TRAINER TEST AND EVALUATION PROCESS REVIEW

CDR Paul S. Kenney, Paul R. Little, and R. Thomas Galloway

Naval Training Systems Center

Orlando, Florida

ABSTRACT

This paper presents the results of a process review of the Naval Training Systems Center development test and evaluation procedures used in the majority of its current contracts. Data were derived from a survey of project engineers, 79 completed contracts, interviews with 11 simulator manufacturers, and contacts with the National Simulation Evaluation Program (FAA) and local Defense Contract Management Command Area Office (DCMAO). Recommendations are made for improved test planning, changes to the Contractor Preliminary Inspection process, interfaces to MIL-STD-2167A and general policy guidelines for test policy and practices.

INTRODUCTION

Training systems, in many cases, represent the most complex systems procured by the Navy. They are somewhat unique when compared to other systems: specifications are performance based detailed hybrids; usually procured on a single or very low production basis; the prototype is the first "production" unit; trainer design begins after or concurrent with the parent system, however, the Ready-For-Training date often precedes delivery of the parent system; the time available for testing becomes compressed; man-machine considerations (behavioral and ergonomic) are important; and early operational data availability for trainer use is a problem. In addition, trainers mostly use commercial hardware components and are software intensive. This combination of characteristics has spawned a test and evaluation philosophy that differs from operational systems. This philosophy may or may not be optimum in today's environment.

The Naval Training Systems Center (NAVTRASYSCEN) process of testing a training device is a serial sequence of test processes beginning with a preliminary test by the Contractor followed by the Government, and a final test phase at the training site first by the Contractor then by the Government. Government acceptance occurs upon successful completion of this sequence of serial tests. Specification and Statement of Work (SOW) language for these tests have been, with small adjustments, unchanged for 17 years. The contract language used in the SH-2F Helicopter Weapon System trainer contract dated 15 May 1973 is virtually identical to the current specification language. The current NAVTRASYSCEN device testing process is illustrated by Figure 1.

The key features of this figure are as follows:

a. The test process begins after critical design review (CDR) approval.

b. Navy Preliminary evaluation (NPE) defined by MIL-D-8708B, may be held at the earliest possible opportunity to determine: (a) potential or existing deficiencies of the trainer; (b) to highlight the need for identification and early correction of deficiencies and (c) to evaluate changes incorporated. NPEs have been used in aircraft simulators to verify the flight dynamics early in the development cycle, and in the surface program as a mini Test Readiness Review.

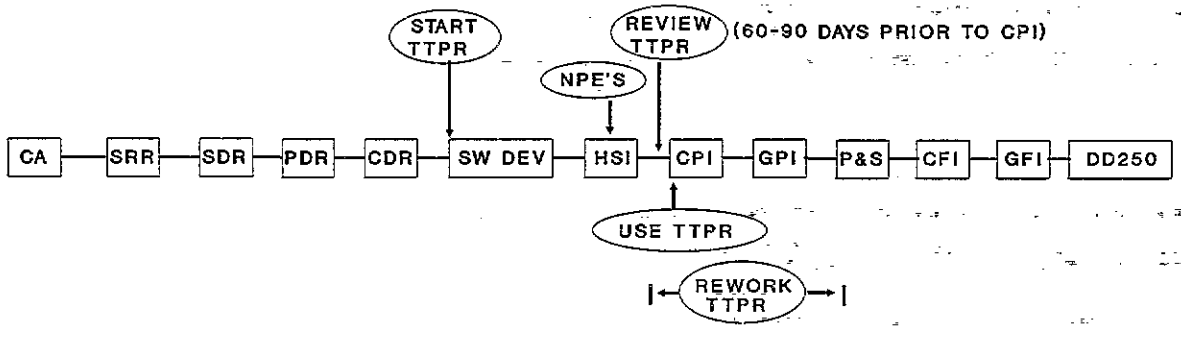

FIGURE 1. CURRENT T&E PROCESS

c. The Contractor develops the draft Trainer Test Procedures Report (TTPR) document prior to the start of Contractor Preliminary Inspection (CPI).

d. The TTPR (as a draft) is submitted for review and comment 60-90 days prior to the CPI.

e. Upon Government authorization, CPI is commenced by the Contractor with Government monitoring.

f. Upon completion of CPI, identified discrepancies are corrected and the TTPR updated.

g. Government Preliminary Inspection (GPI) is commenced and includes Functional Configuration Audit (FCA), Physical Configuration Audit (PCA), software cold start, and the execution of the revised TTPR under Government-controlled test conditions. Discrepancies are formally identified and the trainer is under configuration control. Tests include functionality tests and mission operability tests.

h. Upon completion of GPI, identified discrepancies are corrected, verified, and the training device is shipped and installed at the training site.

i. The Contractor's Final Inspection (CFI) verifies successful reassembly at the training site and successful implementation of final corrections.

j. Government Final Inspection (GFI) reruns the TTPR (usually selected portions), including cold start and extensive mission tests to ensure final operability and implementation of the specified performance.

k. GFI includes functional tests of the equipment operations through mission tests and in some cases unconstrained missions which executes the widest latitude of trainer functionality.

l. Upon successful completion of these tests, device acceptance is executed.

m. The Trainer Test Procedure Report is now finalized with the result of the tests and becomes the Trainer Test Procedure Results Report (TTPR/R). This document is subsequently used to verify baseline performance of the training devices.

