated not only by Antekna's performance in the past. It is our dedication to the future by expenditure of time, personnel, and Antekna funds to develop new technologies and products specifically designed to help solve new Naval training requirements that best illustrates our corporate commitment. One such newly developed capability is a single man transportable "suitcase" simulation device which economically provides multiple radar and communications emitters with complete dynamics of motion and fully automatic control. While laboratory and classroom trainers are highly useful, this new portable dynamic simulator, developed from our standard product technology, will provide a multitude of inexpensive new opportunities for training experience formerly precluded by the size and bulk of conventional simulation systems. When students or career personnel cannot be present in a classroom, this new system will carry the classroom to them. When a large multiple signal van or trailer cannot be cabled to a ship at dockside, this system will carry the training aboard. When a surface ship, submarine, or aircraft crew is on deployment, this system can be right there beside them to provide a realistic training scenario, anytime it is needed. For the first time, a really small, truly portable and completely self-contained stimulator is available to inject realistic high density training scenarios into operational equipment no matter where it is located. Now let's look at the portable dynamic simulation trainer.

The portable simulator equipment is designed to effect efficient on-station training of EW communications and radar operators in a variety of Naval applications. To attain this goal the system has been physically configured as a set of target generation, control, and interface modules which plug into ruggedized "carry-on" cases. A photograph of a typical "carry-on" case with a full complement of functional modules is presented in Figure 1. From a performance standpoint, the system is capable of realistically simulating complex threat emitters at either the RF or video levels. The system electronics is entirely solid-state and over 75% of the circuit cards and other component modules employed are identical with those in Antekna's time-tested classroom/laboratory product line. The system incorporates a high degree of control flexibility with capabilities ranging from self-contained digital magnetic tape cassettes to on-board computer control interfaces. Scenarios of up to 50 hours in length or more can be provided for either single ship or aircraft training or multi-location coordinated group exercises.

Paramount to the development of the portable simulator concept were the following key requirements:

- Cost Effectiveness (economy)
- High Transfer of Training
- Portability
- Modularity and Flexibility
- Reliability
- Signal Security
- Commonality with Existing Spares Inventories

In a very real sense the requirements for economy encompasses the majority of the remaining requirements. The portability of the equipment allows extensive utilization of the in-port or at sea training concept, thus eliminating the high cost of operating laboratory size equipment while still providing dynamic and realistic training on-station. The high degree of commonality with existing government spares inventories means lower costs in both provisioning hardware and documentation. Additionally, the equipment's solid-state reliability tends to lower spares hardware cost and provide more efficient training due to a higher percentage of equipment up-time.

