BASELINE CORRELATION MATRIX - A MANAGEMENT TOOL THAT GOES THAT EXTRA MILE

John O. Smith

Chief Test and Deployment Management Division
Training Systems System Program Office
Wright-Patterson AFB OH

ABSTRACT

Baseline Correlation Matrix (BCM) is a fairly new program management tool in the acquisition business that provides traceability and comparison of the user's requirements, developer's specifications, and operational tester's evaluation criteria. Its primary purpose is to relate and align those requirements, specifications, and evaluation criteria to ensure orderly system development and test. A major problem encountered in the test and evaluation arena has been the agreement on the parameters selected for test evaluation. As an example, during the Initial Operational Test and Evaluation (IOTE) of the EF-111A Operational Flight Trainer (OFT), problems surfaced that obviously showed discontinuity on what the developer specified. Because of this disconnect, the Training Systems System Program Office (SPO) (ASD/YW), Aeronautical Systems Division, Wright-Patterson AFB, researched the BCM concept and developed a process for application to our training system programs. The paper will lay out the methodology used to apply the BCM to training system programs. The areas of the BCM will be summarized with a short history and how it was developed. The paper will discuss the approach and criteria used for selecting specific training programs for the BCM process and provide a guide for preparation and approval. Future test management objectives of the Training Systems SPO using BCM techniques will be outlined.

SHORT HISTORY

It all started when the Ground Launch Cruise Missile (GLCM) was undergoing IOTE. The Operational Test and Evaluation (OTE) agency was the Air Force Operational Test and Evaluation Center (AFOTEC). Definitions of test requirements for reliability, availability, and maintainability were ambiguous. The test parameters AFOTEC was evaluating did not match the requirements from the specifications, and the user's requirements. In other words, there were disconnects. A joint Air Force Systems Command (AFSC)/AFOTEC study team was chartered in June 1983 to review the GLCM problem, to review other programs with similar problems and to determine how to avoid these problems during operational testing. The recommendations of the joint team were (1) to develop a single document which would correlate user's requirements, developer's specification, and the operational tester's evaluation criteria and (2) to proceed with examining a number of programs to determine if the process would work. The recommendations were approved by AFSC and AFOTEC. Selected for review were the HH-60 Combat Rescue Helicopter, T-46 Undergraduate Pilot Trainer, Global Positioning System (GPS), and the Advanced Medium Range Air-to-Air Missile (AMRAAM). Findings indicated that the single document was extremely valuable and a needed tool. Value added included identification of serious disconnects, forced crosstalk between the user, developer, and operational tester and, was most effective when begun early. The recommendation from AFSC and AFOTEC was to institutionalize the correlation process Air Force wide. AF Regulation 800-46, "Baseline Correlation Matrix," published 6 March 1987, directed the implementation of the BCM process on all Air Force systems acquisition programs.

In 1986, operational testing was conducted on the EF-111A Operational Flight Trainer (OFT) by AFOTEC. The final report indicated areas where user's requirements disagreed with operational tester's criteria. For example, the instructional capability of the Instructor Operator Station (IOS) was rated marginal. The report stated the IOS was too complex for a single operator. Upon further review, it was determined that the user was aware of its complexity and the user's requirement was for an IOS capable of being run by one instructor pilot and one Electronic Warfare Officer (EWO). Here was an example of a serious disconnect between what the requirements were versus what was being evaluated by the operational tester. There were other areas; however, we will not address them in this paper. Because of obvious advantages, the Training Systems SPO has written a policy to implement the BCM process for future test programs.

GUIDANCE

AF Regulation 800-46 prescribes the BCM process to be used on major Air Force acquisition programs and on major multiservice acquisition programs for which the Air Force is lead service. Included in the regulation are all commands and separate operating agencies, including US Air Force Reserve and Air National Guard. All major acquisition programs as defined in AFR 800-46 are required to prepare a BCM. Less than major acquisition programs, i.e., training systems, qualify when program participants see benefit in accomplishing the BCM process for programs having high visibility, changing requirements, substantial operational testing, complex interfaces, or challenging interoperability issues. The regulation sets policy, defines procedures, and assigns administrative responsibilities for the preparation, control, and approval of the program BCM.