DATA SOURCES

Data were derived both internal and external to NAVTRASYSCEN. External data collection was from:

o Unstructured interviews with 11 simulator Contractors.

o The National Simulator Evaluation Program, Federal Aviation Administration.

o Defense Contract Management Command Area Office, Orlando, Florida.

o Review of Air Force Systems Command Trainer System SPO YW Operation Instructions (Reference 1).

o Naval Air Test Center (References 2 & 3) publications.

o Visit to DELTA Airlines Simulation Facility.

Interview with Industry

Representative members of the simulation industry were invited to meet with the test and evaluation committee. These meetings were unstructured and no agenda was provided by the Government other than our interest to appreciate the test problems as viewed by our Contractors. The focus was to have a constructive dialogue and receive recommendations which may be offered. The 11 Contractors who participated in this dialogue represented approximately 67% of the total dollars for all contracts awarded in FY 90 and were as follows:

1. Loral
2. E&S
3. Link CAE (TSD)
4. Reflectone
5. McDonnell-Douglas
6. Quintron
7. Grumman ESD
8. Hughes (HSSI)
9. General Electric
10. AAI
11. Lockheed Sanders

The National Simulator Evaluation Program managed by the Federal Aviation Administration (FAA), Flight Standard Division, was visited by members of the committee. This visit focused on understanding the National Simulator Evaluation Program and the recent proposed Airplane Simulators Advisory Circular, AC No. 120-40B, Reference 4, and the Airplane Flight Training Device Qualification (Draft) AC No. 120-45A, Reference 5. The extent of overlap between the FAA simulator standard development process and the NAVTRASYSCEN simulator contract process was explored through discussions of lessons learned and items of mutual concerns and benefits.

The Defense Contract Management Command Area Office (DCMAO) develops and monitors procedures for process control, test, and inspections to meet contract designated requirements. Should DCMAO be asked to inspect or qualify the functionality of equipment operation, the degree to which this could be supported is related to the skills and background of the current employees. In most cases, Weapon System functionality exhibited by the system under test could be witnessed as to occurring and under what conditions,

but the goodness or nuances of partial performance would not be directly detected. Under current practice DCMAO usually requests NAVTRASYSCEN to provide engineers or subject matter experts with the necessary performance knowledge.

Internal data were collected from:

o Review of 79 completed contracts over the last 6 years.

o Direct survey of NAVTRASYSCEN Project Engineers.

o Review of prior studies, reports, and current practice.

DISCUSSION

The following discussion summarizes the major process observations based on the review of previous data sources. The test and evaluation committee sought to highlight major significant items. Several items of data are thought to be secondary indications of primary events.

Trainer Test Procedure Results Report (TTPR)

For 27% to 29% of our contracts, the TTPR is not acceptable at the start of CPI. In addition, for new first article simulators, an average of 12% of the time the TTPR is unacceptable at the start of GFI. This is illustrated in Figure 2.

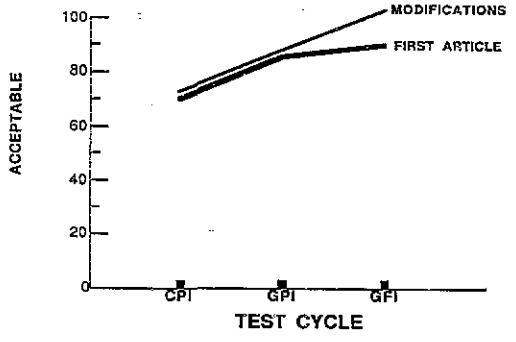

FIGURE 2. TTPRS ACCEPTABLE AT START OF TEST CYCLE

For the unacceptable TTPR documents, the degree of completion at CPI was 60% for first article, rising to 84% by GPI, and again dropping to 78% for GFI. This is illustrated in Figure 3. The Government assumption that the TTPR would be virtually complete at the beginning of each serial test is obviously erroneous.

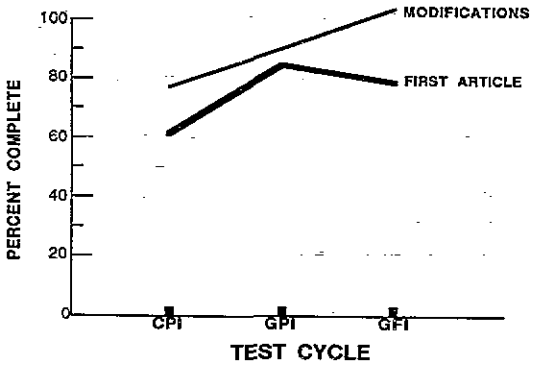

FIGURE 3. TTPR PERCENT COMPLETE

The second assumption of our serial test model is that early identification of discrepancies during CPI would diminish the number of subsequent discrepancies during further testing. The average number of discrepancy reports observed during each test cycle is shown in Figure 4. It is clear from the rise of discrepancy reports (DR's) during the GPI test cycle that CPI is not a completed process by the beginning of GPI.

