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DEFENSE SYSTEMS MANAGEMENT COLLEGE

PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

DEVELOPMENT and OPERATIONAL TESTS I:
XM-1 MAIN BATTLE TANK PROJECT

STUDY PROJECT REPORT
PMC 76-2

Hugh N. Williams
CPT(P) USA

FORT BELVOIR, VIRGINIA 22060

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE: DEVELOPMENT and OPERATIONAL TESTS I:
XM-1 MAIN BATTLE TANK PROJECT

STUDY PROJECT GOALS:

The goal of the project was for the author to become familiar with test doctrine test organizations, and tools and techniques available to project personnel in developing and executing developmental and operational test plans.

STUDY REPORT ABSTRACT:

The purpose of this study was to provide some insight as to how the XM-1 project management office (PMO) organized, planned, and executed DT/OTI from concept through validation.

The report looks at what actions were necessary in order to formulate the various test plans, and how these plans were executed. It begins with how the XM-1 PMO organized for test and then takes the reader through the evolution of test plans, their execution, and provides a limited analysis regarding some problems encountered during plan execution.

Key Words: XM-1 PMO
Coordinated Test Program
DT/OTI
Test Organizations
OTEA
TECOM

NAME, RANK, SERVICE	CLASS	DATE
Hugh Williams, CPT(P), USA	IMC 76-2	November 1976

DEVELOPMENT and OPERATIONAL TESTS I:

XM-1 MAIN BATTLE TANK PROJECT

Study Project Report

Individual Study Program

Defense Systems Management School

Program Management Course

Class 76-2

by

Hugh N. Williams
CPT(P) USA

November 1976

Study Project Advisor
MAJ Carlton Roberson, USA

EXECUTIVE SUMMARY

The purpose of this study project was to provide some insight to the author as to how the XM-1 Main Battle Tank Project Office organized, planned, and executed DT/OTI, from the Conceptual phase through the Validation phase.

The goal of the project was for the author to become familiar with test doctrine, test organizations, and tools and techniques available to project personnel in developing and executing developmental and operational test plans.

The report looks at what actions were necessary in order to formulate the various test plans, and how these plans were executed. It begins with how the XM-1 PMO organized for test, and then takes the reader through the evolution of XM-1 test plans, their execution, and provides a limited analysis regarding some problems that were encountered during plan execution (DT/OTI).

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I. INTRODUCTION

Background

On 14 December 1971, the Congress directed the termination of the XM-803 Tank Development program. Fiscal Year 1972 RDT&E funds in the amount of $20 million were made available for their termination. Congress also appropriated $20 million for a new Army tank prototype program. On 20 January 1972, the Vice-Chief of Staff of the Army assigned responsibility for development of a materiel need (MN) phase of a new Main Battle Tank (MBT) Development Program. The primary responsibility for the formulation of the effort was assigned to the Commanding General, Combat Developments Command (now Training and Doctrine Command - TRADOC). A special MBT Task Force was established in early February 1972 to develop a requirement for a MBT by 1 August 1972. In April 1972, the MBT Task Force was directed to complete a Concept Formulation Package for the MBT no later than 1 August 1972. In meeting this requirement, a Joint Working Group was established and prepared a Coordinated Test Program (CTP) first draft for inclusion in the August 1972 Concept Formulation Package. The Development Concept Paper (now Decision Coordinating Paper) (DCP) for the XM-1 Tank system was approved on 18 January 1973 and the Request for Proposal (RFP) was released on 25 January 1973. Contracts for the Validation phase of the program were signed with General Motors Corporation and Chrysler Corporation on 29 June 1973.

Materiel Description

The XM-1 is a fully-tracked, low profile, land combat assault weapons system possessing armor-protected firepower and a high degree of maneuverability and tactical agility. Operated by a crew of four, the XM-1 will mount a large caliber main gun and complementary armament systems to provide a capability to defeat a variety of battlefield targets. To achieve ballistic protection, the XM-1 will utilize the most efficient combination of armor materials and design to provide the maximum protection against both kinetic and chemical energy projectiles. The XM-1 will have the lowing characteristics:

Gross Weight	*49-58 tons*
Maximum Speed	*40-50 MPH*
Acceleration, 0-20 MPH	*6-9 seconds*
Cruising Range	*275-325 miles*
System Reliability	*320 + MMBF*

Purpose of Study

The purpose of this study project was to provide the author with some insight as to how the XM-1 Main Battle Tank Project Office (XM-1 PMO) organized, planned, and executed DT/OTI, from the Conceptual phase through the Validation phase.

Scope of Study

This study report includes only that portion of test and evaluation that deals with organizing, planning, and execution of XM-1 DT/OTI from Concept through Validation. The study begins with how the XM-1 PMO and

the Operational Test and Evaluation Agency (OTEA) organized for DT/OTI, and then takes the reader through the evolution of test plans, their execution, and provides a limited analysis of problem areas.

II. TEST REQUIREMENTS and XM-1 TEST ORGANIZATIONS

Test Requirements

Department of Defense requires test and evaluation be commenced as early as possible and conducted throughout the system acquisition process as necessary to assist in progressively reducing acquisition risks and in assessing military worth. To insure that this is accomplished, two types of tests are conducted; Development tests (DT) and Operational tests (OT). DT are those tests conducted during the Validation, Full-Scale Development, and Production phases of the acquisition cycle to demonstrate that the engineering design and development process is complete, risks have been minimized, and that the system meets specifications. DT are conducted by the Materiel Developer. OT are conducted during the same phases as DT and are designed to provide independent estimates of military utility, operational effectiveness, and suitability. OT also provides information on organization, personnel requirements, doctrine and tactics. Conduct of OT is the responsibility of the Operational Test and Evaluation Agency (OTEA) in coordination with the Materiel Developer. Figure 1 depicts testing requirements as a system or item moves through the acquisition cycle.

XM-1 Organization for Test

When the XM-1 PMO was first established, only one person was assigned to the Test Management Branch (Figure 2). This person had been involved in the joint planning which had begun in the summer of 1972. Most test planning was accomplished at this time through the establishment of in-house

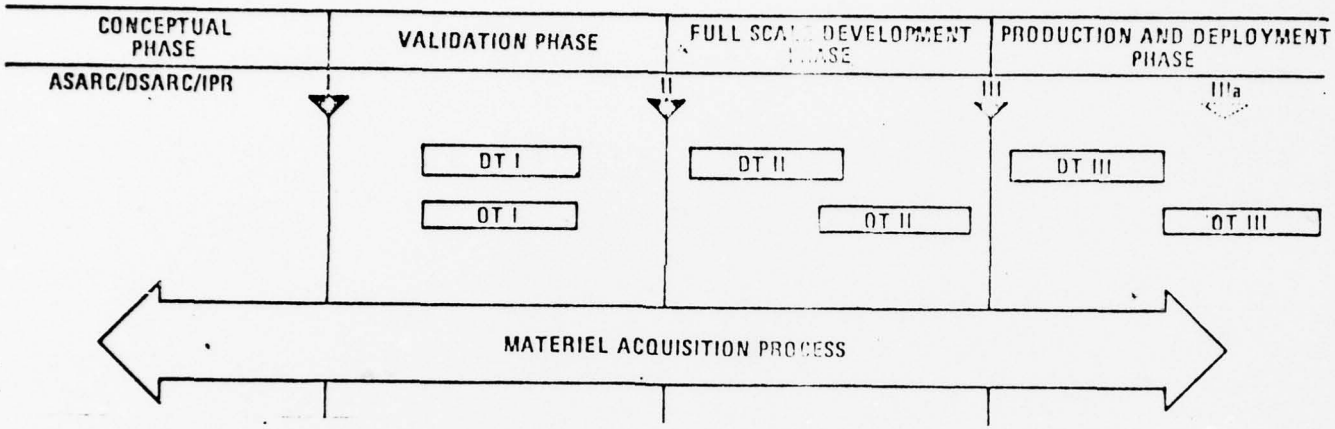

CONCEPTUAL PHASE
VALIDATION PHASE
FULL SCALE DEVELOPMENT PHASE
PRODUCTION AND DEPLOYMENT PHASE
ASARC/DSARC/IPR
I
II
III
IIIa
DT I
OT I
DT II
OT II
DT III
OT III
MATERIEL ACQUISITION PROCESS

