SUMMARY

In summary, the large screen real-time projector described is an advanced state-of-the-art equipment. Being a CRT, it can be utilized in all applications where CRT's are used today and it is compatible with the driving requirements of current displays. It can provide to group audiences, those displays and data formerly available only to operators of individual consoles on a real-time basis. It is very flexible in operation and does not limit the system designer to update cycles or history trails which may be undesirable. No chemicals are involved nor is there a continuous consumable requirement. The low cost, long life projection CRT is readily replaceable. This system is without equal for the display of dynamic data in real-time to a group audience.

BUILT-IN TEST (BIT) FOR TRAINING DEVICES

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As trainer electronics grows in scope and complexity, a similar growth is required in the equipment needed to check it out. The importance of speeding the repair of trainer systems is being accentuated by the increasing complexity of computer systems, microminiaturization, incorporation of operational equipment and GFE, and the demand for realistic, cost-effective training. Many approaches are being investigated, including sophisticated off-line test equipment, built-in test (BIT), and fault-analysis systems that isolate the fault to a single black box. For some applications, automatic test equipments (ATE) are being considered that can be used to isolate the fault within a black box, indicate the needed repair, and check out the required unit for proper operation and adjustment.

Little thought and time were devoted in the past to the design of test and checkout equipment. It is now evident that the same consideration should be given to the design of a test equipment system as we give to the design of the trainer system. A thorough analysis must be made of the training requirement and of the mission of the test system and its environment. Trade-offs must be made between the constraints of cost, time, operator skill levels, accuracy, repeatibility, and user confidence to arrive at an optimum test system.

Since most training devices are unique, or at least limited in number, the justification for using a fully automated test system from the standpoint of cost-effectiveness is questionable. There is justification, however, for utilizing Built-in-Test (BIT) on the more complex trainers and life-critical trainers such as environmental chambers.
Some of the more important factors to consider when deciding to incorporate BIT are:

a. It aids in achieving a more maintainable trainer by reducing the MTTR (mean-time-to-repair), which ultimately results in a higher operational availability factor. The high level of availability (98.5% or higher) required by most using commands is achievable only by using highly reliable equipment supported by efficient test and maintenance concepts.

b. It makes possible the diagnosis of failures in complex systems where manual methods of fault detection and fault isolation are impractical.

c. It reduces the maintenance manpower burden by reducing the overall maintenance man-hour and skill level requirements. The life-cycle cost of assigning three extra Navy TD's (TRADEVMEN) to a training device for 10 years is on the order of a million dollars. In addition to reducing manning requirements and costs, BIT can guarantee a consistent performance capability for failure diagnosis independent of the individuals assigned.

d. It reduces the requirements for general and standard manual test equipment and the associated requirements for calibration and repair.

e. Easily repeated consistency standard tests can be quickly run and rerun with a minimum personnel effort during engineering test and checkout to certify most of the interval hardware operations.

BIT costs are decided by the level of failure identification desired. With the modular construction techniques used in trainer design today, the most cost-effective repair level is failure identification to an LRU (line-replaceable unit). In most cases the LRU will be a replaceable module such as a printed circuit card, and on occasion the LRU may be a functinal grouping of 2 or 3 cards or a small sub-assembly of a larger assembly. Specific fault isolation to a lower level and the repair/ discard decision can best be accomplished off-line at a later time. With this maintenance concept, the trainer will be back on the line quickly with a minimum loss of training time.

Let's take a look at what some contractors have done with BIT for training devices. We'll be looking at various degrees of sophistication, all the way from simple monitoring systems to computer-controlled test programs. Some of the more basic types of BIT are panel meters and indicator lamps. One of the first orders of sophistication would be to add a manual scanning system, which consists of a standard rotary switch connected to selected test points. Even this simple example of BIT can be made elaborate by use of a test point scanner which automatically feeds information to the meters and lamps.

When a failure occurs in a system, one of the initial steps the technician will take is to verify the condition and the very existence of his power. This can be accomplished in a variety of ways, perhaps by using a combination of methods. Is the unit "plugged in"? Is a blown-fuse lamp lighted (basic BIT)? Perhaps the maintenance man has available a Power Supply Status Panel such as that used in Device 2B24. The panel consists of a matrix of lamps which gives instant Go, No-Go confirmation of the condition of the power. A test lamp feature precludes a burned-out bulb giving an erroneous indication. A very simple, yet useful example of BIT.

Most complex training devices already have the necessary equipment to perform extensive testing, particularly those with digital computers.

Another, more complex form of BIT is "introspective testing". "Introspection" is the utilization of one part of a system to test the entire system. Many contractors are now using the main trainer computer for testing in response to the requirements of MIL-T-23991C, General Specification for Military Training Devices. Device 15E22, EA-6B Team Tactics Trainer is a good example of this application. The maintenance and test programs for Device 15E22 consist of a variety of open-loop and closed-loop test routines. These routines not only detect faulty assemblies and modules, but they also indicate the nature of the failure. There are five basic categories of test programs:

a. Test Exercise Program - Checks the accuracy and flow of signals between the computer and all signal sources and terminal points in the trainer. The program is also used to calibrate the interface equipments and all displays and controls, and it is capable of exercising the equipment in both static and dynamic modes.

b. Daily Readiness Check - Determines visually that the trainer is ready for operation. This check uses automatic sequencing through a series of static outputs, utilizing the normal iteration rate of the main simulation program. A provision is also made for stepping through the programs or portions thereof, incrementally to verify the desired outputs. The type and nature of all failures are permanently recorded through the use of a teletypewriter.

c. Computer Diagnostic Programs - Commercially available diagnostic programs are used for the computer system.

d. Real-time Interface Equipment Diagnostics - Enables on-line program control checkout of the simulation interface equipment. These programs are automatic, requiring a minimum of operator intervention, and they provide a hard-copy of the test results. These diagnostics can be further broken down into two subprograms:

(1) Discrete input/output tests - Check the proper functioning of the discrete input/output channels of the trainer in a closed-loop fashion. All disconnection and reconnection are accomplished either under program control or by using a patchboard type device. Upon detection, the program indicates to the operator the faulty channel.

