MISSION TRAINING CENTER UTILIZATION TO AUGMENT OPERATIONAL TESTING

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Abstract

While the primary purpose remains the training of aerospace crews and system operators, the potential of the DMT environment and its components to support ancillary efforts such as experimentation, test, and tactics development has been theorized since the inception of the DMT initiative. An effort to investigate the potential utilization of the USAF Distributed Mission Training-Aircrew (DMT-A) initiative's Mission Training Center (MTC) resources to augment Air Warfare Center's 53d Wing (53WG) test activities has recently been proposed. Significant portions of the 53WG activities are dedicated to the support of operational test and evaluation of new equipment and systems proposed for use by these forces. The utilization of the MTCs is viewed as a possible means to not only further enhance the efficiency and effectiveness of 53WG test activities, but also as a way to mitigate the expense and personnel tempo issues associated with such activities. The flexibility offered by the high-fidelity simulators within the synthetic environment allows for direct application within the 53WG's Design of Experiments (DOE) test methodology. The initial effort, which will focus on the replication of specific legacy tests and their associated objectives within the local F-15C MTC at Eglin AFB, FL, can easily be extended across 53WG functional missions and the spectrum of operational components within the DMT network.

Biographical Sketch:

Mr. R.H. Taylor is a member of the Technical Staff for the Technology Evaluation and Transition Division of Dynetics, Inc. Since graduating from the University of Missouri-Rolla and joining Dynetics in 1987, Mr. Taylor has participated in systems engineering and analysis efforts utilizing digital simulations, hardware-in-the-loop simulations, installed system test facilities, and open-air flight tests. In recent years, the majority of Mr. Taylor's activities have centered upon the employment and evaluation of real-time simulations in aircrew training applications. Mr. Taylor is currently supporting the 29th Training Systems Squadron (29TSS) of the Air Warfare Center's 53D Wing at Eglin AFB, FL, with the development and execution of methodology to assess both independent and networked aircrew training devices for the F-22 Raptor.

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INTRODUCTION

The Air Warfare Center's 53d Wing (53WG) serves as the focal point for the combat air forces in electronic combat, armament and avionics, chemical defense, reconnaissance, command and control, and aircrew training devices. Significant portions of the wing's activities are dedicated to the support of operational test and evaluation of new equipment and systems proposed for use by these forces. Utilization of U.S. Air Force Distributed Mission Training (AF DMT) resources to augment 53WG activities is viewed as a possible means to not only further enhance the efficiency and effectiveness of 53WG test activities, but also as a way to reduce the costs associated with such activities.

U.S. AIR FORCE DISTRIBUTED MISSION TRAINING (AF DMT)

The U.S. Air Force Distributed Mission Training (AF DMT) is a readiness initiative to achieve and maintain the individual, team, and composite force skills needed by combat and combat support forces to accomplish their missions. Unit-level Mission Training Centers (MTCs) with linked high fidelity simulators are the core of the DMT system. These components operate as independent devices (i.e., single ship) or within a networked environment (local and long haul) with both homogeneous and heterogeneous systems. Existing resources include F-15C MTCs at Eglin AFB, FL, and Langley AFB, VA and an E-3A AWACS MTC at Tinker AFB, OK. Additional assets projected in the near-term include: F-16C MTCs at Shaw AFB, SC, Mountain Home, ID, and Spangdahlem AFB, GE; F-15C MTCs at Elmendorf AFB, AK, Kadena AFB, and Lakenheath; an AWACS MTC at Elmendorf AFB, AK and three additional AWACS MTCs at Tinker AFB, OK.

DMT will develop incrementally and will continually grow and evolve via the addition of MTCs. As each system is added, it will be integrated into the common training environment and be able to interact with other applicable components. Eventually, the DMT environment will include constructive (simulated entities controlled by a computer), virtual (real people operating simulated systems), and live (real personnel using their operational systems) entities. This will allow individual aerospace crews and system operators to experience and train alone or in conjunction with friendly forces against the threats they would face during actual operations. As DMT matures, its linkage to other systems may support expanded mission rehearsal activities, allowing commanders to take advantage of DMT's unique synthetic battle space to improve the combat readiness of their staffs and to test and evaluate operational concepts. Multiple focus areas that are being actively pursued under the AF DMT umbrella concept by the individual Major Commands (MAJCOMS) are shown in ***Figure 1***.