Figure 1

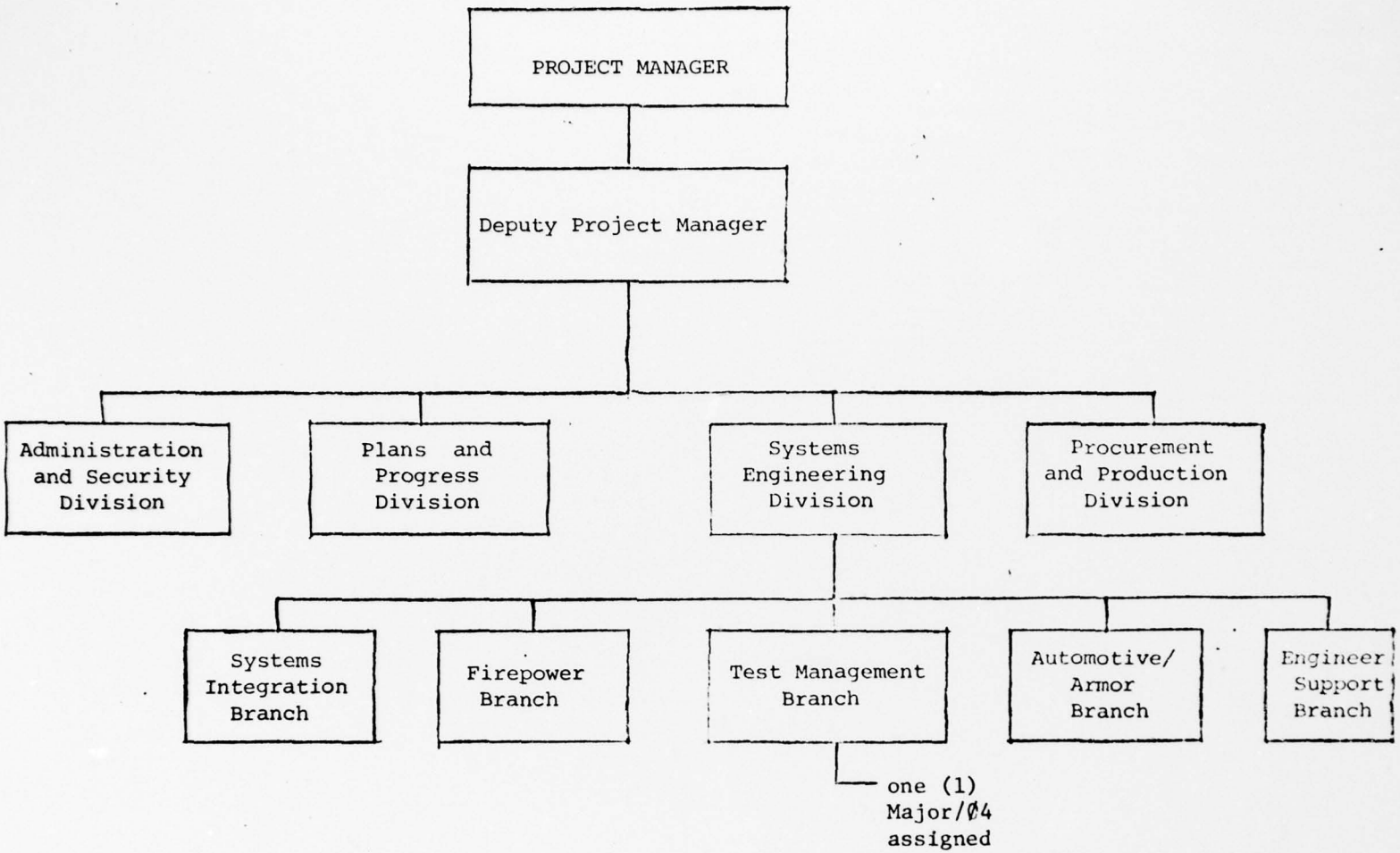


Figure 2

XM-1 ORGANIZATION FOR TEST
(AS OF JUNE 1973)

"ad hoc" working groups and joint working groups which included outside personnel from the test community, user, trainer, and logistician. As the need for greater coordination and test planning became necessary, the XM-1's test personnel strength increased proportionately with the workload until, in mid-1976, it reached its present strength (Figure 3). The present Test Branch is manned to a level that should enable the program to progress through the remaining development phases without assignment of additional personnel provided that the planned program schedule is not accelerated significantly (Figure 4).

OTEA Organization for XM-1 OTI

OTEA had the responsibility for planning, organizing and conducting XM-1 OTI. OTEA's OTI plans for the XM-1 called for the organization shown in Figure 5. Personnel assigned to this organization came from various commands in the Army structure on a temporary basis, plus assets from OTEA. The Test Directorate shown was organized at Aberdeen Proving Grounds, Maryland, on or about 5 January 1976, since DT/OTI were to be integrated to the maximum extent practicable. This Test Directorate consisted of 14 Officers, 13 enlisted men, and two civilians.