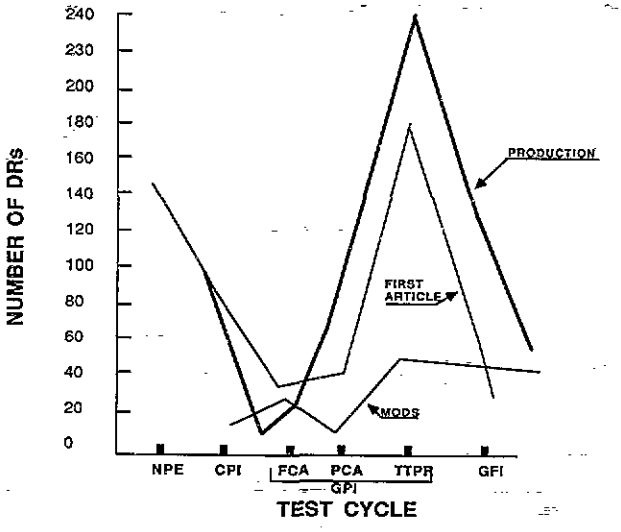

FIGURE 4. DISCREPANCY REPORTS BY TEST CYCLE

Discussions with industry and our engineers have led the testing and evaluation process review team to examine the impact of software. Our current test practice has been identified to be essentially unchanged for over 17 years. During this time, the growth of our simulation software in aviation programs, Figure 5, has grown by an order of magnitude. During this time, simulator manufacturing characteristics have changed primarily from hardware intensive to software intensive. This change to software development under the process of MIL-STD-2167A has not been incorporated successfully into our test practice.

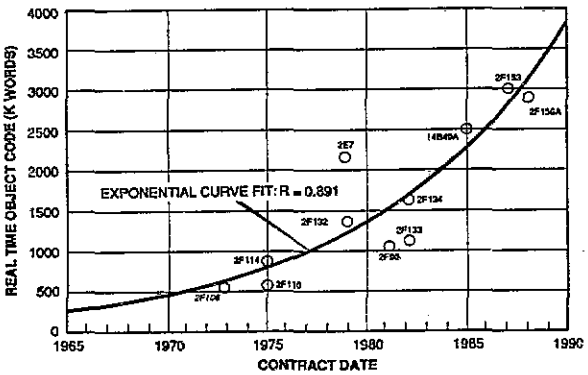

FIGURE 5. GROWTH TRENDS IN SIMULATION SOFTWARE CONTRACT AWARD YEAR VS REAL TIME OBJECT CODE

Computer development standards were reviewed and included *DOD-STD-2167A*, Reference 6, Defense System Software Development, and Defense System Software Quality Program, DOD-STD-2168, Reference 7. In addition, the tri-service Joint Integrated Avionics Working Group (JIAWG) tailored DOD-STD-2167A, Reference 8, guidance was obtained. This document establishes policy and standards for on-board software or firmware on JIAWG aircraft using DOD-STD-2167A. The goal is to ensure that Computer Software Configuration Items (CSCI) maintain the same DOD-STD-2167A development process across all JIAWG programs. This will affect aircraft simulator software development and testing when interfacing to the JIAWG software.

Computer Software Growths

It appears that hardware/software integration (HSI) is being extended on software intensive simulator developments to overlap the start of CPI and in some cases, the start of GPI. This HSI may be planned but is not consistent with the approved schedule and anticipated test in the SOW. This is seen as incomplete test documents and delays in the start of testing, a symptom very evident in the in-house surveys. For the current NAVTRASYSCEN device testing process as illustrated in Figure 1, the key point is the linkage between HSI tests and the TTPR revision process. These feedback loops contribute to excessive cycling of TTPR revision. On the other hand, the manufacturer uses the hardware/software integration and the Contractor's preliminary inspection time to develop and test the TTPR, and often will carry this over into the Government preliminary inspection process. The trainer consoles become the instruments used to test the software. NAVTRASYSCEN's software SOW's anticipates the testing of software, primarily through equipment operation, which reinforces this model. In highly complex software developments, the linkage of CSCI test and HSI test to total system testing was not identified and not consistently planned from the early initiation of the contract activity.

Results of Industry Meetings

In order to evaluate NAVTRASYSCEN Test and Evaluation (T&E) procedures from the supplier's perspective, eleven 3-4 hour meetings were held with individuals representing various training system Contractors. Based on these open discussions, a pattern of themes emerged. These themes are provided in Figure 6 in perceived priority order. Specific issues raised by industry are presented here as areas of concern and recommendations for improvement from the Contractor's perspective.

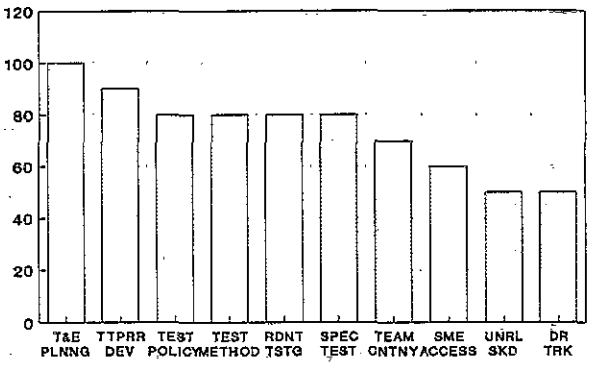

FIGURE 6. MAJOR PROBLEMS IDENTIFIED BY INDUSTRY

a. T&E Planning

NAVTRASYSCEN programs do not always require the development of a program Test and Evaluation Master Plan (TEMP). The lack of a TEMP or equivalent document can result in a disjointed and poorly planned test evolution. As a result, issues can arise during the test phase which can severely impact schedule and the success of the procurement.