(2) Analog input/output tests - Exercise the analog devices through their full range of operation. This is accomplished in a closed-loop fashion using known calibrated digital-to-analog converters as a reference. The test is compiled so that the operator can specify the accuracy limits to which the equipment will be tested, and it readies the period and amplitudes of test signals via an on-line input device. All converters, multiplexers, and demultiplexers are tested, and all channels not functioning within specified limits are printed out on the teletypewriter.

e. Real-time Clock Test - Automatically checks the real-time clock for proper functioning and accuracy and automatically prints out the results on the teletypewriter.

Device 15E18, Tactical ECM Trainer, has a unique feature called a maintenance panel which is separate from the computer. The maintenance panel has various switches which enable the operator to take the computer off the line (when a problem is suspected in the computer), and step through the program manually, one word at a time. The panel can also be used to fault isolate to the LRU (line replaceable unit) level within the trainer. This concept of BIT is relatively simple and inexpensive to develop and is well-suited to smaller trainers in which elaborate software programs are not justified.

Another approach to BIT is the incorporation of off-the-shelf data logging equipment into the trainer design. Such a system built around a programmer comparator contains the following elements:

a. An operator's console, including control and display devices to present the evaluation of the tests to the operator.

b. Programming equipment that provides coordinated and precise control of the test equipment and the unit under test by using prepunched or magnetic tape.

c. A stimulation control unit that provides signals to be injected into the unit under test.

d. An adapter unit that is the link between the tester and the unit under test.

e. A test point switching unit that selects test points determined by the programmer and routes the signals to the test evaluator.

f. A comparator that accepts the information from the test points as ordered by the programmer and determines if the selected test results are within permitted tolerance.

g. A measurement unit which provides a standard for the comparator. Depending upon the encoded instructions and the results of the comparison, the test system may proceed to the next test, stop and allow the operator to make the next decision, or automatically search to a desired sub-routine for further evaluation of the malfunction.

Keep in mind,that so far, we have only discussed on-line testing. Once a module or assembly has been declared faulty and has been removed for off-line checkout, another type of BIT equipment comes into play. This particular equipment may or may not actually be built-in, but nevertheless, its importance can not be overemphasized. This is the assembly or module tester. Sophistication is definitely in order for the assembly tester. MIL-T-23991 specifies that all assemblies in the training device which are used more than five times must be checked on an automatic or semi-automatic test system, whereas assemblies which are used less than five times may be tested manually. A complete assembly tester will have power supplies, signal generators, oscilloscopes and other measuring equipment built into the tester. The tester should be capable of testing all cards and modules used in the trainer, including those used in the computer. It is desirable to have the tester programmable by means of a punch tape, punch card,or patch board. Special loads and other passive signal conditioning elements should also be included in the tester.

All that was discussed exists in training devices today. Where do we go tomorrow? We are always receptive to new ideas and breakthroughs in the field of testing as you submit proposals on new training devices. First, train your designers to be conscious of the maintenance problem and help them become familiar with the latest techniques in BIT. Then the bids will tend to be reasonable and trainer BIT capabilities will grow. One of the most outstanding sources of up-to-date information in the realm of BIT and automatic testing is PROJECT SETE which is conducted by New York University School of Engineering and Science. The project director's name is David M. Goodman. You can obtain a wealth of information from Mr. Goodman in the form of study reports, lecture papers, and actual instruction classes. You're missing a good source of information if some of your key people aren't on-board with Project SETE.

THE DRAGON ANTITANK MISSILE SYSTEM TRAINING EQUIPMENT AND GUNNER TRAINING

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The requirement for a medium range antitank/assault weapon that would provide the infantryman with an improved capability against tanks and hard targets over that provided by its predecessor, the 90MM recoilless rifle, was stated in a Qualitative Development Requirement Information document released by Ballistic Research Laboratories in October 1962. A United States Army Combat Developments Command Small Development Description, dated October 1968, identified the requirement for a Conduct-of-Fire Trainer to be used with this system. To meet these requirements, McDonnell Douglas Astronautics Company, TI-CO, developed the DRAGON Weapon System and its allied training equipment.

Prior to describing the training equipment, it is necessary to briefly describe the weapon system.

THE DRAGON WEAPON SYSTEM

The DRAGON is a one-man portable and operable, command to line of sight wire guided missile system. It consists of a tracker and a round.

ROUND. The DRAGON round consists of a launcher and a missile, packaged together, and is the expendable portion of the system.

1. The Launcher - The Launcher consists of a smooth bore fiberglass tube, breech, canister assembly, tracker mount, support stand, launcher wiring harness assembly and tracker battery, carrying strap, forward and aft shock absorbers. It is disposed of after the missile has been fired. The Launcher has an overall length of 44.10 inches and weighs approximately 8.9 pounds, without the missile. The high pressure canister and low pressure breech configuration supplies the required muzzle velocity without exceeding the permissable acceleration levels and with a minimum of recoil. The Launcher also serves as a storage and carrying case for the missile prior to launch.