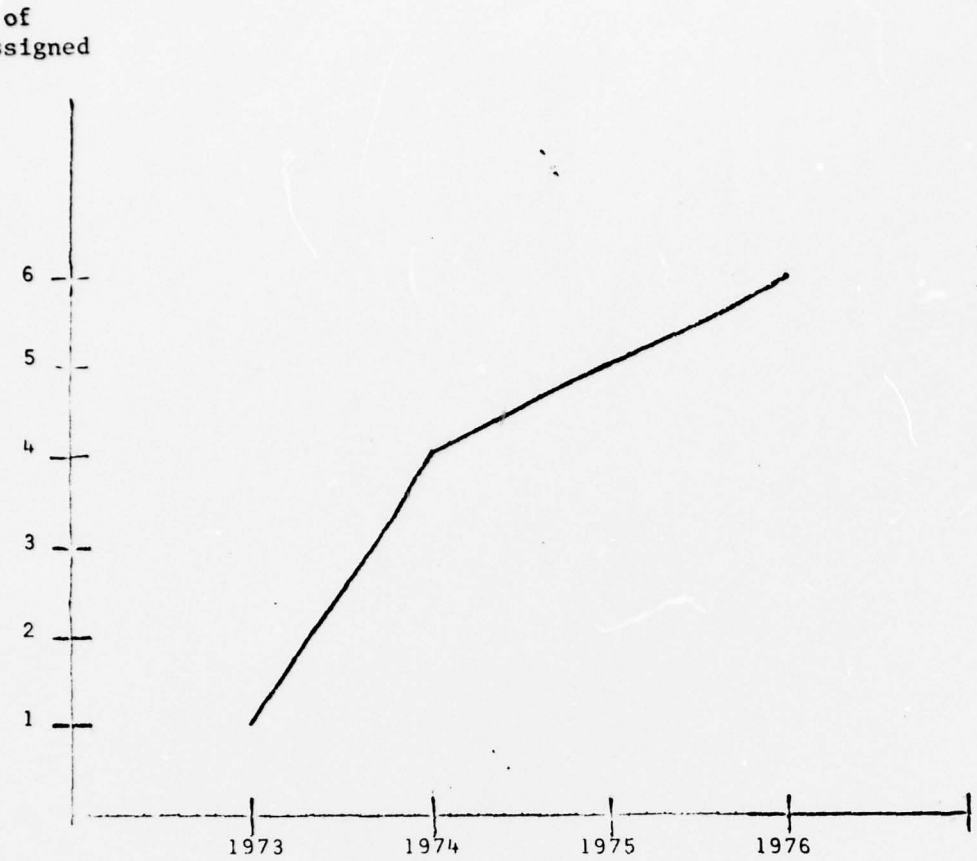
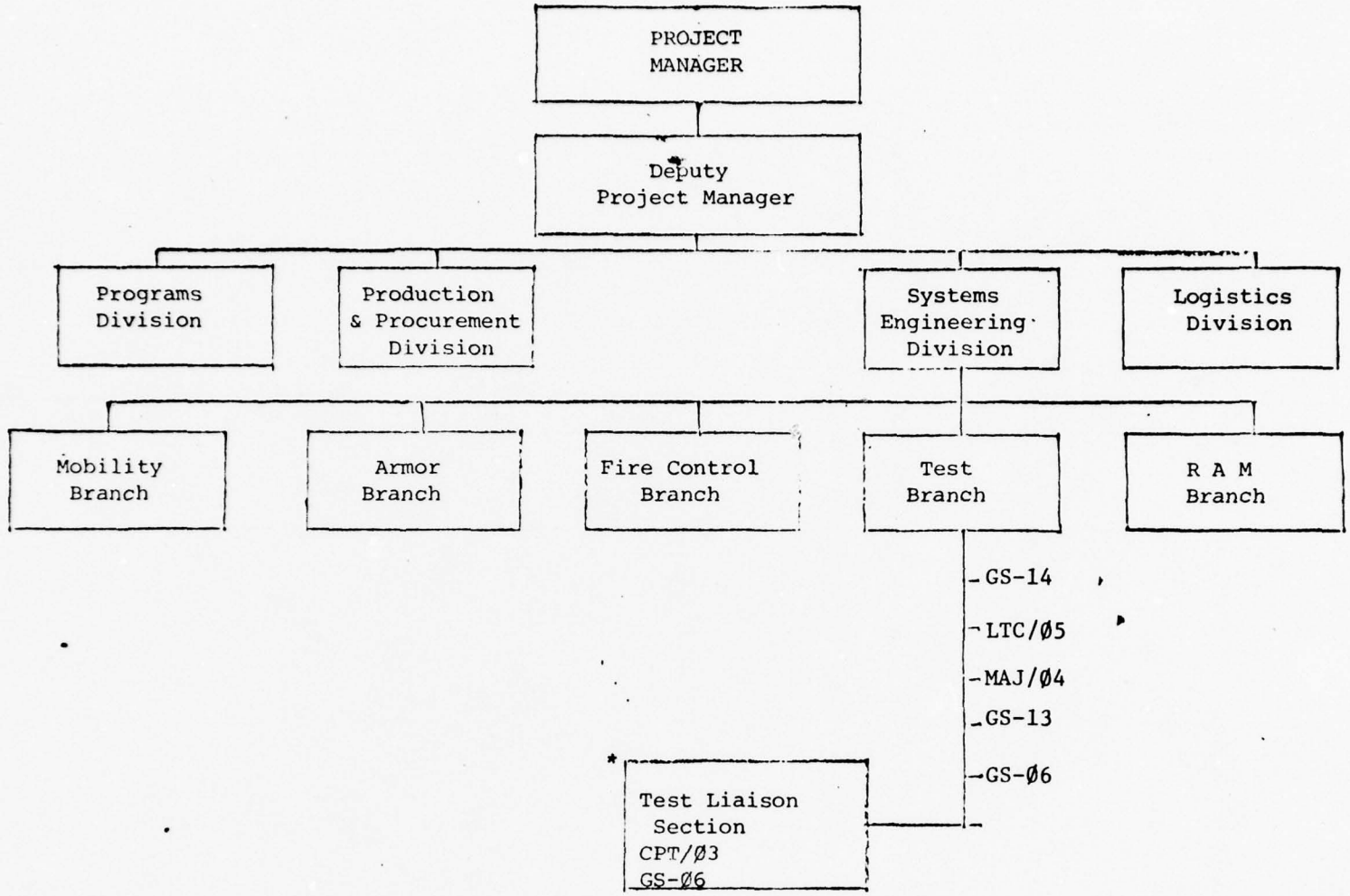


Figure 3

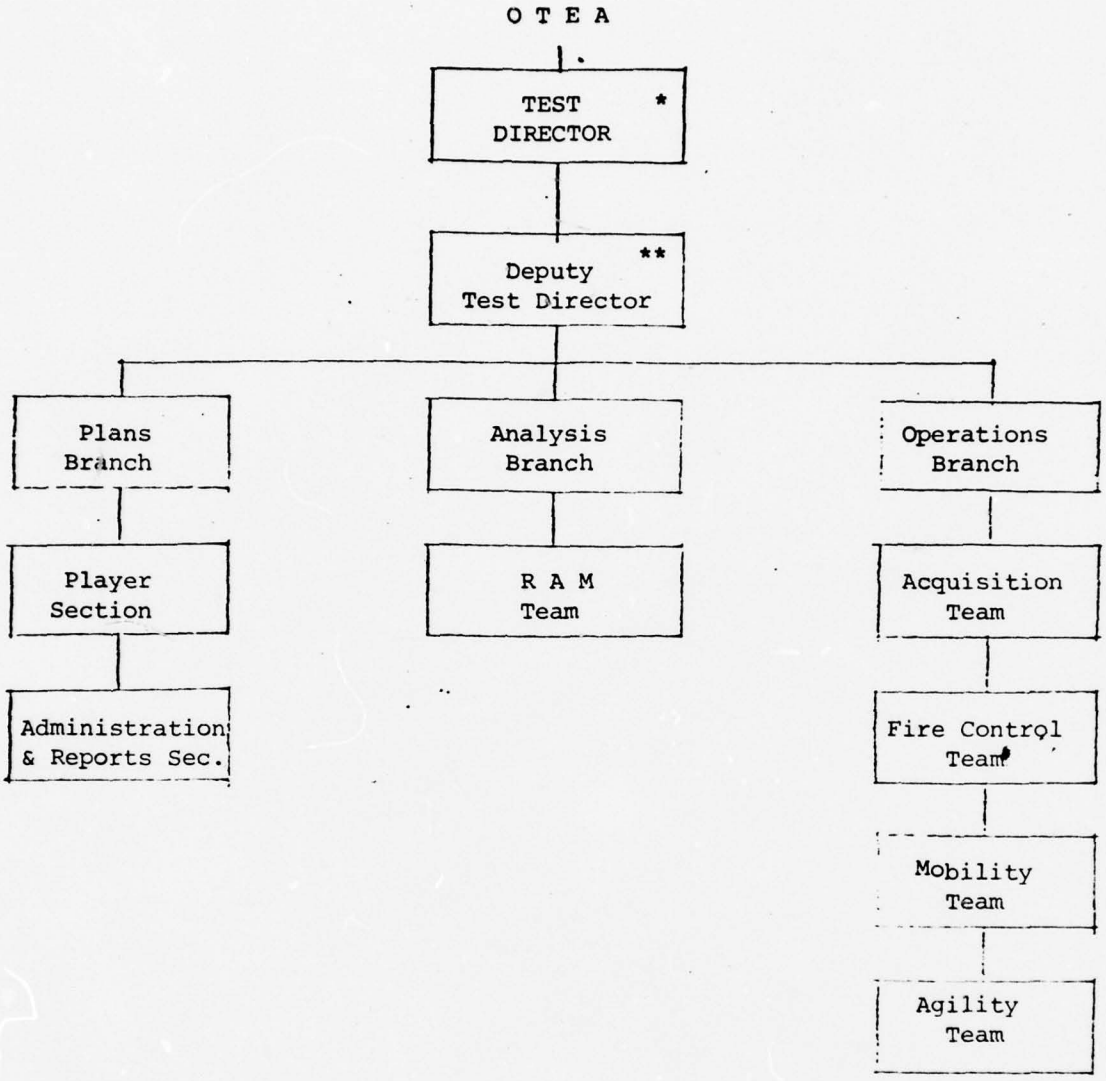
EVOLUTION OF THE XM-1 TEST
MANAGEMENT BRANCH



XM-1 TEST ORGANIZATION AS OF 19 OCTOBER 1976

* *Section is located at Aberdeen Proving Grounds, Maryland. XM-1 home office is located in Warren, Michigan.*

Figure 4



* Ø6 furnished by DARCOM
**Ø6 furnished by TRADOC

Note: Organization was set up along functional lines based on test plans.