The objectives of the BCM are to relate, align, summarize, and provide an historical record of requirements, specifications, and evaluation criteria to ensure orderly system development and test. To insure a common understanding and a consistent application of the terms by all participants, the following definitions were developed for use by AFR 800-46.

Requirement. The level of performance, quality, supportability, compatibility, and interoperability necessary for a particular system to accomplish its mission at maturity.

Specification. As used in this paper, a contractual requirement describing the capability that will yield the required performance of the subsystem or system being procured.

Evaluation Criteria. Standards used to judge the achievement of required operational effectiveness or suitability characteristics or the resolution of technical or operational issues.

The BCM will afford the user the opportunity to clearly understand the system's capabilities, allow the developer to completely address all major program requirements, and allow the operational tester to address those same requirements in his operational evaluation. A key activity in the BCM process is the interaction between the user, developer, and operational tester as early as possible in the acquisition cycle.

The BCM format consists of a four-column spreadsheet with the following descriptive heading--Parameter, Requirement, Specification, and Evaluation Criteria (IOTE). Descriptive parameters are entered in the first column and columns 2, 3, and 4 are designed to ensure that (1) the system capabilities are clearly stated by the user, (2) that the developer has addressed all major requirements, and (3) the operational tester has addressed those same requirements. A major problem discovered in the Training Systems SPO is that some of the source documents lack the necessary details to clearly define the requirements. Parameters have been hard to define objectively. For example, an aircraft system can specify terms such as cruise speed, take off field length, rate of climb, etc. These are specific terms that can be measured. On the other hand, the training systems use terms such as training capability, instructional capabilities, software supportability, and computational capabilities. The reader can see from these examples that to define a test program to measure these parameters are not clear cut. In order to develop an approach for training systems, it was necessary to tailor the BCM to unique training systems application. The approach focuses on the training aspect and not on system capability such as defined on an aircraft. The draft B-1B Simulator System (SS) BCM indicated in Figure 1 illustrates the four column-format. Additional text may be added to incorporate brief clarifying statements, traceability information, and methodology descriptions that directly relate to entries on the matrix as shown in Figure 2.

Content of source documents (e.g., System Operational Requirements Document, System Operational Concept, Program Management Directive, Product Specification, or Operational Test and Evaluation Plan) must translate into program specific parameters; provide parameter traceability back to the source document, and in turn, may illuminate disconnects between program parameters in source documents. The BCM does not substitute for clear articulation of requirements, force resolution of disconnects, initiate corrective action by itself, cause specifications to be written in operationally meaningful terms and will not work without universal support. Instead it is designed to ensure user requirements are properly addressed by the developer and operational tester. Early crossfeed, understanding, and agreement between the user, developer, and operational tester is necessary to ensure a successful test program.

CRITERIA

The Training Systems System Program Director directed that BCMs be prepared on certain programs. The criteria for selection is, that a

Parameter	Requirement	Specification	Evaluation Criteria
1.0 Training Capability	Satisfy training objectives not satisfied by the aircraft	Complete simulation of all aircraft systems with which the crew interacts	100% training objectives not satisified by the aircraft, trainable
1.1 Crew Stations	Pilot/Copilot Station Joint OSO/DSO Station	Pilot/Copilot Station Joint OSO/DSO Station	"
1.2 Visual System	Day/night visual over flight profile	Day/dusk/night operations within full flight envelope	"
1.3 Motion System	Correlate visual simulation and flight instrument readings	Motion system using MIL-STD-1558 as a guide	"
1.4 External Environment Simulation	Pressure, Wind, Temperature, Navigation Aids, Threat Data	Pressure, Wind, Temperature Navigation Aids, Threat Data	"
1.5 Threat Simulation	Friendly and hostile RF Emitters/antenna beams Missile emitters/flight paths Airborne interceptor gun/ missile emitters and flight paths	Jammer, Artillery, Radar or Missile (JARM) is the generic term for all simulated hostile systems external to aircraft.	Trainable

Figure 1: B-1B SS Baseline Correlation Matrix

1. Training Capability:

a. Requirement. Satisfy training objectives that are not satisfied by the aircraft due to airspace restrictions, operating limitations and safety (Ref PMD 3032, para 2c(1)).

b. Specification. The WST shall include a simulation of all aircraft systems and the flight environment with which the crew interacts with the fidelity necessary to accomplish SAC Combat Crew Training Squadron and Main Operating Base training objectives (Ref. PIDS for B-1B SS Weapon System Trainer, SSPO-07878-3010, para 3.2.1).

c. IOTE Evaluation Criteria. One hundred percent of the training objectives that are not satisfied by the aircraft due to airspace restrictions, operating limitations, and safety training (Ref B-1B WST IOTE Test Plan).

