AIRCREW TRAINING DEVICES, TESTED FOR TRAINING

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ABSTRACT

Now that the industry has acknowledged that training requirements must drive training device design, it makes sense that the training device should also be tested against these same requirements.From extensive front-end analysis through device design, training requirements are a major consideration, yet traditionally contractor test is limited to hardware and software specifications. In many cases this has led to a device that, although technically compliant with contract specifications, was unable to accomplish the training for which it had been purchased.On a current Link ATD (Aircrew Training Device), final contractor verification test objectives and customer acceptance test objectives are being oriented toward a fully integrated system and the training that the device is designed to accomplish, in addition to the contract's technical specifications. Link's approach on this ATD is to include "Mission Test" as a phase of the contractor testing. This mission test is being designed and accomplished by company personnel with operations, training, and engineering backgrounds, in close coordination with the Air Force users. This cooperative approach is critical, particularly with a concurrent development program where aircraft design and its mission are changing. Mission Test will ensure that the training system can accomplish the user's training objectives by flying "real world" sorties in the ATD that incorporate all the tasks the user intends to train in the device. The combined Link-Air Force team will test the interaction of the entire system, including crew and instructors, for all tasks under a variety of conditions.

HISTORY

Prior to 1973, the AFR 3/5 Series regulations were in force, invoking the concept of Category I, II and III testing. Essentially, a series of engineering tests were conducted leading to "system test", but no operational test and evaluation. The device was delivered to the user and it may have subsequently worked in the operational environment, but there was no guarantee of this. In 1973, AFR 80-14 formalized OT&E procedures and, in 1974, the Air Force Operational Test & Evaluation Center (AFOTEC) was created. Two of the earliest simulator programs tested under 80-14 were the Undergraduate Pilot Training/Instrument Flight Simulator (UPT/IFS) and the C-130 Weapon System Trainer (WST). OT&E on these devices was conducted by the using commands. In the mid to late 1970's, AFOTEC managed the OT&E of four major simulator programs: the F-5 IFS for the Royal Saudi Air Force, the A-10 OFT, the B-52 WST, and the F-16 WST.

Throughout this period simulator OT&E was not accepted as an integral part of the Air Force test program, either by the Simulator System Program Office (SPO) or, in some cases, by the using commands. Part of the problem could have stemmed from a lack of a fully developed plan to implement an operational test and evaluation program. An example of this is the OT&E's failure to identify the training deficiencies inherent in the initial specifications of the FB-111 Mission Simulator (MS). It may have been the result of a lack of understanding of the benefits of OT&E by all participating organizations, or more likely, a basic misunderstanding of the purpose of OT&E. Whatever the cause, misunderstandings abounded and test program procedures became a subject of controversy. Valid OT&E deficiency reports (DR's) were not submitted to the contractor for correction, time for OT&E was not provided, and OT&E recommendations were not acted upon. The only loser in this situation became the user.

For example:

1. The B-52 WST prototype was accepted by the Air Force in the contractor's plant and delivered to Castle AFB, where satisfactory training could not be accomplished on it even though it met all contract specifications. It was eventually torn down and the parts were used for spares.
2. *Other training problems with the B-52 WST* production devices are still not totally solved.
3. AN AFOTEC report on the F-16 Electronic Warfare Training Device (EWTD) in June 1982 noted training problems though it met technical specifications, but it was still delivered. The training problems are yet to be resolved.

All of these instances have led to low aircrew acceptance of the devices as a training medium. And even when the problems are finally corrected, the device is generally several levels behind aircraft configuration, reducing the amount of useful training.

Recently the situation has improved considerably, and the Air Force is moving toward a truly combined development test and evaluation (DT&E)/OT&E program for simulators. The importance of OT&E is becoming clearer to the SPO and to the user (and to the contractor as outlined in this paper). The prejudices are breaking down. For example:

1. From Nov '84 to Apr '85, AFOTEC conducted OT&E on the final building block that created the F-16 WST. In testing the integrated systems, problems were detected. AFOTEC strongly recommended that the device not be used until the problems were corrected. Due in large part to this report, the Air Force let a contract to correct the deficiencies and asked AFOTEC to assist in testing the corrections.

They found that the integration deficiencies and reliability/availability problems had been corrected, but potential problems still remained that might degrade training. All agreed that these should be corrected before fielding the device.