OTEA'S XM-1 FIELD TESTING DIRECTORATE
(LOCATED AT ABERDEEN PROVING GROUNDS, MARYLAND)

Figure 5

III. EVOLUTION of TEST PLANS

Coordinated Test Program (CTP)

Definition: *"The CTP is fundamentally a management document used for identifying required testing, test personnel and organization, materiel, facilities, troop support, logistics support, and funds for implementing test programs. Its preparation, coordination, distribution, and updating are the responsibility of the materiel developer, the operational tester, the trainer, the combat developer, and the logistician. The CTP is used to plan, coordinate, and integrate the scheduling of all tests for an item or system. It contains all DT and OT and any other testing required; as such, it provides a complete testing perspective permitting tailoring of DT and OT. The CTP identifies the critical issues to be examined through testing and the planned testing to resolve these issues. All features of the CTP will require updating, particularly in preparation for a decision review. An updated CTP requires the same coordination, concurrences, and review as stated above."* (*Army Regulation 70-10, 29 August 1975*)

During concept formulation, a joint working group was established to determine the critical issues that had to be resolved as the XM-1 progressed through the DT and OT test phases. To insure that correct issues were identified, the joint working group established "strawman" critical issues and sent these to the combat developer, OTEA, user, trainer, and logistician for review and comment. As recommendations came in, the draft CTP was updated to reflect those recommended issues that could be addressed early in the acquisition cycle. A second draft CTP was formulated and was again sent to all parties in the test community for review and comment. The second draft was updated as the latest round of recommended changes were received. The test criteria were then established through joint meetings of the test community, user, trainer, and other

interested parties. Once this was accomplished, the draft CTP was updated again. The new draft CTP was then incorporated in the Concept Formulation Package for support of the Defense Systems Acquisition Review Council I (DSARC I) milestone. After DSARC I review, the CTP was updated and necessary changes coordinated with the test community, at which time the new draft became the "final" CTP.[1] The test criteria were then incorporated into the Request for Proposal (RFP) for the Validation Phase of the XM-1 acquisition, and the CTP was incorporated into and became Section IV, to Volume I, of the XM-1 Development Plan.

As changes were required during the Validation phase, the changes were coordinated with the test community and contractors and were incorporated into the CTP. Copies of the "final" CTP were furnished to agencies/commands and contractors concerned. The "final" CTP contained the Test Design Plans, Outline Test Plans, and other necessary test plans and information. (See Figure 6 for an idea of what a CTP should contain.)

The following is a partial overview extracted from the XM-1 DTI portion of the CTP prior to its scheduled update in 1975. This overview addresses the methodology to be used during DTI. The overview is included to give the reader some idea of how much detail is contained in some test plans.

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[1] *Even though the CTP at this point is considered to be a final CTP, it is subject to revision as the program progresses.*

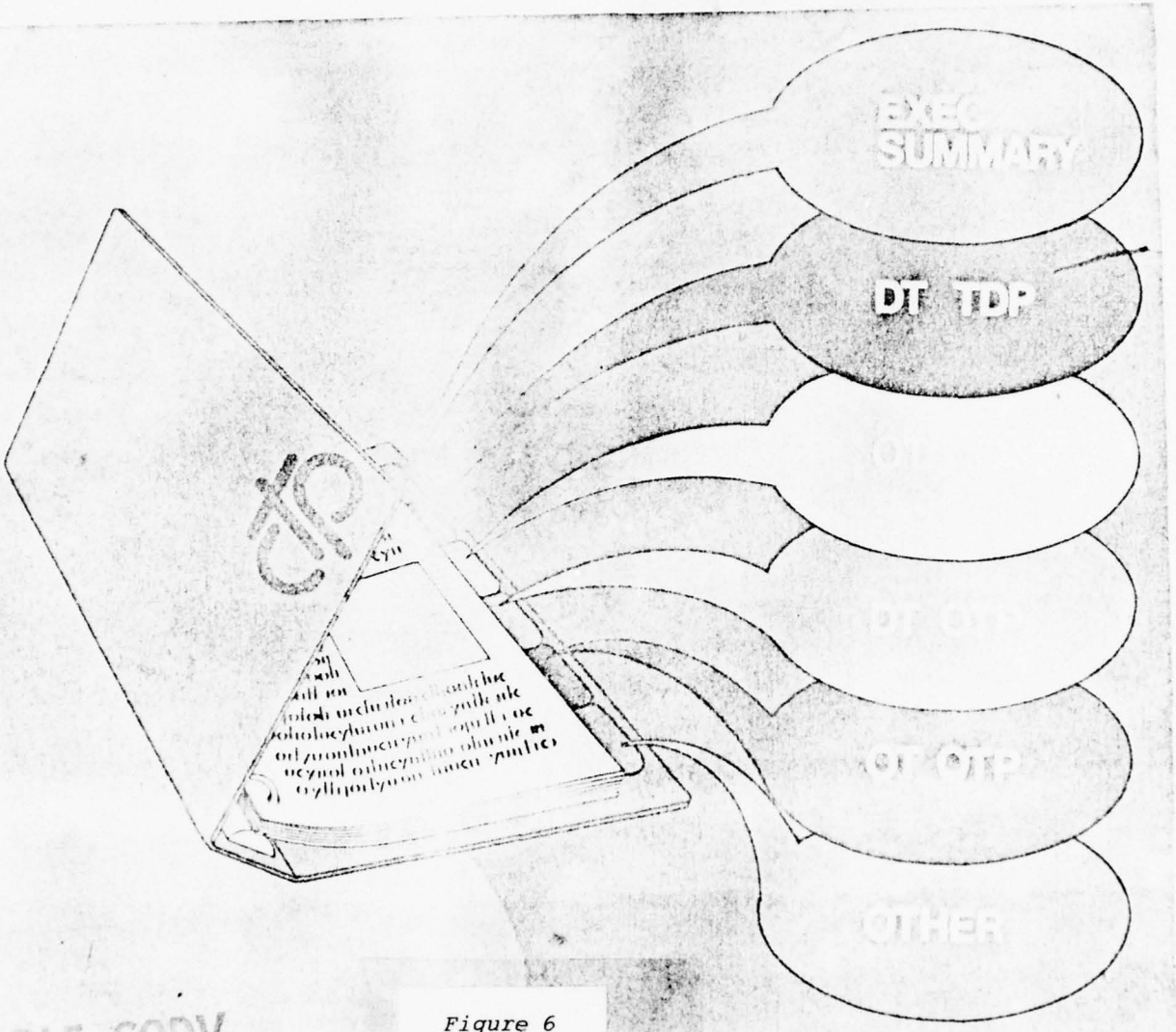


Figure 6

"The critical technical issues and sub-issues to be resolved during DTI are detailed in paragraph 1.0.3.1. The methodology by which development testing will answer these issues and demonstrate that validation phase requirements have been satisfied will be structured in part in the form of an 'evaluation tree.' The evaluation tree model is a block diagram used to logically identify the relationships of the various characteristics that are considered necessary to test and evaluate before a system is accepted by the Army. It relates what TECOM has called measures of effectiveness (MOE), objectives, essential elements of analysis and data elements that are used in test evaluations. Measures of effectiveness are usually few in number and broad in scope. Performance, safety, etc., are examples of appropriate MOEs. The objectives represent a qualitative sub-division of an MOE which, if met, contributes to the achievement of a specific MOE. The essential elements of analysis are those specific questions or critical issues which must be resolved to properly support the accomplishment of an objective. The lowest level of the tree model is the data element, which is the actual quantitative data to be acquired through testing and evaluation. In the case of DTI, the MOEs, objectives, and essential elements of analysis have been tentatively identified."