Industry Recommendation:

NAVTRASYSCEN requires the development and use of a TEMP to address all areas of T&E as they apply to that specific program. The TEMP should be a contractual document that is jointly prepared by the Contractor and the Government. The TEMP should be a living document that matures as the program develops through design and into HSI (Hardware/Software Integration). A T&E working group consisting of members from NAVTRASYSCEN, Subject Matter Experts, the FPT (Fleet Project Team), and the Contractor should be established as the focal point for all areas concerning T&E.

b. Trainer Test Procedures Report

The current process for TTPR development, submission, and review is incomplete. TTPR submission is usually required 60 days prior to the commencement of CPI and the document is frequently disapproved by the Government. Many rounds of revision and resubmission occur during CPI/GPI and sometimes into CFI/GFI.

NAVTRASYSCEN often requires the TTPR to test each specified performance

parameter of the training device from a given set of initial conditions. Even though many of these parameters could be tested as a group, they are detailed in the TTPR as segmented tests which often require extensive repetition of switch positions to achieve the same test condition.

TTPR's frequently do not contain detailed procedures for mission testing (sometimes called freeplay). As a result, the area of mission testing is not well understood by the Contractor and represents an area of risk during the test phase.

Industry Recommendation:

TTPR generation should commence early in the program (not later than the PDR and should be a joint Contractor/Government effort. TTPR's should address mission testing and should define the specific mission profiles (provided by the government) to be tested by the operators.

c. Test Procedures

Test procedures seem to vary from one program to another. The current structure of training system T&E leaves many unanswered questions which result in various approaches to testing based on the experiences of the personnel involved with the program. Testing is usually not discussed in detail until late in the program and as the test date approaches. NAVTRASYSCEN has not published its test procedures to industry except as contained in individual RFP's.

Industry Recommendation:

NAVTRASYSCEN define and publish its test procedures for training systems.

d. Test Methods

Certain aspects of training systems have more than one accepted test method for determining specification compliance. This is especially true in visual systems. The test method selected can often effect the test results achieved and hence the systems compliance with the specification. This is also true in the area of aerodynamic testing when comparing automatic test methods to manual test procedures.

Industry Recommendation:

NAVTRASYSCEN determine and publish accepted test methods for the various areas of training system performance. The test methods should be referred to in the RFP. If test methods are not published, the RFP should specify the method to be used in either the statement of work or the detailed specification.

e. Redundant Testing

Current NAVTRASYSCEN contracts allow the Government to require a full running of the TTPR at CPI, GPI, CFI, and GFI. Certain sections of the TTPR could be run only once during CPI, with adequate Contractor quality assurance certification, and not be repeated during subsequent Government/Contractor testing. Repeating all tests on subsequent lots of the same device are also unnecessary and should not be required. Airline flight simulator programs sometimes limit testing of subsequent lots to on-site testing only.

Industry Recommendation:

Early test planning should be accomplished to determine which sections of the TTPR are applicable for the various phases of trainer development and testing.

f. Specifications

NAVTRASYSCEN contracts frequently require the TTPR to address each paragraph of the specification. The Contractor is then required to design a specific test to demonstrate compliance with the specification on a paragraph by paragraph basis. Some performance specifications are general in nature and do not lend themselves to a structured test evolution.

Industry Recommendation:

NAVTRASYSCEN perform a test validity review on specified performance parameters to ensure that compliance can be demonstrated with a structured test.

g. Team Continuity

The lack of Government test team continuity results in frequent changes in the direction and priority of test evolutions. Areas of subjective testing are especially vulnerable to differences of opinion as test team membership changes.

Industry Recommendation:

Although it is recognized that test team turnovers are inevitable, they should be minimized as much as possible. Upfront planning for personnel replacements could help to reduce the disruption caused when critical personnel leave the program during specific test evolutions.

h. Subject Matter Experts

Limited access to Subject Matter Experts (SME's) until the program enters the testing phase often results in misunderstandings between the Government and the Contractor on the relative importance of system performance parameters especially in subjective areas. A better understanding of the Weapon System mission and its tactical employment could enhance the training system design approach and maximize the utility of the system in achieving the desired training objectives.

Industry Recommendation:

SME's be made available to the Contractor early in the program design phase in order to increase the Contractor's familiarity with the simulated weapons system and its operation. Increased availability of SME's immediately after HSI may help to detect major software design errors that might otherwise not be discovered until commencement of acceptance testing. A caution here is that SME's should not be used as a source for reporting performance parameters but rather to highlight areas of concern and to familiarize the Contractor with mission scenarios. The training system specification and appropriate technical documentation should serve as the official source for system performance parameters.