2. Crew Stations:

a. Pilot/Copilot Station

(1) Requirement. Visual and motion system with all external environments realistically simulated. Interactive with the OSO/DSO station (Ref SAC SOC, Oct 82, page 50).

(2) Specification. The WST flight station shall include simulation of the pilot/copilot positions. The flight characteristics of the aircraft shall be simulated in accordance with the design criteria throughout the full operating envelope. Interfaces to and from the OSO/DSO station shall be as defined in 3.1.1 of the PIDS and its subparagraphs (Ref PIDS SSPO-07878-3010, para 3.7.1.1).

(3) IOTE Evaluation Criteria. Same as 1 (Training Capability).

Figure 2: Clarifying Information (B-1B example)

BCM will be accomplished on all training programs where AFOTEC has been designated as the operational test and evaluation command. Further, a BCM will be prepared for other programs when requested by the user or because of high visibility, changing requirements, substantial operational testing, complex interfaces, or challenging interoperability issues the BCM may be directed by the SPO Director. Figure 3 is the current list of programs which have been selected for BCM preparation. Note that there are currently two programs which have been selected even though operational testing is being accomplished by the using commands. These are the KC-135/MB-26 OFT and the C-5/C-141 Air Refueling Part Task Trainer (ARPTT).

PREPARATION GUIDE

An operating instruction (OI) has been established which sets the standard policy, responsibilities, and procedures for development and updating BCMs. This OI implements the provisions to suit the unique requirements of training systems programs. The OI also includes information about a closely related document, the Requirements Correlation Matrix (RCM), that is required to be submitted by the using agency for each new program. The OI applies to all personnel assigned to or collocated in the Training Systems SPO.

Test management specialists assigned to programs requiring a BCM will serve as chairperson of the group developing the BCM. His responsibilities include drafting the BCM with the assistance of other team members and working closely with the user and operational test agency to insure a fully coordinated BCM is completed as early as possible. The BCM will be updated annually by the anniversary date of its approval or more frequently if program maturity dictates. If the BCM is still current, the BCM team chairperson will sign an endorsement to the approval sheet so stating and redistribute the approval sheet only.

DEVELOPMENT MILESTONE

AFR 800-46 states that a BCM should be prepared within 270 days after receipt of Program Management Directive (PMD). Figure 4 represents the milestones required to develop a BCM to include the timelines necessary to comply with the 270 day suspense. The test manager should prepare this schedule. He should prepare a draft BCM using all the available information that can be assimilated. A copy of the PMD, System Specification and Statement of Need or Statement of Requirement Document will be used during this phase. In some cases the RCM will be used as a baseline for development of the BCM. The BCM should be internally coordinated with the functional areas such as program management, engineering, logistics, etc, to determine if the draft is consistent with current direction. The test manager will then send the BCM out to the users for review and schedule the test planning working group (TPWG) meeting. The TPWG is the test planning forum for discussing test related activities. The BCM should be discussed at great length during the TPWG. The comments from the TPWG will be incorporated in the BCM and sent to Offices of Primary Responsibility (OPRs) for approval. When OPRs signatures and comments are incorporated, the BCM will be sent to the approval authority for final approval. The final approval authority for training systems programs will be either the Directorates of Tactical and Training Training Systems (ASD/YWF) or Strategic and Airlift Training Systems (ASD/YWS) for their respective programs. Finally, the BCM will be published and submitted to all interested parties.