2. The EF-111A OFT test began in April 1985 and was halted after two weeks due to numerous deficiencies. Many were corrected, but two major problem areas had not been resolved by the restart of test. Resolution of these problems was critical to the conduct of a meaningful OT&E; the program office agreed, and test was further delayed. OT&E was scheduled to begin in March 1986. Although delivery was delayed over nine months, the delivered system was usable, not the "hangar queen" that would have gone out had the problems not been resolved.
3. AFOTEC was tasked to conduct OT&E on the new F-16 Block 25B WST after the system had been fully integrated with a new EWTD and new Digital Radar Landmass System (DRLMS). When the delivery of the OFT component was advanced several months the SPO and AFOTEC agreed that an OT&E of this initial component would be appropriate to insure it would meet TAC's needs. OT&E was included in the AF test program and was completed prior to system acceptance. In past years, OT&E would not have been considered under these circumstances.
4. AFOTEC is the test monitor for the F/FB-111 MS Modifications. They have been an active participant in the test planning process since contract award. Both users, SAC and TAC, and the acqulsition command, AFLC, have requested and listened to AFOTEC's advice and are working toward a fully integrated DT&E/OT&E.

Other examples of cooperation exist. The precedent is there to insure that OT&E, whether conducted by AFOTEC or the using command, becomes an integral part of every T&E program. Because AFOTEC is the Air Force OT&E agency, it is their responsibility to insure that the policy and procedures are there to allow the task to be accomplished.

Because the Air Force has established a viable operational test and evaluation program, it is in everyone's best interest that the contractor address a portion of his testing to the device's operational requirements. To date most attempts at this have fallen short.

Link and the Air Force are well on the way to implementing a test program based on a team concept, thus delivering a well defined and usable device to the operational command. Key to this program is the Mission Test, designed by Link in close coordination with Air Force personnel, to exercise the total integrated system and test the system's capabilities to accomplish its intended training. This Mission Test will produce significant benefits to the customer/user and will result in a faster and smoother acceptance of a more capable device.

Prior to the inception of a true contractor mission test, flight simulator test programs consisted of three distinct phases: 1) Contractor verification tests, 2) Air Force development tests, and 3) Air Force operational tests. Rarely was there any coordination between the three phases. The first phase, contract or verification testing, was to be the proof that all of the system design was complete, technical specification compliance had been achieved, the test procedures were correct, and the system was ready for Air Force test. The procedures tested the system functions in a static mode with expected results but not in a dynamic mode that represented the real operational world. These tests were designed for very specific results, and were limited in scope to the test for which they were designed. When attempts were made at a mission test, the result was often a simple functional check flight (FCF) profile and not a full go-to-war representation mission. Such a mission test would be extremely difficult to conduct because most contractors' engineers had no aircrew training experience.

Assuming that the system passed the contractor tests, it was turned over to the Air Force for development and operational testing. Development testing, because of its engineering and technical orientation, was a repeat of contractor verification testing to insure that problems had been corrected and the system did meet specifications. Operational testing, on the other hand, looked at the integrated system in a scenario that attempted to duplicate the real-world environment. In this scenario, problems were found that contractor or Air Force testing had never encountered. This led to problems. One need only look at the B-52 and F-16 programs to see the results of not addressing these problems. In theory, the three phases of test should complement each other, leading to an acceptable device - accomplishing this means breaking new ground.

Link and the Air Force have attempted to take the lessons learned and produce a test program that logically leads to customer acceptance. From the very beginning, the cooperative team concept has been in place and test has been a major consideration throughout the design process. Contractor, SPO, user, and AFOTEC together have put a workable program in place. All agencies are actively involved from informal hardware design on. This open discussion and teamwork has produced an innovative approach - a comprehensive Mission Test.

If contractor testing and Air Force testing are considered separately, the section of contractor testing of concern is the verification testing, conducted using development test procedures (DTP's) that have been written for ultimate Air Force approval and use. The DTP is written to verify an engineering or performance specification. It tends to consist of structured procedures conducted under sterile, often static conditions, with expected results. The procedures do not replicate real-world conditions. They tend to be written by engineers, for engineers, to produce a result based on the same engineer's design. This may be a bit of an exaggeration, but nearly all DTP's fail to represent the operational environment, and they were not meant to.

When the contractor uses the DTP to run verification testing, his goal is to insure that the system is ready for Air Force testing and that the DTP itself is free of errors. Often part of the DTP is a volume called "Mission Test", theoretically designed to verify the performance of the integrated system in a dynamic environment. These "mission tests" tend to be run with a pseudo FCF profile that really demonstrates nothing more than the device's ability to take off, fly around, and land; its training capability is not tested. In other words, the device may be capable of replicating aircraft functions but hasn't been tested for its use as an instructional tool.

Air Force testing begins when their engineers run the "verified" DTP on a "verified" system. Problems start here because few DTP's are free of errors due to recent design modifications and system complexity. This causes many Test Discrepancies (TD's) to be written against the DTP rather than the device. Much time is wasted in determining if a discrepancy is a problem with a system or with the procedure.

Ultimately Air Force aircrews are employed to run an operational test using real-world scenarios to determine if the system meets the user's training requirements. More often than not, the system fails. There are many reasons for these failures and the subsequent fights over deficiency corrections, acceptance, etc. The most common reason was the failure to define the requirements up front and then to test those requirements.