Problems arise when trainer performance fails to meet the user's expectations and he doesn't understand that the causes may be due to inherent limitations of the simulator. The services of experienced technical experts from NAVTRASYSCEN are invaluable for mediating and resolving problems in visual systems, aerodynamic modeling, and motion cueing systems by relating user expectations to practical trainer capabilities, thus reducing the potential for adversarial situations in the trainer test and evaluation process.

i. Unrealistic Schedules

NAVTRASYSCEN contracts typically specify 6 weeks for CPI and 6 weeks for GPI regardless of training system complexity. This is also true for subsequent production lots of the same system. In actuality, in-plant testing of the prototype system may take several months while testing of subsequent production lots could be limited to on-site testing only. NAVTRASYSCEN Request for Proposals (RFPs) tend to be very strict when it comes to program schedule and force the bidders to meet the schedule in their proposal or be considered non-compliant with the RFP.

Industry Recommendation:

NAVTRASYSCEN RFP's be less rigid in scheduled test performance between contract award and RFT dates in order to allow the Contractor to bid the program schedule tailored to simulator complexity and intensity of software development.

j. DR Tracking Procedures

Multiple systems exist for tracking DR's during testing. The lack of a standard DR tracking system requires each program to develop its own system or adopt a system used on another program.

Industry Recommendation:

NAVTRASYSCEN adopt and publish a standard PC based DR tracking system for use on all programs.

ANALYSIS

Test Policy

The current structure of NAVTRASYSCEN contracts requires a CPI which essentially duplicates the Government Preliminary Inspection. CPI is usually observed and certified by the local DCMAO representatives. Current contract language requires correction of "all" deficiencies discovered during CPI prior to the commencement of GPI. Depending on the DCMAO representatives involvement with CPI and their understanding of how the trainer operates, correction of discrepancies found during CPI may or may not be allowed until after the full TTPR has been completed. The nature of the discrepancies found during CPI may require re-running portions of the TTPR to ensure that software corrections to the device have not generated problems in another area. Some DCMAO representatives have required substantial retesting of the device to ensure otherwise nondiscrepant areas of the trainer have not been altered by DR corrections. As a result, once the trainer enters CPI, the Contractor's flexibility to correct discrepancies may be severely constrained.

The recommended change to the above process would replace the CPI (as we know it) with a Contractor in-plant test process which is more flexible and places more responsibility for certifying the trainer ready for GPI on the Contractor. Early development and qualification of a Test and Evaluation Master Plan (TEMP) and supporting T&E working group would serve to improve the process. The TTPR structure would be built via T&E working group meetings and current status reported during the same time frame as progress reviews. As the TTPR develops, it will be reviewed by this team and approved incrementally. As soon as appropriate sections of the TTPR have been deemed "suitable for testing" by the T&E working group, the Contractor would be free to complete those sections of the TTPR at Contractor discretion. The completion of the test and the test results would be certified by the Contractor's quality assurance (QA) department and presented to the Government during follow-on T&E working group sessions.

As the trainer development progresses, sections of the TTPR would fall into one of four categories:

a. Test procedure under development

b. Test procedure ready for review

c. Test procedure approved and ready for testing

d. Test procedure completed and QA certified

As trainer construction and HSI matures, the T&E working group would determine when the device was ready for a Test Readiness Review (TRR). During the TRR, the Project Engineer, assisted by the fleet project team, would run sample demonstration mission scenarios (defined in the TTPR) to verify device readiness for GPI.

Test Methods

Potential candidates for standardized test methodologies include motion platforms, g seats, control loading systems, transport delay/cue synch measurements, basic visual system performance, and basic flight characteristics. Further study may reveal other candidates. The FAA has applied this concept of standardized testing to the qualification process for airline pilot training simulators. Advisory circulars issued by the FAA (References 4 and 5) describe test standards and, to a limited extent, test methods for the candidate areas mentioned above. These advisory circulars clarify the FAA's expectations in advance with respect to the testing required to qualify a simulator for airline pilot training. A similar concept can be established for military pilot training simulators but the scope must accommodate the broader spectrum for military mission tasks. Other resources for standard testing are the flight test manuals published by the test pilot schools which describe the theory and test technique for investigating aircraft performance and handling qualities. The U.S. Naval Test Pilot School (TPS) manuals have been referenced in NAVTRASYSCEN procurements for over ten years. This experience has shown that further documentation is needed to clarify how the TPS methods should be adapted to trainer use and to take advantage of trainer unique features such as parameter freeze and automated test drivers.

In summary, NAVTRASYSCEN should identify candidate test areas and publish standard test procedures for demonstrating training specification performance requirements. Existing FAA and TPS documents should be utilized for guidance in format and content.

NAVTRASYSCEN Project Engineer Survey Results

The adequacy of the specification, SOW, contract schedule, and DD 1423s in the testing area were rated as approximately 3.5 on a scale of 1 (poor) to 5 (excellent). In addition, the survey indicated the statement of work was 2.6, below average, and the contract schedule was 2.9. The major difficulties cited were in the areas of preparing procedures for test, and defining test criteria and fidelity requirements. Government Furnished Equipment (GFE) performances was also cited as a difficulty. While the Technical Proposal Requirement (TPR) may address testing, in most cases, this was not a significant factor in the source selection.