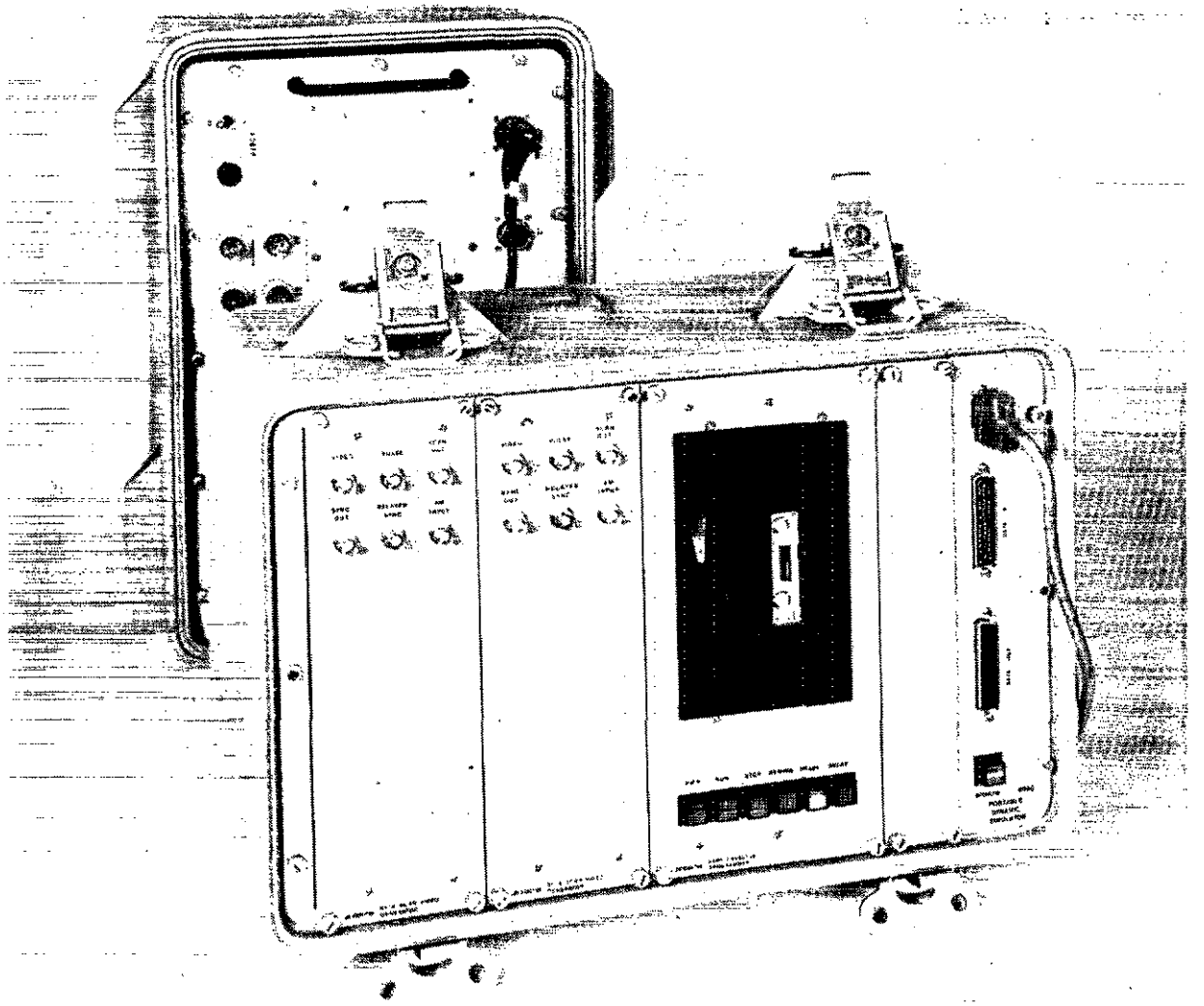

Figure 1. PDS 6000 Carry-on Case with Modules

A high transfer of training of "real-world" situations is achieved by the on-station application and by the high-degree of realism which the system provides. The latest in proven solid-state technology including Antekna's unique Memory/Oscillator module allows simulation of the most sophisticated threat systems. The systems programming flexibility allows insertion of all parameters by the user, thereby protecting the security of the program information. All signals can be directly connected at low-level RF or video resulting in extremely low signal emanations, allowing realistic signals to be used in training exercises without danger of unwanted detection. Radiation from ship to ship or ship to aircraft may also be used.

Operationally, a typical system consists of one or more carry-on "suitcases". These units would be connected to the operational equipment by a very limited number of cables. Scenarios of up to 50 hours length may be run with student/scenario interaction. Scenario control can be accomplished by several means depending on requirements of the application.

- By direct control of a self-contained digital tape cassette.
- By control data received via RF communications channels including FLEETSATCOM.
- By control data from on-board digital computer equipment including the AN/UYK series.

Scenarios for the digital cassette programmer use a conversational scenario generation program. The non software-trained user is thus able to generate complete threat training routines.

A great deal could be said about the requirements for dynamics of simulation in equipments which replicate real scenarios of actual conditions as seen in the operating environment. For brevity here, it will suffice to simply list some necessities the portable simulator provides. Most are encountered sooner or later in the complex EW environment:

- Motion (scanning) of the threat antenna
- Motion (scanning) of the receiving antenna
- Relative motion of both the friendly receiver and the threat radar
- Relative motion of ECM versus radar positions
- Changes in target signature including PRR, pulsewidth, center frequency, frequency hopping, chirp, slides and jumps
- Mode changes from active to passive
- Threat coordination and interaction
- Guidance and command controls different from "normal" radar signals
- Pulse groups and pulse codes in the RF environment
- Mode changes in ECM and "smart" jamming
- Anomalies due to tuning and other equipment "quirks"

This brief description sets forth the salient physical characteristics and the performance of the Portable Dynamic Simulator.

Simulation Signal Format: RF or Video at user's option.

Target Types: EW Threat Emissions and Radar Skin Return.

Physical Configuration: Modular Target Generators housed in rugged "carry-on" cases. Number of cases determined by complexity of simulation required.

Scenario Control Input: Pre-recorded Digital Cassette Tape, or Data from Common Carrier or private Comm. channels, or Direct Connection to Scenario Data Computer, or Manual Control via simulator panel switches.

Simulation Dynamics: 3-Dimensional Target Motion and Target Signature Change.

Scenario Interaction: Provides dynamic interaction between Active ECM equipment and the simulated scenario.