Independent Evaluation Plans (IEPs)

The XM-1 PMO had the responsibility for formulating the DT IEP. This was accomplished through a series of coordination meetings held with the DT testing community, which includes the Test and Evaluation Command (TECOM), and the Army Materiel Systems Analysis Agency (AMSAA). Issues for testing, identification of data sources, test descriptions, scheduling, and the approach to evaluation and reporting were addressed. Details as to responsibility for evaluation of the XM-1's technical effectiveness were agreed on -- subject to revision -- and then the DT IEP was finalized as the PMO's internal master plan for evaluation.

OTEA followed a path similar to that of the XM-1 PMO in formulating their IEP Master Plan. Throughout the IEP formulation, an iterative process similar to that used in CTP formulation was used. IEPs are the basis for formulation of Test Design Plans (TDPs).

Test Design Plans (TDPs)

Definition: *A formal document approved by the test organization which states the circumstances under which a test is executed, the data required from the test, and the means of analyzing test data.*

Once IEPs were finalized, both the XM-1 PMO and OTEA began their formulation of TDPs. Draft TDPs were produced and copies were sent to the testing community for comment. In the case of the DTI TDP, copies were sent to AMSAA and TECOM in addition to the Combat developer, trainer, and logistician. Recommendations received from these agencies were analyzed and those recommendations that had merit were incorporated into the final TDP. OTEA's draft TDP took a similar coordination path but also included the operational tester, the Armor and Engineer Board located at Fort Knox, Kentucky. Once final DT and OT TDPs were formulated, they were sent to the respective testers - Armor and Engineer Board for OTI, and the Test and Evaluation Command for DTI - to be used as a basis for developing follow-on test plans. TDPs were released to the field agencies in the fall of 1974. DT/OTI was scheduled to commence in early February 1976 (Figure 7).

XM1 TANK SYSTEM
COORDINATED TEST PROGRAM
MILESTONES

▽ INTERIM/OUTLINE
▽ FINAL

CALENDAR YEAR

MILESTONES	1973	1974	1975	1976	1977	1978	1979	1980
BTTF (Feb Aug 1972)								
SARC/DSARC 1 (Nov 72)								
CP Approved (Jan 73)								
elease DP (CTP)	▽							
T/OT Outline Test Plans	▽							
T/OT I Test Plans			▽					
onduct DT/OT I				▽—▽				
T/OT I Report				▽				
pdate DP (CTP)		▽	▽	▽				
SARC II/DSARC II				▽				
T/OT II Test Plans					▽			
onduct DT/OT II						▽	▽	
T/OT II Report							▽	
pdate DP (CTP)					▽	▽	▽	
SARC/DSARC IIA						▽		
T/OT III Test Plans						▽	▽	
onduct DT/OT III								▽
T/OT III Report								▽
pdate DP (CTP)								▽
SARC/DSARC III								▽

Figure 7

Outline Test Plans (OTPs)

Definition: *The formal document which contains appropriate administrative information; the test purpose, objective, scope, and tactical context; resource requirements; and cost estimates.*

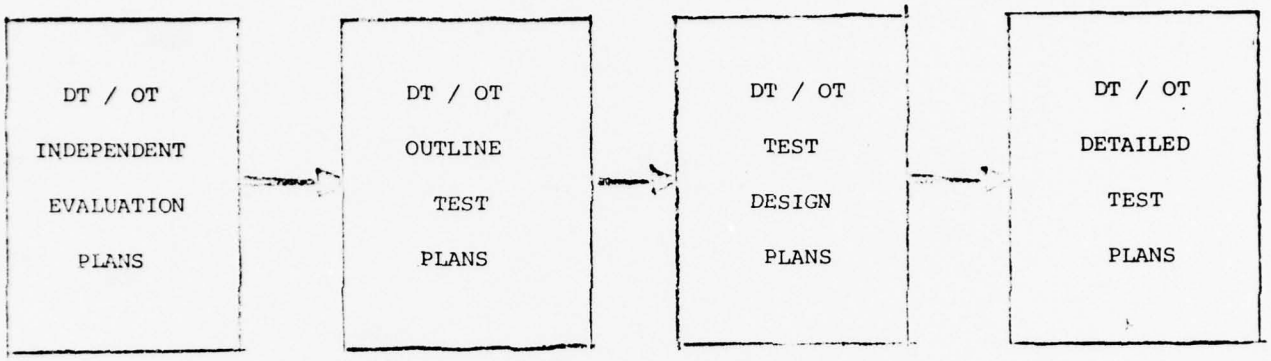
OTPs were coordinated during coordination and review of the various draft CTPs. Therefore, OTPs were formulated with the "final" CTP. These OTPs identified specific requirements for resources (men, materiel, time, and space), set the scope for DT/OTI tests, and provided administrative data on test reporting and support. Once completed, these OTPs were included in the XM-1's CTP. Copies of the XM-1's OTPs are included at Appendixes B and C. These plans were included to give the reader an idea of what OTPs contain. (See Figure 8 for an idea of how plans were sequenced).

Detailed Test Plans (DTPs)

Definition: *A set of explicit instructions for directing every phase of the test, particularly test control and data collection and analysis.*

TECOM formulated the draft DTI DTP and sent it to the XM-1 PMO in February of 1975. The PMO in turn sent copies out to the test community and prototype contractors for review and comment. When the comments were received regarding the draft DTP, a series of meetings was held in order to iron out test community differences before publication of the "final" DTI DTP. The OTI DTP was formulated, coordinated, and published by OTEA in conjunction with the Armor and Engineer Board.[2]

[2] *The schedule set for accomplishing coordination, review, and publication of test plans was not allowed to slip. The PM made it clear that a slip in getting the DT/OTI plans approved would have an adverse impact on the overall schedule of the XM-1 project. This emphasis assisted in keeping the XM-1 on time to DT/OTI.*



TEST PLAN SEQUENCING

Figure 8

Figure 1

Specific Requirements of DT/OTI Plans

Engineering Design Tests (EDTs). *Engineer design tests are those tests conducted by or under the control of the materiel developer to determine achieveability of technical characteristics, to provide data for refining and ruggedizing hardware configurations, to eliminate design risks or to determine their manageability, and to provide for evolution of the design and verification of design changes.*

EDTs would be accomplished at the contractor's facilities - General Motors and Chrysler - to the maximum extent practicable. These tests were to be monitored by the PMO with assistance from TECOM. The objective of these tests was maximum use of contractor test data when such tests were conducted in accordance with the procedures contained in the DTI test plan. The monitorship program was set up to follow the below schedule.

CHRYSLER	*7 July 1975 - 28 October 1975*
GENERAL MOTORS	*9 July 1975 - 9 January 1976*

Comparison Testing (CT). *Comparison testing is side-by-side testing of the new system and the system it will replace under the same test conditions, to ascertain the degree of improvements the new system has over the old system.*

It was planned that two M60A1E3 combat tanks would be used for comparison purposes. The objective of the comparison tests was to ascertain the degree of improvement of the XM-1 candidates over the M60A1E3 in the areas of 1) crew survivability; 2) firepower; 3) mobility; 4) RAM-D considerations; 5) fightability; and 6) other technical performance characteristics. The two M60A1E3 tanks were to be furnished by DARCOM. Delivery of these items was scheduled for November 1975.

Contractor-Furnished Materiels. Each contractor was scheduled to deliver one XM-1 prototype, one automotive test rig, one ballistic hull and turret, and special tools and test equipment during January 1976.

Contractor Training of Test Personnel. Two training courses were scheduled to be conducted by each contractor in support of DT/OTI; an operator's course of 1-2 weeks in length consisting of classroom and on-the-job training for operation of the XM-1 prototype during DT/OTI, and a maintenance course of approximately two weeks in length consisting of classroom and on-the-job training in the area of performing scheduled maintenance tasks and some remove/replace unscheduled maintenance tasks. Twenty-four personnel were to be trained.