AF DMT ANCILLARY CAPABILITIES

While the primary purpose of the DMT-Aircrew (DMT-A) initiative remains the training of aerospace crews and system operators, the potential of the DMT environment and its components to support ancillary efforts such as experimentation and exercise support has been theorized since the inception of DMT. The DMT Concept of Operations describes experimentation to include "tactics development, weapons testing, research and development of new weapons systems components, analysis of weapons systems and human interactions, exploitation of potential adversary capabilities, technology insertion, software development, training evaluations, etc. [1]." The DMT CONOPS also states that one MTC within each major weapons system will be designated as an experimentation center. In the case of the F-15C, the F-15C MTC at Eglin AFB, FL, is designated as an Aerial Combat Enhanced Simulation (ACES) center [2].

The Eglin F-15C MTC consists of four high fidelity F-15C advanced simulators on both local and long-haul networks. The four-ship simulation system allows full combat tactical training for four pilots simultaneously to support all applicable training requirements. It includes a high fidelity, simulated combat environment integrated with simulations of all avionics and weapons system. This includes simulations of programmed or interactive threat aircraft, gunner, air-to-air and surface-to-air missiles, electronic counter-measures, communications, networks, command and control structures, and atmospherics. The system has an instructor operator station (IOS) capable of managing the F-15C local and long haul networking environment. Additional components of the Eglin F-15C MTC include four man-in-the-loop adversary simulators (threat stations) and an AWACS console station. The MTC has multiple brief/debrief facilities as well as a mission observation center which support real-time mission observation as well as mission replay [3].

DMT Operational Domain	Operational Domain Focus	Operational Domain Lead Command(s)
DMT-A	Aircrew	Multiple (Air Combat Command primary)
DMT-C2	Command & Control	Air Combat Command
DMT-S	Space	Air Force Space Command
DMT-SO	Special Operations	Air Force Special Operations Command
DMT-M	Mobility	Air Mobility Command
DMT-T	Training	Air Education and Training Command

Figure 1. DMT Operational Domain Overview

53D WING, USAF AIR WARFARE CENTER

Headquartered at Eglin AFB, FL, the Air Warfare Center's 53d Wing (53WG) serves as the focal point for the combat air forces in electronic combat, armament and avionics, chemical defense, reconnaissance, command and control, and aircrew training devices. The wing is also responsible for the performance of operational test and evaluation (OT&E) of new equipment and systems proposed for use by these forces.

Earlier this year, the 53WG initiated a formal training program aimed at enhancing test efficiency [4]. The training program focuses on the implementation of Design of Experiment (DoE), a statistical process for planning experiments developed more than 70 years ago by British mathematician Sir R. A. Fisher. Fisher's DoE process allows for the simultaneous testing of as many as twelve variables within a single experimental trial. While the initial thrust of the 53WG's program is to enhance the efficiency of the open-air range (OAR) test missions conducted by the wing (i.e., test sorties conducted by actual aircraft on a test range such as the Nellis Test and Training Range, NTTR), other test methods such as bench testing and the use of computer simulations are by no means excluded from use within the DoE process. In fact, the numerous advantages associated with the use of these alternate test methods are the driving force behind the effort discussed herein.

RETURN ON INVESTMENT (ROI)

FINANCIAL CONSIDERATIONS

The costs associated with the conduct of a test mission may be viewed as a compilation of direct costs, derivative costs, and intangible costs. As an example, consider a test of an air-air weapon within a standard strike mission. Items categorized as direct costs items would include those costs associated with use of the range complex, the strike package (e.g., the fighter and bomber aircraft), the support package (e.g., AWACS and tankers), and the surrogate threat aircraft and ground-based threats (as applicable). Items categorized as derivative cost items would include the cost of wear on the aircraft and the environmental clean up associated with the test event. Derivative costs should not be confused with intangible costs; unlike intangible costs, the financial impact associated with these derivative items is traceable, although often at a great expense of effort. Finally, intangible costs would include those costs associated with factors that cannot be quantified (e.g., environmental impacts).