Multi-Location Coordination: PDS systems located at physically different locations may be coordinated by means of common carrier or RF Comm. channel data connection.

Target Multiplex Capability: Up to 16 different RF targets may be generated by a single target module by time-multiplex techniques.

Built-In-Test: Equipment incorporates a diagnostic self-test system for rapid determination of operational condition and fault isolation.

Signal Fidelity: System incorporates capability for complex pulse trains, pulse compression, pulse doppler, frequency diversity and barrage jammer simulation.

The system 6000 PDS consists of the following basic types of modular components:

- Target Generator Modules
- Control Modules
- Interface Modules

Each suitcase system is capable of simulating EW radar emitters having all parameters under full control of the scenario program.

Frequency Range: 0.5 GHz to 18.0 GHz in 6 Octave Bands.

Target Multiplexing: Up to 16 separate RF target signals may be produced by a single RF Module by Time Multiplexing.

Output Power Level: 0 dbm Nominal

Dynamic Range: 60 db Nominal

Frequency Change Time: 4 μs maximum

Frequency Resolution: 0.1%

Absolute Frequency Accuracy: Better than 2%.

Frequency Modulation Response: 100 Hz to 5 MHz.

Amplitude Modulation Linearity: Typically ±2 db from straight line.

Simple Repetitive Pulsetrain: Pulse Repetitive Interval (PRI)

0.2 μs - 99.90 μs in 0.1 μs increments
1.0 μs - 999.00 μs in 1.0 μs increments
0.01 μs - 9.99 ms in 10.0 μs increments

Pulse Width: Variable from 100 nanoseconds to 1 millisecond.

The system is capable of generating arbitrary complex pulsetrains of up to 16 pulses in length. The width of each pulse as well as its time-of-arrival relative to the immediately preceding pulse may be independently specified.

Antenna Scan Simulation Characteristics: Circular/Conical/Unidirectional Sector/ Bi-Directional Sector/Raster/Spiral/Palmer.

Performance Characteristics for Circular, Sector and Conical Scans are 99 Hz.

Beam Width: 1 - 60° in 1° increments

Sector Width: 1 - 360° in 1° increments

Lobe Amplitude Adjustments: 1st side lobe, and back lobes - 0 to 40 db below main lobe in 1 db increments.

Sector Scan Offset: 1 - 359° in 1° increments

Conical Scan Track: Adjustable from "lock-on" to "search".

Palmer Scan Rates: 10 - 100 Hz

Spiral Scan Performance Characteristics: Frame Rate 0.16 Hz to 20 Hz.

Raster Scans of numerous variables are also provided.

The dynamic motion of EW targets is simulated by applying suitable amplitude or phase modulation to the signal to emulate the effects of the operational system's DF antenna. DF characteristics are:

Relative Bearing: 0 - 360°

Relative Bearing Accuracy: ±1° - ±10° (depends on operational equipment)

Target Range is simulated by varying the RF output power level, for example:

60 mi to 500 mi in 500 mi gaming range
25 mi to 200 mi in 200 mi gaming range
6 mi to 50 mi in 50 mi gaming range

The system utilizes plug-in functional modules housed in ruggedized carry-on cases. All connections with the exceptions of RF and video outputs, power and data lines are accomplished within the carry-on cases. The size of each carry-on case is about 18.5 inches wide by 15 inches deep by 16.5 inches high. The weight of each carry-on case when fully loaded with functional modules does not exceed 60 lbs and the carry-on cases are equipped with suitable handles to allow the case to be carried by 1 or 2 persons. Input power is 115 VAC, 50 to 400 Hz, 200 watts maximum per "carry-on" case.

Power supplies for the functional modules are within the hinged case lid. Signature data directed to the Scan/Video Module, Figure 2, command the generation of specific antenna scan pattern and pulsetrain signals. These signals are applied to the RF/MPX module in Figure 3 to modulate the RF output of this module. The RF frequency and power level are established by data input to here. The RF output from this module is now a realistic replica of the desired threat signal and is applied directly to the operational equipment input terminal.

Antenna Steering signals are measured by a DF module and compared with actual target bearing as specified by the digital data. When coincidence is detected between the antenna position and the target bearing, a gating signal is applied to enable the scan/video output. An ECM Interface accepts antenna steering signals as well as control position signals from the operational ECM equipment and compares these signals with the target parameters at that time. If effective ECM has been taken by the operator, data signals will be applied to the target generators to effect appropriate modification of the signal and its course.