To preclude the device failing to meet its training requirements, the user must become involved in the design process early in the program, and be an active participant in the test planning process. This participation is even more important as more simulator development and test programs are structured to be concurrent with aircraft development and test programs (e.g., F-15E, B-1B, MV-22, and P-7). Lines of communication should be created with aircraft OT&E teams to draw on their knowledge and expertise with the weapon system. Such communication will improve test procedures and be a valuable source of information.

OTAG

The individuals planning, developing, and executing Link's mission test are engineers by education and aviators/ experienced flight instructors by profession. They belong to a group at Link called OTAG (Operations and Training Analysis Group). The purpose of OTAG is to incorporate training requirements into every level of design in the training devices. Having included training requirements in the design, it makes sense to test the device in terms of training capability.

OVERALL MISSION TEST CONCEPT

The OTAG process insured that the training requirements were incorporated into the device design. Mission Test is designed to test the device's compliance to these training requirements. It is designed and conducted by training-oriented people. But most important, Mission Test allows identification of problems in a dynamic system environment and permits an evaluation of the system's capability to train aircrews prior to the detailed, static verification tests. Because Mission Test identifies problems and capabilities sooner, it should allow a smoother running of the DTP to verify specification compliance. It may also make it easier to differentiate DTP problems from system design problems. Most important, it will give the Air Force more insight into the system and its readiness for Air Force test. Link's Mission Test and Verification Test are the counterparts to Air Force's OT&E and DT&E. If well designed and well run, the system is corrected earlier, our test is simplified (and possibly shortened), and the odds of delivering a good device are increased.

PROCESS

The process used to define mission test is outlined in Figure 1. This process was defined by members of OTAG and agreed to by the Air Force test team. The key is traceability from the training requirements used to define the system through testing the device for capability to train those same requirements.

Training Objectives

The first input is the list of training objectives allocated to the training device. This list was generated via a thorough

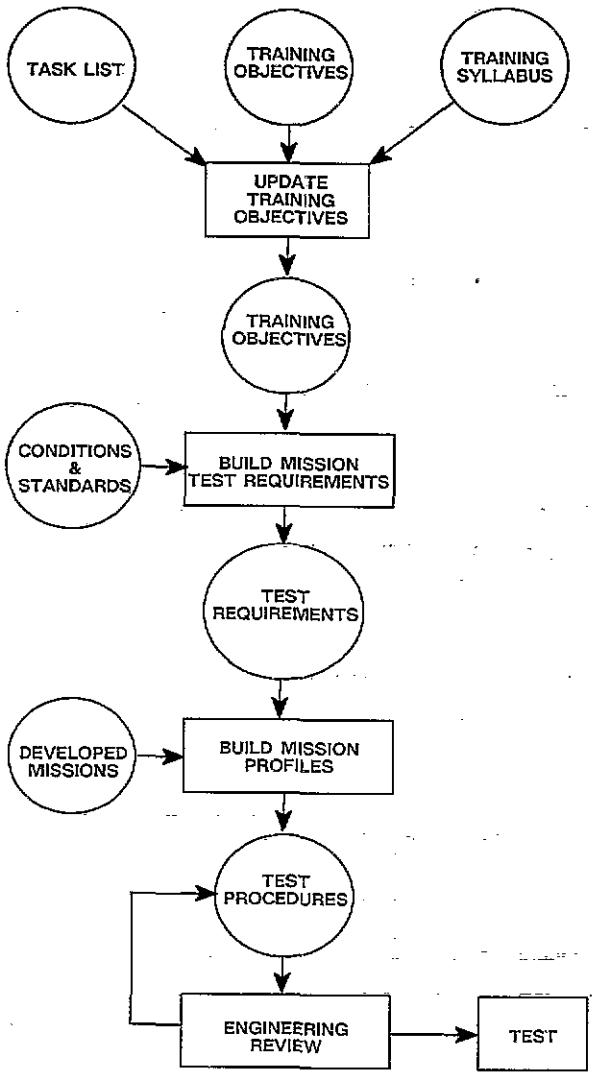

FIGURE 1

training analysis using the tasks to be performed in the aircraft. The aircraft manufacturer's allocation of tasks to the training devices for use by the Air Force was also considered. The training objectives must be the most current list (when designing the training devices concurrently with the aircraft, this is especially important.) The training objectives should include every task to be trained in the device.

Conditions & Standards

Once the training objectives have been defined, conditions and standards are applied to each objective. These are the conditions under which the objective will be trained and the standards to which the student must be able to perform the objective, under given conditions. A list of conditions is generated from possible conditions to be simulated in the training device (i.e., day/night, hot/cold, etc.). Then each objective is examined and assigned the appropriate set(s) of conditions it will be tested under. Objectives combined with conditions and standards are termed test requirements (for mission test).