Comparative execution of this example test provides valuable insight regarding the significant fiscal advantages associated with MTC utilization (*Figure 2*). Based on the responses received with regard to an aggregate cost of a sample F-15C OAR mission, utilization of the F-15C MTC was projected to provide an order of magnitude cost savings (FY02 contracted rates). Unlike OAR assets that are susceptible to cost increases (e.g., inflation), such factors have already been incorporated within the MTC contracted rates. In fact, the predetermined rates associated with the initial MTC service contracts actually *decline* over time as the initial investments of the simulation service providers are amortized. As it is reasonable to expect future increases in the costs associated with OAR activities, this temporal component should (at a minimum) increase in value, making MTC use even more attractive *(Figure 3).*

As a final note, isolation of the specific costs associated with OAR testing was found to be akin to cat herding; that is to say, it is a very frustrating endeavor that is not easily accomplished to any degree of success in a reasonable timeframe. For example, should range complex costs be included when the test was conducted as a concurrent objective of an otherwise separate mission (the "piggyback" method)? If cost sharing is the proposed solution in this case, how are the proportionate costs determined? Rather than belabor this point further, let me simply state that the exploration of specific fiscal components for a ROI estimation led to the receipt of many disparate values. However, the responses received with regard to the *aggregate* cost of a sample mission (which were within a 5% range) were sufficient for comparison purposes.

- **4-Ship of F-15Cs on Open Air Range (OAR)**
  - *Plus* Costs of Surrogate Airborne Threats
  - *Plus* Costs of Surrogate Ground-Based Threats
  - *Plus* Aircraft Maintenance/Wear Costs, Tanker Costs, etc…..
  - *With* Environmental Impact and Clean-up (if applicable)

- **4-Ship of F-15Cs within a Mission Training Center (MTC)**
  - Pre-Determined Contracted Rate (Fee for Service Contract)
  - *Includes* Simulated Airborne Threats, with Manned Option
  - *Includes* Simulated Ground-Based Threats
  - Aircraft Maintenance/Wear Costs, Tanker Costs are Non-Issues
  - No Environmental Impact or Clean-up

Figure 2. Required Resource Comparison

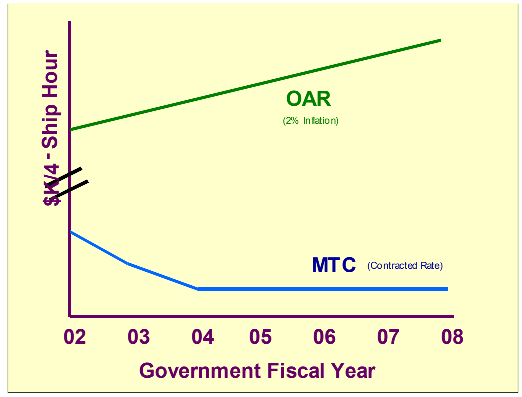

Figure 3. Cost Comparison

ADDITIONAL CONSIDERATIONS

In addition to the financial advantage already discussed, the MTC enjoys the standard characteristic advantages of simulations in comparison to OAR operations. The theme common to these characteristic advantages is *flexibility*. This flexibility is a direct result of operating within a *controlled, repeatable environment*. The simulation allows for the avoidance of penalties associated with positioning of test resources. The simulation can avoid the additional time (and inherent costs) associated with enroute, set-up, and recovery periods. While these periods are not without some value to the participants, such activities consume resources and are clearly subordinate to mission accomplishment. The simulation offers the possibility for an increase in the number of "go's" within the standard mission period through its ability to "freeze" and "re-set" participants to initial or intermediate positions.

Generally, simulations provide for a greater access to and volume of performance data than OAR operations, without need of synchronizing data obtained from multiple sources. Finally, use of simulation provides a means to avoid encroachment and environmental impact concerns at an increased level of safety for those participating.

KEY OBJECTIVES

The key objectives of the effort are to investigate the utility of the MTC to augment OAR testing in the following areas:

(a) Provide for increased effectiveness and efficiency of T&E missions through pre-mission rehearsal and refinement of planned missions
(b) Allow for the accomplishment of test objectives within the simulated battlespace, and
(c) Provide a representative environment for controlled, repeatable exploration of operational employment decisions (i.e., tactics development)

FLEXIBILITY vs. ACCEPTABLE VALIDITY

Given the positive (and increasing) ROI and the inherent advantages offered by the simulation as a result of its flexibility, the choice would seem obvious – make use of the MTC for test purposes whenever it is appropriate. And so we get to the crux of the biscuit – when is utilization of the MTC *appropriate*?