PROGRAMS	OTE COMMAND	IOTE DURATION
B-1B SS	AFOTEC	4 WKS
F-15E WST	AFOTEC	4 WKS
F-16 BLK 40 WST	AFOTEC	2 WKS
KC-135/MB26 OFT	SAC	2 WKS
C-5/C-141 ARPTT	MAC	2 WKS

Figure 3: Training Systems Programs Developing BCMs

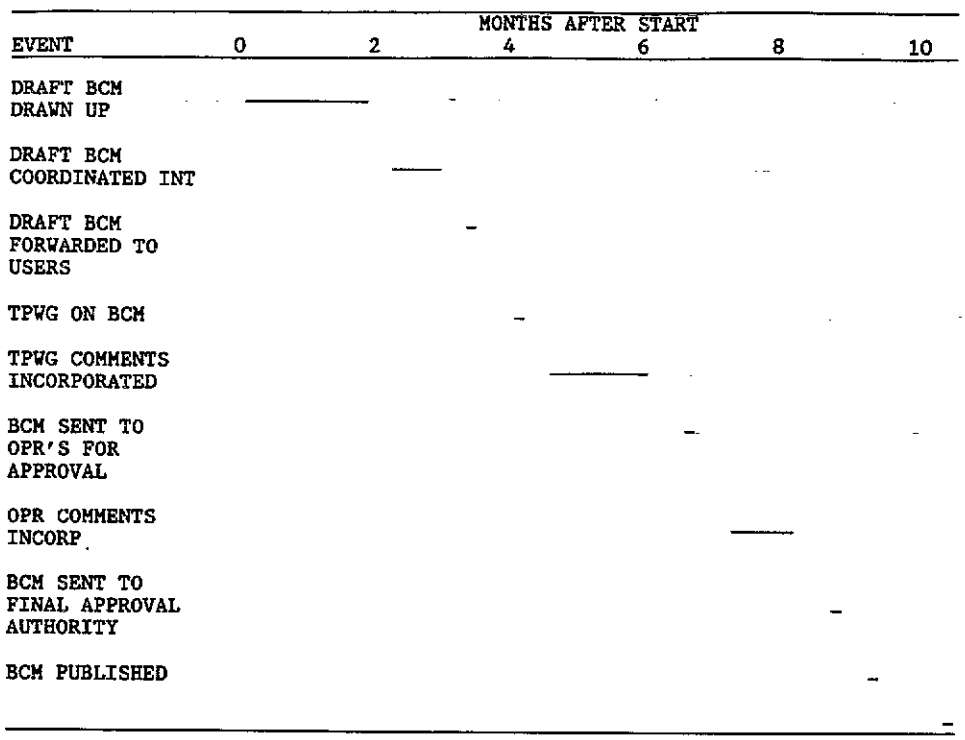

Figure 4: Suggested Milestones for BCM Development

LONG RANGE OBJECTIVES

As mentioned previously, there are three programs, KC-135/MB-26 OFT, B-1B SS, and the C-5/C-141 ARPTT that have BCMs under development or in place. Two additional programs, F-15E Weapon System Trainer (WST) and the F-16 WST Bock 40, will be initiating their BCMs in the near future. The lessons learned from the initial BCM process will be applied as necessary to these programs.

Since the BCM process is a recently adopted management tool, the process will need to be further reviewed to determine application to maintenance trainers. The only maintenance training program currently being procured is to support the C-17 Weapon System, and there is currently no separate OTE requirement. Aircrew Training Systems (ATS) programs exclude government testing, so no BCMs are required. As future training programs evolve, the Training Systems SPO must decide whether to develop a BCM.

CONCLUSIONS

The BCM is a unique management tool available to the program manager to insure the user, developer, and operational tester adequately address the requirements, specifications, and evaluation criteria for orderly system development and test. However, it must be implemented early in the acquisition cycle to maximize benefits. Use on programs having high visibility, changing requirements, substantial operational testing, complex interfaces, or challenging inter-operability issues is recommended. BCMs will continue to be developed for training system programs meeting this criteria.

REFERENCES

1. Air Force Regulation 800-46, "Baseline Correlation Matrix"

2. YW Operating Instruction 800-30, "Baseline Correlation Matrix"

3. B-1B Weapon System Trainer (WST), "Baseline Correlation Matrix"

ABOUT THE AUTHOR

Mr Smith is the Chief of the Test and Deployment Management Division, Directorate of Acquisition Support, Training Systems System Program Office, Aeronautical Systems Division, Air Force Systems Command. Mr Smith is a graduate engineer from Tennessee State University where he earned a Bachelor of Science degree in Physics. Mr Smith was awarded a Master of Science degree in Management Science from the University of Dayton. As test and deployment management chief, he is responsible for the oversight of all assigned test program and deployment planning tasks within the Training Systems System Program Office.