Conduct of Tests. DTI and OTI were scheduled to be integrated to the maximum practicable extent in accordance with the guidance contained in AR 70-10. However, evaluation and reporting would remain independent to insure objective evaluation of tests. DTI was scheduled tc commence on 1 February 1976, and was scheduled for completion in early April 1976 (11 weeks). OTI was scheduled to commence in mid-April 1976, with a completion date of 1 May 1976. Reports were due in early June 1976 (DTI), and mid-June 1976 (OTI). The XM-1 PMO was scheduled for DSARC II in July 1976.

IV. EXECUTION of TEST PLANS

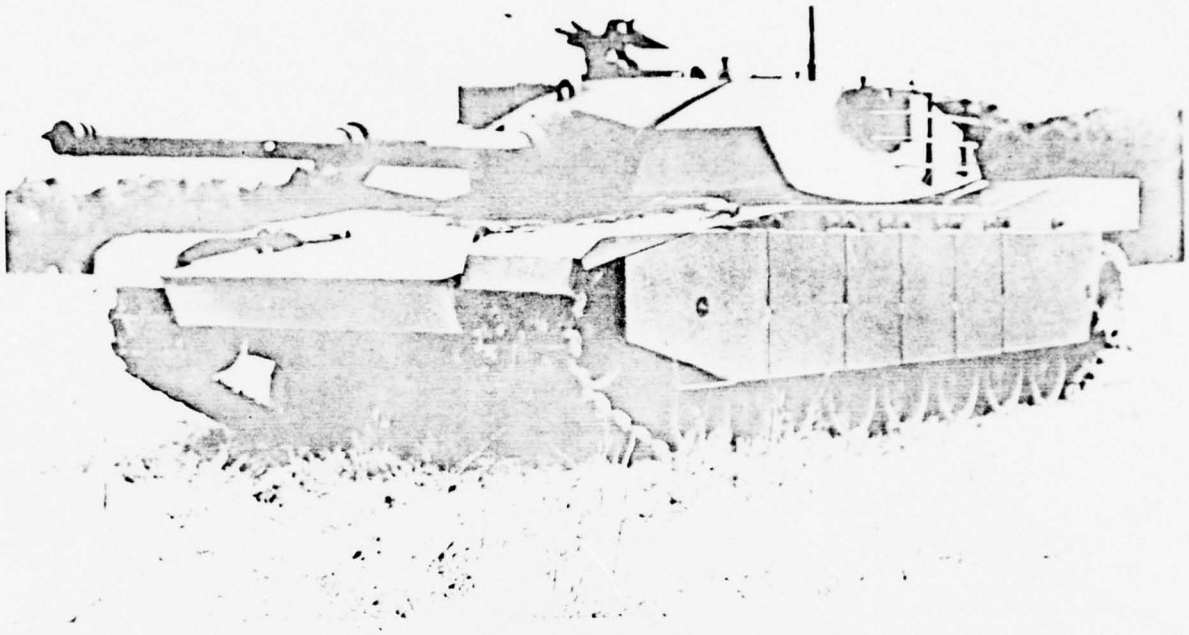
EDT Monitorship Program

The monitorship program began in July 1975, at the contractor's facilities and went according to test plans. Each contractor had identified those items that they felt should be included in the monitorship program and made their recommendations to the XM-1 PMO. The PMO reviewed each recommended item, got clarification on fuzzy areas, and recommended that TECOM approve the program plans. TECOM approved these recommendations and the tests got underway as scheduled. Since both contractors had extensive test facilities, each sub-system was tested, reworked as necessary, each prototype main gun and mount fired more than 1,000 rounds, and each vehicle chasis was operated over 2,000 miles during the EDT monitorship program. When the time came to begin DT/OTI at Aberdeen Proving Grounds, Maryland, (TECOM), the XM-1 prototypes were reasonably mature (Figure 9).

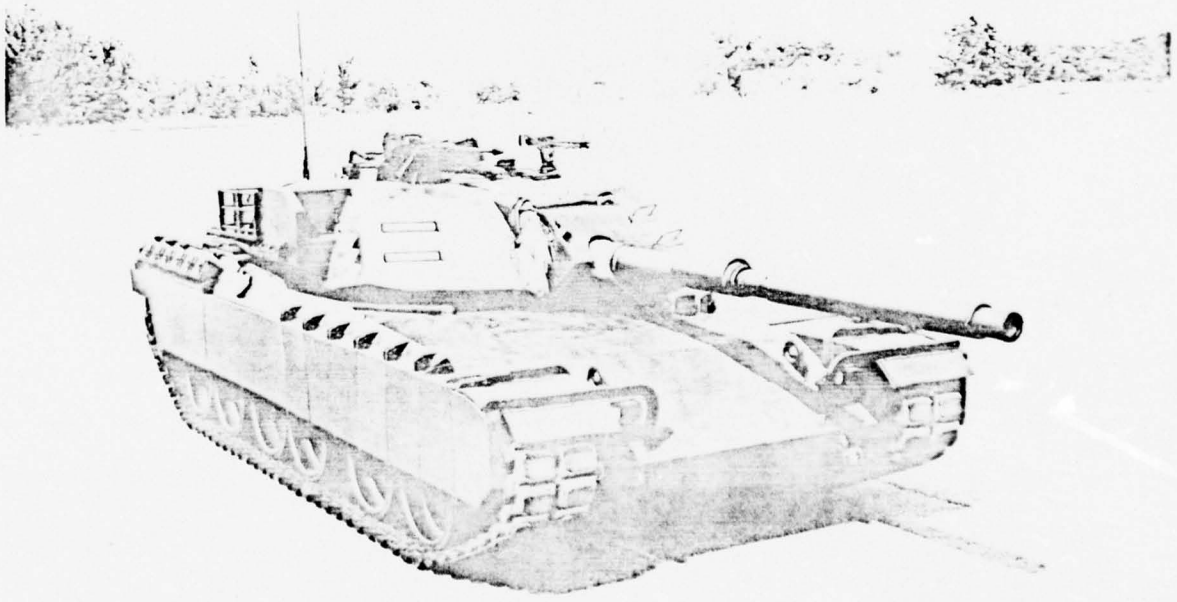
Contractor Training of Personnel

Two different training programs were conducted by each prototype contractor. One program trained TECOM test personnel in operations and maintenance of the prototypes, the other trained military operator personnel furnished by user organizations. Training of TECOM personnel was monitored by TECOM and PMO representatives. Training of military personnel was monitored by the Armor and Engineer Test Board (AETB) and PMO personnel. Military personnel were selected by the AETB and civilian personnel were

CHRYSLER CANDIDATE



GENERAL MOTORS CANDIDATE



XM-1 PROTOTYPES

Figure 9

selected by TECOM in accordance with test plans. The military candidates were required to first attend a basic combat tank operators course (M60 series) at Fort Knox, Kentucky. Those personnel that were successful in completing the combat tank basic course were then moved to the contractor facilities and later to Aberdeen Proving Grounds for prototype training. The training philosophy of each contractor was found to be very different. General Motors took the approach of catering to the soldier. GM instructors led each trainee by the hand and made sure that each trainee was qualified at one level before moving him to the next level of training. This formal classroom training was then followed up with on-the-job-type training with each operator getting their hands on the actual prototype vehicle. GM's program resulted in very qualified operators. On the other hand, Chrysler basically said, "there's the tank, go to it!" Chrysler gave one day of formal classroom training, and the rest of the allocated time was spent on the prototype. PMO personnel feel that both training programs were successful; however, GM's approach provided more depth which was felt contributed more to the soldier's understanding of the weapons systems. OTEA representatives felt that the contractor training programs were adequate enough for OTI purposes. Trainee personnel were trained on both prototypes, and the training program was completed on schedule.