To answer this question, I polled several of my colleagues in hopes of achieving a consensus answer. Our initial attempt was as follows:

Utilization of the MTC for test purposes is appropriate when the MTC is capable of representing the characteristic performance of the system under test within the simulated environment to a level of validity acceptable for the accomplishment of specific test objectives.

Of course, this answer had the possibility to raise as many as questions as the first as it contained an equally ubiquitous term – *acceptable validity*. One could reasonably argue that the term "acceptable validity" is synonymous with accreditation. However, we purposely eschewed the use of the standard M&S terminology to avoid any misperception regarding the status of the resource in question. Many of us recalled a commonly employed table used to present the definitions of the M&S "Holy Trinity" - verification, validation, and accreditation (VV&A). While not explicitly stated as such, the left to right format of the table infers a natural progression of activities; that is to say, an M&S resource is first verified, then it is validated, and then, finally, it is subjected to accreditation. Such an occurrence would be ideal; however, we knew that this was not always the case. Many of us had direct experience with programs in which the performance results of M&S resources were readily accepted in spite of the fact that the resources had never been subjected to a formal validation process. Therefore, the group chose to use "acceptable validity" in (grudging) acknowledgement of the fact that if an M&S resource that has not been subjected to a formal validation process is nevertheless utilized and becomes established within a using community, it will generally be preferred to an unknown model that has undergone formal validation.

After incorporating additional language to consider key objectives to encompass rehearsal and tactics development, the group arrived at the following guideline regarding MTC utilization:

Utilization of the MTC is appropriate for test purposes when the MTC is capable of representing the characteristic performance of the system under test (SUT) within the simulated environment (to include visual and aural situational awareness cues) to a level of validity acceptable for mission rehearsal or the accomplishment of specific test objectives.

PLANNED APPROACH

As stated previously, the initial effort involves the replication of specific 53WG legacy tests and their associated objectives within the local F-15C MTC at Eglin AFB, FL. The conditions associated with select test missions previously executed by the 53WG on an OAR (primarily NTTR) will be duplicated within the MTC as closely as possible using various data sources, including post-mission data from the aircraft. Hypothetical assessments of the MTCs capability to support the evaluation of the legacy test objectives will be developed, with current support capability to be categorized as: (1) none, (2) degraded, (3) equivalent, or (4) enhanced. The mission will then be executed within the MTC and performance with respect to the specific objectives of the test will be compared to those obtained on the OAR. The initial capability assessments will then be re-assessed in light of the results achieved. Recommendations will then be offered with regard to utilization of the current MTC to augment testing, as well as to specific enhancements desired within the MTC.

INITIAL CHALLENGES

ESTABLISHING A LEVEL PLAYING FIELD

While testing provides data for discrete conditions, these are but points upon and along a performance continuum. This point can often be paid little heed when conducting OAR testing. If the objective was tested and it was successful against the stated criteria, you move ahead; if it was unsuccessful, re-test until the first occurrence of success – *then* you move ahead. The "ultimate truth" aspect of OAR testing (i.e., the test is executed within actual physical world conditions) and the amount of resources expended to perform such tests seemingly serve to quell most fears associated with single-point successes.

M&S resources do not benefit from execution within an "ultimate truth" environment. As such, the performance results of simulation resources are generally subject to a greater level of scrutiny than OAR results. However, this scrutiny can sometimes digress into a prolonged exploration of the minute details of the models, essentially rendering the applicability of performance results a mute issue. In sharp contrast to the perspective for OAR tests, simulation often suffers from a perspective of "keep looking until you find something that raises some uncertainty."

Are these biased overstatements of case-specific issues? Perhaps. However, issues such as this are often the most challenging to overcome, and it is crucial to this and to future efforts that potential utility for test application is not dismissed out of hand due to the nature of the resource to be utilized. A comprehensive answer (even with some known assumptions) is often of equivalent or greater value as a single OAR flight test.