The current test and evaluation procedure and policy is only considered sufficient by 60% of experienced project engineers. There is considerable inconsistency regarding discussion of testing responsibility.

In the area of test and acceptance of training devices the top concerns were as follows:

- Incomplete test procedures at CPI and subsequent schedule impact
- Continuity and skill of Fleet Project Team SMEs
- Contractor indicates trainer is ready for test when it is not
- Poorly written test procedures - GFE operation not understood.
- Unrealistic test schedule - minimum consideration for correcting large number of Discrepancy Reports (DRs).

Major contributions identified for extending the test time were as follows:

- Incomplete and inaccurate test procedures
- Software malfunctions and reliability
- Discrepancy Reports (DR) acceptance and resolution
- TTPR Documentation use incomplete or inaccurate, with limited testing prior to Government test
- Faulty coldstarts, hardware and software failure
- Insufficient time, DR clean-up was slow

A test plan was used by the test team on most cases (the TTPR). The use of DCMAO representatives was minimum, and "free play" test planning was normally not available or coordinated in advance with the Contractor. The test time reported by the engineering group suggested that delay in starting of testing and actual execution of the tests were from 2.4 to 2.8 times the originally planned test duration. These delays are symptoms of the additional time needed for HSI and time required not previously planned for the correction of extensive discrepancies. One program had a delay of a year and was not included in the data. There was no consistent requirement for a TEMP application and use.

RECOMMENDATIONS

The following recommendations are made in order to improve the efficiency and effectiveness of the trainer testing process:

The general approach is to revise the T&E process to help Contractors better understand the test requirements earlier, to begin preparation of test documents earlier, to reduce Government intrusion during the later stage of HSI, and to allow phased development of the TTPR. The proposed process is illustrated in Figure 7.

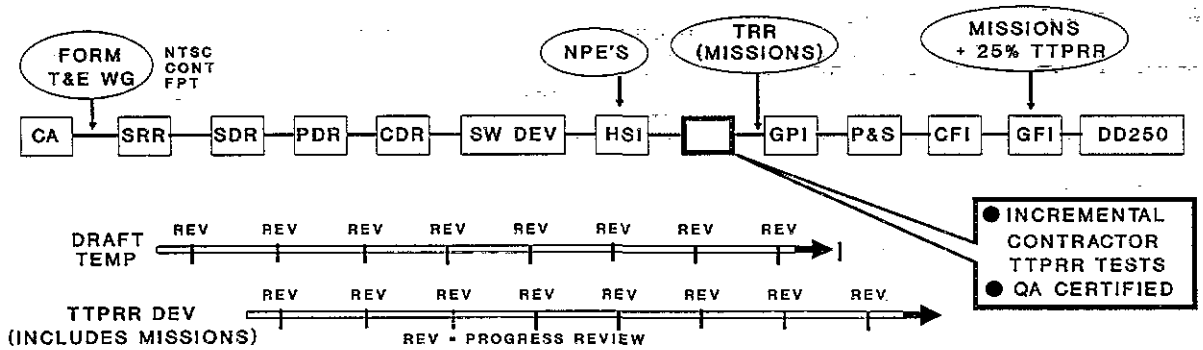

FIGURE 7. PROPOSED T&E PROCESS

o Replace the current CPI with a Contractor controlled process beginning earlier which contain the following features:

a. Use of TEMP, test plans, DR resolution plan

b. Incremental TTPR development including intent of in-process software testing

c. Contractor certification of readiness for Government test

d. Verify readiness via demonstration of Government mission scenarios in a Test Readiness Review.

The following specific process changes are recommended:

Recommendation 1. A Test and Evaluation Master Plan (TEMP) should be developed as a CDRL item and define objectives, critical issues, system characteristics, responsibilities, resources, and schedules for test and evaluation (Reference DoD 5000.3-M-1). It should list the participants and each of their roles. Finally, the plan should state the conditions required for completion of the Test Readiness Review, discrepancy reporting resolution, Conditional Acceptance, and Final Acceptance. A sample TEMP checklist is included in Appendix A.

Recommendation 2. A Test and Evaluation working group consisting of Government project engineers, Contractor, fleet project team and any additionally required SME's should be established. This working group would be responsible for the development and implementation of the TTPR, Test Planning, Test Witnessing, Test Readiness Certification and determination of cold start requirements. This group will report during all progress review meetings on current status and test and evaluation planning for the acquisition, and will resolve differences, develop program solutions, and provide overall direction for the test and evaluation program. This group will document all decisions and agree to procedures relative to the training system test and evaluation. Subsequent Contractor TTPR submission for Government review and approval would not be required. Membership on this Team should be from contract award until RFT in order to ensure continuity throughout the program to the T&E master plan.

Recommendation 3. Incremental Testing during HSI of completed CSCI threads is recommended. This would reduce the current testing redundancy reflected in the manner in which the TTPR is repeatedly run in CPI, GPI, CFI, and finally GFI. Contractor presentations, NAVTRASYSCEN Engineering surveys, and experience within the process review team indicates that TTPR development and implementation could be accomplished so that, with early planning, test sequences could be built in increments and it would not be necessary to repeat many of the tests once they were run and verified. This would allow more detailed test and better confidence than current practice.