Mission Profiles

The mission scenario will ensure that the required training and environmental conditions exist in order to provide valid testing of the training requirements. The missions are the "glue" that hold the test requirements together in a logical sequence. The missions are to be "flown" in the device in the same fashion that it will be used in an operational environment.

On our program, five test missions have been developed, each of which is capable of supporting multiple test scenarios allowing the flexibility required to test the full range of training requirements.

The missions developed are successively more complicated to test more capabilities of the simulator with each mission. For example, the first mission would be a simple safety of flight mission with some takeoffs, touch-and-go's, and full-stop landings. The next mission may include some instrument flight, and succeeding missions become more complicated until the final missions are full wartime scenarios.

Each mission test requirement will be reviewed in relation to the five missions and allocated to the specific mission which best supports that requirement. Those test requirements which could be supported in any of the five missions will be grouped and reviewed again in relation to the missions and the test requirements already allocated to the missions.

Conditions are applied to each test requirement. For example, approaches may be required under a variety of wind, visibility, and daylight conditions. These requirements may be spread over several mission scenarios (day approaches in one and night approaches in another). Most of the different conditions applied to the requirements will be varied at the instructor station in real time. This allows for more flexibility in the operational environment and also for test purposes.

Engineering Review

The last step prior to executing the test with the missions developed is to perform an engineering review of the missions to ensure acceptance of the test by all parties. The review has included the Air Force test team throughout the process. The engineers responsible for each system must also approve the test to ensure that the test does not expect results not attainable in their design. Where that is the case, both the test and the design must be evaluated to see which must be changed.

EXECUTION OF MISSION TEST

The test will be executed by OTAG personnel. They will use a system similar to that used by the Air Force in their OT&E. The nature of mission test makes it somewhat subjective and will rely on the knowledge and experience of the individuals involved in the test. The test discrepancies must be logical and descriptive enough for an engineer to correct them. This is another area where the engineering background of the OTAG personnel will come in handy. They will be able to write discrepancies with enough detail to make troubleshooting easier for the responsible engineer.

ADVANTAGES

Mission test is designed to exercise the total integrated system in a dynamic environment; and it is conducted early in the program with active Air Force participation. It is essentially the first phase of contractor verification testing and implements the overall concept of the program, a thorough bottom-up development and integration followed by top-down testing, and provides several advantages over historical test methods:

1. Because it is designed by people with aircrew training backgrounds, it looks at the system as a training device, not as a complex engineering achievement.
2. It verifies early on that the system has been properly integrated. In past programs the customer could test for weeks only to find some components that don't integrate as a system.
3. It identifies problems early, allows correction, and allows subsequent verification testing to concentrate on problem areas.
4. It leads to a smoother verification for specification compliance because system integration has already been demonstrated
5. It may well make it easier to differentiate between test procedure errors and system errors.
6. It channels verification testing into specific areas. Verification testing of non-problem areas can go much faster while concentrating on areas where problems have been identified.
7. It adds credibility to the test readiness review because the Air Force has been involved and has seen the results.
8. It leads to a smoother, more efficient use of Air Force test time and may shorten the period.
9. It will make the ultimate shipment decision less controversial.
10. It helps define the system capabilities in terms of training, not technology.

Flight Simulator OT&E is absolutely necessary to ensure that the device will function in its operational environment and meet user training requirements. That was the Air Force's conclusion when it incorporated OT&E into its test plans for training devices. Now that process has been incorporated into the contractor's (Link's) test planning for a complete test prior to customer acceptance testing. The end result is a training device delivered to the user that is capable of accomplishing all the training it was intended to perform.

ABOUT THE AUTHORS

Lt. Col. John Clapp (USAF, Ret.) was, until retirement, the Division Chief for Training Systems at Headquarters AFOTEC (Air Force Operational Test and Evaluation Command). He was responsible for all planning and conduct of the operational test and evaluation (OT&E) of an advanced Aircrew Training System. He previously served as the Operational Test Director for several Air Force Training Devices, including the B-52 WST, F-16 WST, and the B-1B WST.

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Wendell Morgan is a Training System Engineer for Link Flight Simulation in the Operations and Training Analysis Group. He came to Link after serving in the Air Force and Air National Guard. He is a rated Navigator, B-52G Radar Navigator, and F-4E Weapons System Officer. He has contributed to the development of the Operational Concept of the Mission Generation Station for various ATD's. He has been deeply involved in directing the Mission Development Concept for training and Test Missions. He is now the Lead Engineer for developing the total mission environment for Test and Training Missions. Mr. Morgan holds a B.S. in Education and Communication and a Masters of Aeronautical Science.