Execution of DTI

The two prototypes and auxilliary equipment were delivered to Aberdeen Proving Grounds three days in advance of the scheduled date. The test comparison tanks (M60A1E3) had been delivered and test personnel were on hand

and everything was ready to commence testing as scheduled. (See Figure 10 for a comparison of the XM-1 prototypes and the M60A1E3 test comparison tank). Each test was to be conducted using the side-by-side method wherein each prototype was subjected to the same tests at the same time under the same climatic conditions. A PMO test representative was present at each test phase. His sole purpose was to insure that all parties were moving in the right direction and that neither competitor was inadvertently given a competitive edge by testing personnel and conditions. DTI testing continued as planned with only minor problems "popping" up here and there, none of which were too large that they could not be solved. However, when it came time for the DTI test reports to be written, TECOM informed the PMO that they (PMO) were almost out of funds and that an additional $500 thousand would be necessary if the reports were to be completed as scheduled. A flurry of messages ensued between TECOM and the PMO but, in the end, the PMO had to transfer the additional funds in order to meet the XM-1 schedule. Part of the additional funds were furnished out of the PMO's management reserve, the other part came from DARCOM. This issue will be discussed later in the paper. DTI was completed on schedule, and OTI began immediately.

Execution of OTI

As stated earlier, XM-1 OTI was combined with DTI to the maximum extent practicable. However, weeks 12 and 13 were dedicated, as planned, to the completion of OTI. Emphasis on OT was placed on test experiences, observations, potential operational problems, and formalized human factors

CHRYSLER PROTOTYPE

M60A1E3
COMPARISON
TANK

GM PROTOTYPE

Figure 10

evaluation of activities, conditions, and system components that influenced the crew's capability to adequately and appropriately operate the tanks. Human factors data were integrated and gathered during the entire DT/OTI test period. The operational activities were in two basic areas - non-firing exercises and live-fire periods. Offense and defense activities were simulated. No effort was made to physically portray a tactical unit. All sub-tests were conducted under operational conditions that were as realistic as time and terrain would allow. None of the standard RAM calculations could be made because of the short test period and non-typical maintenance. OTI was completed on time and the required reports were sent through OTEA independent evaluation channels for inclusion in the upcoming XM-1 ASARC/DSARC II reviews.

V. ANALYSIS and DISCUSSION

Provided herein is a brief analysis and discussion of the XM-1 test organization utilized for DT/OTI; the evolution of DT/OTI plans; and the execution of these plans during the XM-1 Validation phase.

XM-1 Test Organization

The XM-1's test organization seems to have evolved in a manner similar to that advocated by DoD philosophy. That is, the PM must tailor his organization to current needs and seek outside assistance when unknown problems arise in which additional personnel will be required. It is the author's opinion that throughout the planning and execution of DT/OTI, the XM-1 PMO followed this philosophy and only staffed to a level commensurate with the workload.

Evolution of Test Plans

> *"After all has been said and done about systems to control engineering costs and performance after the decision is made to embark on a project, it is the project plan prepared before starting the work that determines to a major extent the outcome of a project in terms of time, costs, and technical performance."*[3]

This statement certainly applies to the test planning conducted by the XM-1 PMO. XM-1 test planning began early in the Conceptual phase. By doing so, the XM-1 PMO was able to bring all the available expertise within the test community on board early to assist in solving test planning problems. The iterative process described in Section III identified many

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[3] *Peter C. Sandretto, "The Economic Management of Research and Engineering," 1968.*

possible problem areas early, which facilitated their resolution. However, no plan can address all possible contingencies; therefore, continuous revision of plans is necessary if a program is to progress as scheduled. The XM-1 PMO kept their test plans pretty well up-to-date throughout DT/OTI. Only one fallacy occurred in the XM-1 test plans which was surfaced during DT/OTI execution. The PMO in conjunction with TECOM had underestimated DT/OTI test costs by half a million dollars. However, the management reserve set aside for unknowns such as this was adequate enough to keep the project on schedule. Hence, the process the XM-1 followed in formulating XM-1 test plans paralleled doctrine as closely as practicable, and should be recommended in other projects.

Execution of Test Plans

Funds Shortage. The U.S. Army Test and Evaluation Command (USATECOM) is the Army's ground equipment DT tester. TECOM, therefore, feels they know their business and know how to predict DT test costs. Because of this, the PMO tells TECOM the scope of testing, and TECOM provides the cost estimate. This process is accomplished in the following manner. TECOM provides to the PMO Test Operating Procedures (TOPs). The PMO defines the scope of DT tests, applies the appropriate TOPs to the scope, and forwards the scope with the appropriate TOPs to TECOM. TECOM then provides the cost estimate to the PMO. In the case of the XM-1, TECOM estimated it would cost $460 thousand to complete DTI. However, before DTI was completed, the test cost had increased to approximately $1 million. Why such a large variance? TECOM felt that this large variance was caused by the

XM-1 PMO not providing a properly defined test scope as required by their policy. The XM-1 PMO, on the other hand, felt that TECOM had never been exposed to a test program that called for two 10-hour shifts, 6 days a week and, therefore, was unable to take into account the details that must be included under such an accelerated test program.[4]

This analysis indicates that the PMO did not furnish a fully defined test scope and this was due primarily to generation of the scope before the test designs were fully formulated and understood. On the other hand, TECOM's TOPs state the work that must be done in each test phase, but do not take into account the changes that can occur in the testing environment. At the writing of this paper, the funds issue had not formally been resolved. However, TECOM and the Army Inspector General's Office had the problem under study.

Customer Test Concept. The actual execution of DT/OTI tests were classified as customer tests. Customer tests are those tests wherein the PMO provides test guidance and TECOM executes the tests. As far as the XM-1 PMO was concerned, this concept worked well (Bib item #11). The concept did, however, require on-site management by the PMO. Thus, the XM-1 PMO Liaison Office was established at the test site (Aberdeen Proving Grounds, Maryland). Under this concept, the XM-1 PMO averaged four people per week at the test site during DT/OTI, and as a result, experienced some negative effects due to personnel resource drains. On the other hand, this testing

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[4] *OSD and DA had directed that the XM-1 DT/OTI tests be completed within the time frame of three months. Tests of this nature usually require at least six months under normal conditions.*

concept did allow the PMO to provide immediate on-site decision-making when the need arose, and it also provided a mediator from the PMO when difficulties arose in the side-by-side testing of the competitive prototypes. It should be noted that some TECOM personnel resented the concept and felt that it required overmanagement by the PMO; thus, these TECOM personnel felt that the PMO was usurping some of TECOM's responsibilities. Nevertheless, TECOM personnel stated at the TECOM Commander briefing at the end of DT/OTI, that the XM-1 test program was the best run to date, even though they felt that the XM-1 PMO had overmanaged in many areas. It is the author's opinion that when side-by-side test of competitive prototypes is being conducted, a problem mediator/solver must be present to insure that one competitor does not get better treatment than the other. This person must be knowledgeable in all aspects of the program, and therefore, should come from the PMO, and not TECOM. Since this concept has the potential of lowering the probability of protests over the conduct of competitive testing, it should be recommended for use when competitive testing is required.

VI. CONCLUSIONS and RECOMMENDATIONS

Conclusions

- That the XM-1 Project met the milestones set forth for DT/OTI in the CTP.
- Early planning and thorough coordination of plans paid dividends during the execution of the XM-1's DT/OTI.
- That a problem existed in estimating development testing (DT) costs.

Recommendations

- That the DA IG study being conducted in the area of DT cost estimating be given the widest dessimination upon its completion.
- That DA test planning procedures be followed in future programs.
- That on-site PMO teams be used when side-by-side competitive testing is necessary.

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6. Department of Defense Instruction 5000.3, *Test and Evaluation*, with Change 2, 2 May 1975.

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Appendix A

EXPLANATION of TERMS

APPENDIX A

EXPLANATION OF TERMS

A–1. The following terms used in this regulation are defined in AR 310–25, Dictionary of US Army Terms:

combat developments
compatibility
component
doctrine
field exercise
force development
human factors engineering
in-process review
instrumentation
materiel
military characteristics
military requirement
military specifications
military training
operational characteristics
operational environment
prototype
reliability
supportability
susceptibility
system
tactical
technical characteristics
technical specifications
technique
test
utility
vulnerability

A–2. For purposes of this regulation, the following explanations apply:

Army Program Memorandum (APM). A program memorandum initiated by direction of HQDA and reviewed by the ASARC when HQDA has final decision authority for a major program. (AR 70–27.)