Recommendation 4. Mission Scenarios should be provided by the Government for inclusion in the TTPR. These scenarios would be used as the primary system test vehicle, and be identified early in the program. These mission scenarios should be identified in the TEMP document and revisions made when they become known.

Recommendation 5. Form a Joint Industry Government Working Group to improve the focus, structure, and format of the TTPR and Results documentation. The growing software and database content

of training devices will continue. Other process controls, such as DOD-STD-2167A and DOD-STD-2168 will impact the form of data, where it is located, accessed, and verified. The current practice of the TTPR as a self-contained volume can be improved upon.

Recommendation 6. Evidence of satisfactory completion of the TTPR by the Contractor must remain a prerequisite to the Government beginning their tests. This would be accomplished through contractor QA certification followed by a Test Readiness Review (TRR).

Recommendation 7. Change the bid process to allow the bidder to propose the detailed test durations and schedule milestones. In addition, Test and Evaluation planning and process becomes an agenda item for all PDR's, CDR's and Progress Reviews.

Recommendation 8. Discrepancy Report (DR) tracking should be standardized. Included in this standard should be a requirement for the Government to be able to monitor the data base on-line via modem access. NAVTRASYSCEN should develop a model PC database program for use when no contract process applies.

Recommendation 9. Develop, publish, and implement standard T&E policy and procedures for the test and evaluation of all NAVTRASYSCEN developed training systems. This policy and procedures document should apply to all warfare areas and include Development, Test and Evaluation (DTE), and Operational Test and Evaluation (OTE).

Recommendation 10. Automatic Testing routines and procedures should be developed and implemented whenever possible. This feature would be utilized to accelerate the testing process and to ensure trainer life cycle integrity before and after trainer modifications. Such automatic testing should be expanded to be included in the design goals of most trainers.

Recommendation 11. Develop and implement a standard "Memorandum of Agreement" for T&E Programs requiring the participation of DCAMO.

Recommendation 12. Provide NAVTRASYSCEN technical expertise to balance user expectation with contract specification.

Recommendation 13. Support specification items with practical test requirements. The Technical Requirements Specification should be written so that each stated requirements has a corresponding test requirement. This will ensure a better understanding of the requirement and how it will be tested.

Recommendation 14. Develop and publish standard test procedures. Commonly accepted trainer test methods should be available for reference at the beginning of trainer development, preferably with the RFP. These referenced test procedures could serve as standard methods for demonstrating fundamental trainer performance characteristics. These standard methods should also establish a process for developing new or modified test methods to address new or unique trainer characteristics.

Recommendation 15. NAVTRASYSCEN should initiate joint Industry and Government working groups to publish joint test guides of standardized test methodologies.

CONCLUSION

NAVTRASYSCEN is currently relying on T&E practices which were considered effective in the days of analog training devices and in the early years of digital computer training devices. However, unlike past trainers, modern training devices are software intensive and are primarily constructed from commercial off-the-shelf (COTS) hardware. These modern trainers lend themselves to incremental testing of subsystems and mission testing of the entire trainer.

The current T&E trainer process from both external and internal perception is incomplete and does not work well with computer software intensive trainers. Growing software and database complexity will continue and does not fit well in our current serial test model. A proposed change to the CPI process is recommended. This change will replace the current CPI with a Contractor controlled incremental process through early TEMP planning, incremental TTPR developments, incremental testing, and a verification process by a Government mission scenario test readiness review prior to GPI. This will allow better software development and test within the systems performance test structure.

LIST OF REFERENCES

1. Training Device Test and Evaluation (Acquisition Management), YW Operating Instruction 800-7, Department of the Air Force, HQ Aeronautical Systems Division (AFSC) Training Systems SPO, 3 November 1989.

2. NAVAIRTESTCEN Policy for Test and Evaluation of Major Aviation Training Devices, NATCINST 3960.12A, Naval Air Test Center, 10 July 1989.

3. *Maximizing Flight Fidelity;* Integration of Naval Air Test Center Capabilities into the Procurement of Major Aviation Training Devices, Technical Memorandum TM 76-4 SA, Naval Air Test Center, Patuxent River, 16 March 1977.

4. Airplane Simulator Qualification, FAA Advisory Circular AC No. 120-40B (DRAFT).

5. Airplane Flight Training Device Qualification (Draft) AC No. 120-45A.

6. Military Standard, Defense System Software Development, DOD-STD-2167A, Department of Defense, 29 February 1988.

7. Military Standard, Defense System Software Quality Program, DOD-STD-2168, Department of Defense, 29 April 1988.

8. Tailored DOD-STD-2167A, JIAWG 89-S6/VER: 3.2, Joint Integrated Avionics Working Group (JIAWG), 31 July 1990.

9. Test and Evaluation Master Plan Guide, Department of Defense Instruction 5000.3-M-1.

APPENDIX A

(SAMPLE)

CHECKLIST FOR TEST AND EVALUATION MASTER PLAN (TEMP)

A Test and Evaluation Master Plan defines objectives, critical issues, system characteristics, responsibilities, resources, and schedules for test and evaluation.