MEASURES OF PERFORMANCE

Any meaningful comparison to legacy AOR test missions must include both qualitative and quantitative measures of performance (MOPs). However, many of the tests conducted by 53WG do not necessarily include quantitative MOPs as test criteria. A force development evaluation, for example, is predominately a subjective assessment. In other cases, such as support of AFOTEC testing, MOPs may exist but at too high a level to be of use in such a comparison. Finally, quantitative MOPs may not necessarily be included in every test plan, as they are deemed extraneous or redundant to adequately assess the accomplishment of the objective.

Should the results of this effort prove positive, one of the primary challenges will be to insure that test plans are constructed so as to include a sufficient number of quantitative metrics to support (potential) utilization of the MTC when applicable.

INCORPORATION OF ADVANCED MODELS

The tests performed by the 53WG customarily involve evaluations of weapons and capabilities on the cutting edge of technology. However, as the MTC "fee for service" contracts are primarily intended to support aircrew training, the supporting models provided by the devices represent current aircraft capabilities. Incorporation of advanced models into the MTC to support specific tests, while possible through forums such as technology insertion boards, will likely be time-consuming efforts that will require a great deal of coordination to insure availability of the proper models to coincide with test needs.

INCLUSION INTO ESTABLISHED PRACTICES

Should the MTC show promise to support the key objectives of this effort, the challenge to incorporate use of the MTC into established practices will remain. This will be compounded by the fact that relatively little is known about the actual capabilities of the MTCs. While beginning to become better known within the training community, the actual capabilities of the MTCs remain largely unknown outside training community circles. Assistance of senior leadership will likely be required to initiate the desired paradigm shift.

NEAR-TERM ACTIVITIES

FY02 funds solicited from OSDs' Live Fire Test and Training (LFT&T) Program were not made available to pursue the proposed evaluation. As a result, the effort has been forced to take advantage of opportunities as they arise. Activities to date have been limited to data that can reasonably be obtained during routine simulator assessments performed by the 53WG's 29th Training Systems Squadron. In addition, attempts are being made to increase awareness of the MTCs potential within the 53WG. Initial emphasis is being placed upon the utility of the MTCs in a mission-rehearsal role as a potential means to mitigate continuing personnel tempo concerns.

Recently, the Air Force Operational Test and Evaluation Center (AFOTEC) has begun to explore the use of the F-15C MTC as a pre-mission assessment tool for use in OAR comparison testing with the F-22 Raptor. Use of a "test the test" philosophy has been at the center of AFOTEC's test efforts on the F-22 program, with multiple simulations of varying levels of fidelity used extensively to scope and verify planned tests prior to live flight. Interest areas currently being discussed by the AFOTEC test team include use of the MTC for pre-mission rehearsal and refinement as well as the limited assessment of tactical implementation within various threat environments.

CONCLUSION

The purpose of this effort is not to promote the AF DMT program; a robust AF DMT program is a fundamental necessity for the effort described herein and is assumed by the author. The objective of the effort is to begin to take the steps necessary to utilize the DMT devices in support of ancillary activities; in this case, OAR testing performed by the Air Warfare Center's 53WG. The recent interest shown by AFOTEC in the F-15C MTC for pre-mission planning and refinement is seen as a positive step forward. Certainly, the results of an effort such as that proposed herein would be of benefit to any organization wishing to explore the use of an MTC in support of a test program.

Unfortunately, common utilization of MTCs to augment operational testing is more likely to occur as a result of budgetary restrictions rather than a fundamental desire of the test community to openly embrace modifications of existing test methodology. Change is often slow and almost always painful, but at the same time, inevitable. While the concept of utilizing MTCs to augment operational testing remains largely unexplored at this juncture, the author remains hopeful that recent activities will serve to expedite constructive change in this area.

REFERENCES

1. Concept of Operations for Distributed Mission Training, Air Combat Command, October 1998
2. Ibid.
3. "Evolution of the Processes Used to Evaluate Aircrew Training Devices in a Distributed Environment", Taylor, Wakefield, and Deems, I/ITSEC 2000 Proceedings
4. *"Wing Adopts DoE Testing Method"*, 53D Wingspan, Vol. 2, No. 53, 22 March 2002