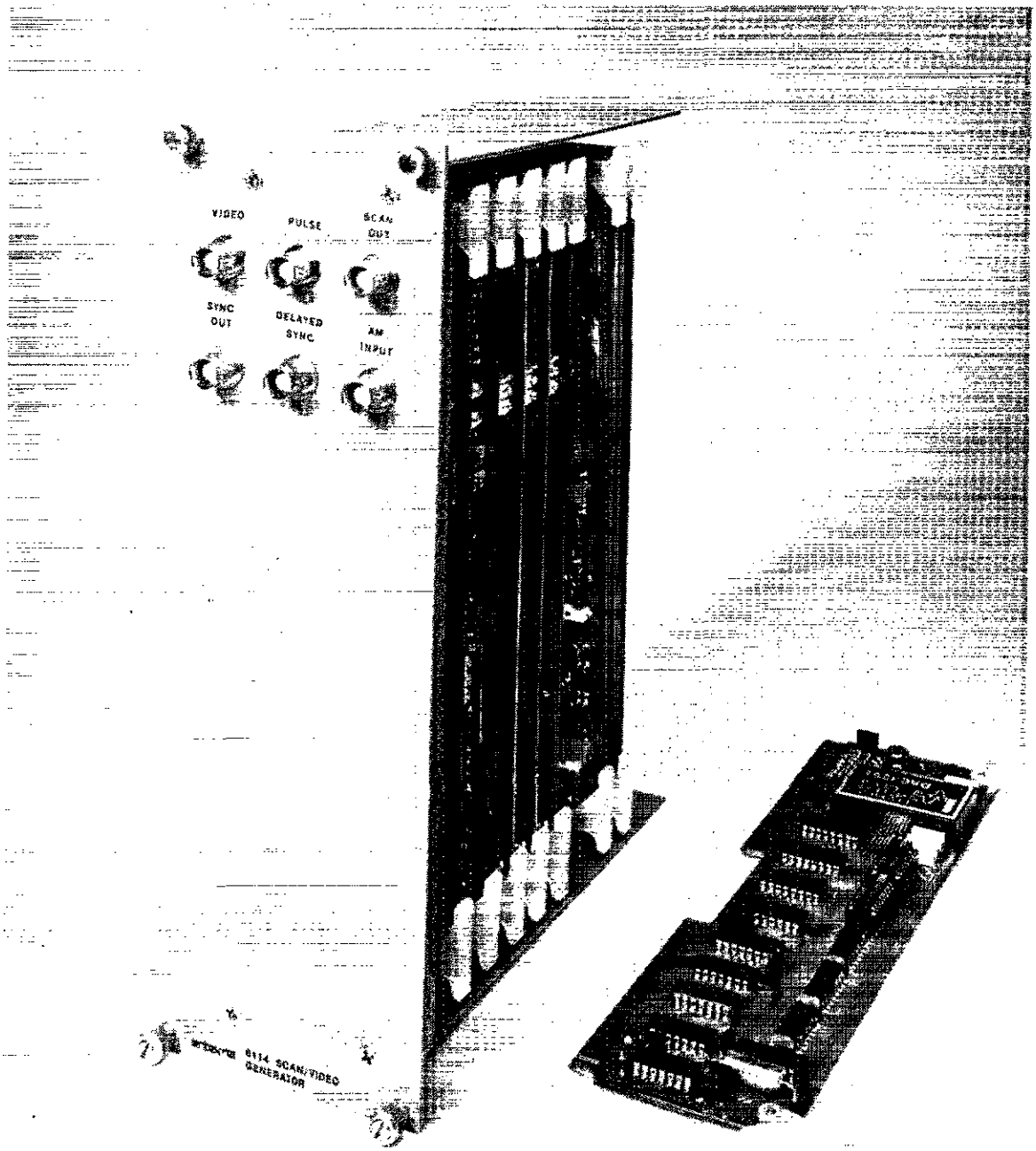

Figure 2. Model 6114 Scan/Video Generator

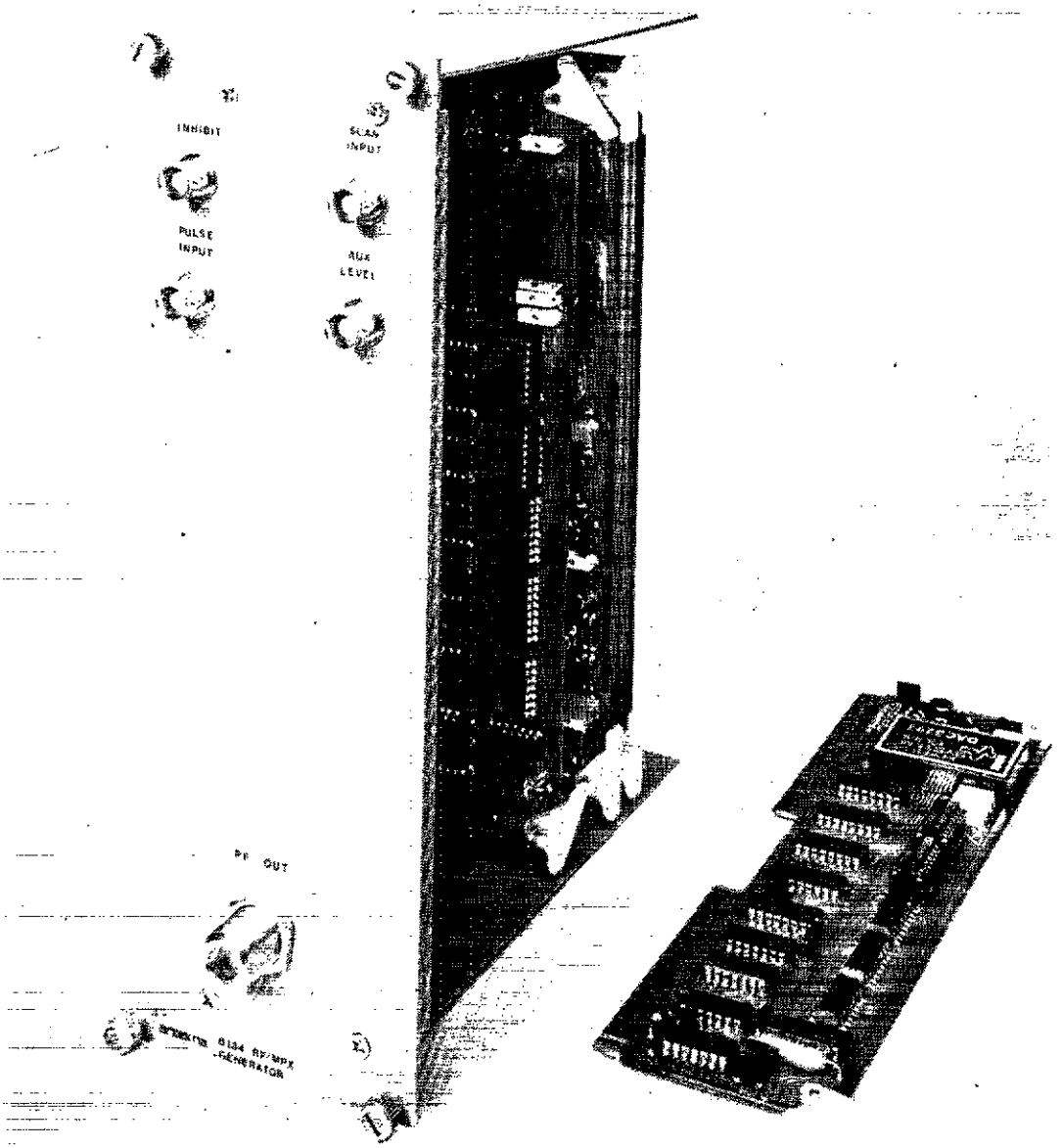

Figure 3. Model 6134 RF/MPX Generator

A Video Radar Target Generator Module generates MIL-STD-751 radar target video, size, range, and azimuth control signals which are programmed by the scenario data. These signals are then directly connected to the radar display repeater.

In conclusion, the portable dynamic simulator provides both new technology for training, and true Economics of Portable Training since:

- The system reduces reliance on pure classroom training
- Group exercises at sea or dock side can be inexpensively performed
- Much of the spares inventory exists now in government stock
- Training can be performed on an "as needed" basis
- The trainer/simulator can follow the operator - aboard ship, down the hatch of a sub, or into the air with the flight crew.

ABOUT THE AUTHOR

MR. TERRY E. BIBBENS is President of Antekna, Inc. A co-founder of the company in 1968, his primary activities include general management, long-term corporate business development and financial planning. From 1963 to 1968, he worked with Applied Technology, Division of ITEK, with responsibility for product planning for LCM equipment and solid-state amplifiers, analyzing technical EW intelligence, and development of long-range plans in the military electronic warfare market. Prior to this period, he worked with Eimac, Division of Varian, and was involved with product planning plus sales and development of the microwave common carrier reflex klystron for the commercial voice and data communications market. Mr. Bibbens has written numerous trade journal articles on application of microwave tubes, and a CREI textbook on vacuum microwave tubes.