1. INTRODUCTION

1.1 System Description
1.2 Critical Technical Characteristics

2. OVERALL TEST AND INTEGRATION APPROACH

2.1 Test and Integration Objectives
2.2 Test Classification
2.3 Test and Integration Methodology
2.3.1 Traceability and Compliance
2.3.2 Incremental Builds
2.3.3 Integration Approach
2.3.4 Testing Approach
2.3.5 Critical Items
2.3.6 Regression Testing
2.3.7 Thread Performance Demonstration
2.4 Software Standards and Control
2.5 SIM/STIM
2.6 Coordination and Visibility
2.6.1 Navy-Conducted Tests
2.6.2 Discrepancy Report

3. TRAINER TEST PROCEDURES AND RESULTS REPORT

3.1 TTPR Development Methodology
3.2 Mission Preferences
3.3 Integrating with DOD-STD-2167A Development Test
3.4 Hardware/Software Integration Test Outline
3.5 Trainer Test Procedures Report - Outline
3.6 Special Test Procedures
3.7 Trainer Test Procedures and Results Report - Plan
3.8 Installation and Checkout Plan

4. TEST FACILITIES AND TEST EQUIPMENT

4.1 System Test Facilities and Test Bay Support
4.2 Support Systems (SIM/STIM)
4.2.1 Tactical Operation Interface
4.3 Component Test Equipment and Test Facilities
4.3.1 Software Generation and Test Facility

5. TESTS AND EVALUATIONS

5.1 Critical Items
5.2 Configuration Item Development and Testing
5.2.1 Requirements Traceability
5.2.2 Hardware Unit Testing
5.2.3 Software Testing
5.2.4 Software Cold Starts
5.3 System Integration and Testing
5.3.1 Software Integration and Testing
5.3.2 System Verification and Requirements Testing
5.3.3 System Stress Test
5.3.4 Weapons Compatibility Test
5.3.5 System Software Documentation
5.4 Reviews and Inspections
5.4.1 Reviews
5.4.2 Software Specification Review (SSR)
5.4.3 Preliminary Design Review (PDR)
5.4.4 Critical Design Review (CDR)
5.4.5 Audits (FCA and PCA)
5.4.6 Maintainability Demonstration
5.5 Government and Independent Testing
5.5.1 Preliminary Evaluation
5.5.2 Test Readiness Review
5.5.3 Government and Preliminary Inspection
5.5.4 Government Final Inspection
5.5.5 Subject Matter Experts

6. SYSTEM INTEGRATION AND TEST OPERATIONAL PERFORMANCE
6.1 Mission Summary
6.2 Integration and Test - Plan
6.3 Resources
6.4 System Test Critical Issues
6.5 Test Management
6.5.1 In-Plant Test
6.5.2 On-Site Test

7. SCHEDULES

8. SECURITY CONSIDERATIONS

8.1 Scope
8.2 Unit EMI Test Plan

ACKNOWLEDGMENT

The authors wish to thank the other process team members for their substantial ideas and insight; Roger Nutter, Bill Rankin, Al Fliss, Carl Thomas, Paul Brothers, Dan Schab, and contributors John Cheney, Keith Russell, Tony Kuhn, John Mills, and Lori Lane.

The companies from the Simulation Industry who participated provided insight, understanding, and generally a point of view not otherwise available. The candor and preparation was evident and appreciated.

ABOUT THE AUTHORS

CDR PAUL S. KENNEY is assigned as the Project Manager for all A-6E/ EA-6B training systems managed by the Naval Training Systems Center. CDR Kenney is a graduate of the US Naval Academy, U.S Naval Postgraduate School, and US Naval Test Pilot School. He holds both Bachelor and Masters degrees in aeronautical engineering. CDR Kenney has completed two operational tours flying the A-6E Intruder and has accumulated over 3000 flight hours and 500 carrier arrested landings. CDR Kenney has also served as the Operation Test Director for Electronics Warfare Systems while attached to VX-5 and was the Director of Product Support at the Naval Aviation Depot, Norfolk, VA.

PAUL R. LITTLE, P.E., C.P.L., is the current manager of the Surface Warfare Division, and provides for technical development, evaluation, and acquisition of simulator programs in the Surface Warfare area. Earlier assignments at NAVTRASYSCEN include management of System Engineering, Software Engineering, and has directed field offices in San Diego and Pensacola. Mr. Little was a major contributor in NAVTRASYSCEN's improved computer/software acquisition strategies and transition to ADA. He holds both a Bachelor and Master of Engineering Degree in electrical engineering from the University of Virginia in Charlottesville. Mr. Little has 23 years experience in the simulation industry, and is a member of I.E.E.E. and Florida Engineering Society.

R. THOMAS GALLOWAY is an aeronautical engineer and head of the Simulation Dynamics Branch at the Naval Training Systems Center. His responsibilities include the investigation of flight simulation requirements both for rotary wing and fixed wing pilot training. He has participated in the development and evaluation of many Navy flight simulators and has authored several technical papers on flight fidelity test practices. Mr. Galloway holds a BSAE from Georgia Tech, an MSAE from Princeton University, and is a graduate of the US Naval Test Pilot School engineering curriculum. He is a member of the AIAA and the American Helicopter Society.