Army Systems Acquisition Review Council (ASARC). An Army panel composed of the VCSA (chairman), CG AMC, CG TRADOC, ASA (R&D), ASA(I&L), DUSA (Operations Research), DCSOPS, and DCSRDA. Additional special members (AR 1000–1) will attend when called by the chairman. The ASARC (AR 15–14) reviews major Army programs when they reach the following milestones:

I _____ Enter validation.
II _____ Enter full-scale development
III _____ Enter initial production; or full production, if initial production is not used.
IIIa ____ Enter full production if initial production is used.

Availability. A measure of the degree to which an item is in the operable and committable state at the start of the mission, when the mission is called for at an unknown (random) point in time. (AR 702–3).

Band of performance. A ceiling and floor that describes a performance characteristic of a system. The ceiling is the most cost-and-operationally effective capability that can be achieved by the materiel developer without exceeding the maximum acceptable cost for the system. The performance floor is the least operational capability acceptable to the user regardless of the potential for increased performance or accelerated initial operational capability (IOC) date.

Brassboard configuration. An experimental device (or group of devices) used to determine feasibility and to develop technical and operational data. It will normally be a model sufficiently hardened for use outside of laboratory environments to demonstrate the technical and opera-

tional principles of immediate interest. It may resemble the end item but is not intended for use as the end item.

Breadboard configuration. An experimental device (or group of devices) used to determine feasibility and to develop technical data. It will normally be configured only for laboratory use to demonstrate the technical principles of immediate interest. It may not resemble the end item and is not intended for use as the projected end item.

Climatic test. A test designed and conducted to assess the suitability of an item or system when it is to be operated or used in a wide climatic spectrum, from extreme climates to normal climates. (Operational climatic testing is explained below.)

Combat developer. The agency or command responsible for the formulation of concepts, doctrine, organization, and materiel objectives and requirements relating to the employment of US Army Forces in a theater of operations and in the control of civil disturbances.

Combined development and operational testing (DT/OT). Conducted jointly by DT and OT test organizations to achieve test objectives for both DT and OT. It can be a complete test, a subtest, or a phase of a test.

Conceptual phase. The first phase in the materiel life cycle. The technical, military, and economic bases for the program and concept feasibility, are established through pertinent studies and the development and evaluation of experimental hardware. Threat projections, technological forecasts, and joint and Army plans are examined by combat developers to determine operational capabilities, doctrine, organization, or potential materiel systems that will improve Army Forces.

Coordinated Test Program (CTP). A planning document which formalizes the all-inclusive testing activities relating to a development project. It is evolutionary, sectionalized by major tests, and developed and maintained by the materiel developer on an item or system basis. It is coordinated with appropriate agencies prior to approval.

Cost and Operational Effectiveness Analysis (COEA). A documented investigation of—

a. Comparative effectiveness of alternative means of meeting a requirement for eliminating or reducing a force or mission deficiency.

b. The validity of the requirement in a scenario which has the approval of TRADOC and HQDA.

c. The cost of developing, producing, distributing, and sustaining each alternative in a military environment for a time preceding the combat application.

Critical issues. Those issues associated with the development of an item or system that are of primary importance to the decision authority in reaching a decision to allow the item or system to continue into the next phase of development.

Decision authority. The officials responsible for making decisions with respect to decision-point transitions for materiel acquisition.

Decision Coordinating Paper (DCP). A summary document for the Secretary of Defense that presents rationale for starting, continuing, reorienting, or stopping a development program at each critical decision point in the acquisition cycle.

Decision review. A program review conducted by the DSARC, ASARC, or by IPR.

Defense Program Memorandum (DPM). A program memorandum initiated by direction of the OSD. Materiel acquisition efforts covered by a DPM may be designated as either major or nonmajor Army programs.

Defense Systems Acquisition Review Council (DSARC). An advisory body consisting of DDRE, ASD(I&L), ASD(C), ASD(PA&E); and, for their programs, the ASD(T), and ASD(I). This council reviews major prog-

rams at critical points during the acquisition process. This review council supports the overall decisionmaking process by advising the SECDEF and the DEPSECDEF on—

a. Courses of or changes in program commitments.

b. Courses of action in response to an actual or threatened breach of a program decision.

Department of the Army System Coordinator (DASC). The individual (or team) designated by the Deputy Chief of Staff for Research, Development, and Acquisition (DCSRDA) to function as the HQDA point of contact for all aspects of system development and to coordinate the status of all events in the Life-Cycle System Management Model (LCSMM) for a major system, a designated nonmajor system requiring HQDA IPR approval, or one or more other similar or related nonmajor systems selected for DASC management (AR 70–16).

Detailed test plan (DTP). A set of explicit instructions for directing every phase of the test, particularly test control and data collection and analysis.

Development plan (DP). A document which records program decisions, contains the user's requirement, provides appropriate analysis or technical options, and includes the life-cycle plans for development, testing, production, training, and logistic support of materiel items.

Development tester. An activity engaged in the conduct of development testing that may be any one or a combination of the materiel developer's activities, including the contractor.

Development testing (DT). Testing of materiel systems conducted by the materiel developer using the principle of a single, integrated development test cycle to demonstrate that the design risks have been minimized, that the engineering development process is complete, and that the system will meet specifications, and to estimate the system's military utility when it is introduced. DT is conducted in factory, laboratory, and proving ground environments.

Doctrinal and organizational test support package. This package contains the doctrine and approved scenario against which a system is to be tested. It should include such items as doctrinal ranges, employment methods, area or joint operations, offense and defense capabilities, mobility requirements, and doctrinal resupply and refurbishment requirements. The package will be used to test the adequacy of doctrine, organization, operating techniques, tactics, and training prior to implementing employment; and of the system for its maintenance support. The package may include a list of pertinent field manuals (FM) or FM extracts.

Durability. A special case of reliability. Durability is the probability that an item will successfully survive its projected service life, overhaul point, or rebuild point (whichever is the more appropriate durability measure for the item) without a durability failure. A durability failure is a malfunction that precludes further operation of an item and that necessitates replacement or rebuild because of degraded safety or because of excessive cost or time to restore (AR 702–3).

Effectiveness. A measure of the extent to which an item satisfies a set of specific, preestablished requirements.

Electromagnetic compatibility (EMC) testing. The testing required to insure that the equipment can be operated in its expected electromagnetic environment without unacceptable degradation of its own or other friendly equipment's operational performance.

Electronic warfare (EW) susceptibility testing. The measure of a system's inability to perform in a hostile electronic countermeasures environment.

Engineer design testing (EDT). A series of tests conducted by or under the control of the materiel developer to determine

achieveability of technical characteristics, to provide data for refining and ruggedizing hardware configerations, to eliminate design risks or to determine their manageability, and to provide for evolution of the design and verification of design changes.

Environmental tests. Tests to determine whether an item or system will perform effectively in the environments of its intended use, including geographical and climatic and where applicable, electromagnetic, radiation, and other natural or induced environments.

Five-Year Test Program (FYTP). A compendium of approved outline test plans (OTP) for user testing. It is a tasking document for test execution and resources allocation, developed within existing budget and program constraints in accordance with Army priorities for the current and budget years, and provides planning guidance for the outyears.

Force development testing and experimentation (FDTE). Tests that range from a small, highly instrumented and high resolution field experiment to a large, less instrumented, controlled scenario and low resolution field test. Data from these tests are evaluated largely by using subjective rather than analytical techniques. They are conducted to evaluate new concepts of tactics, doctrine, organization, and new items of materiel.

Full-scale development phase. The third phase in the materiel life-cycle. During this phase, a system, including all items necessary for its support is fully developed and engineered, fabricated, tested, and initially type-classified. Concurrently, nonmateriel aspects required to field an integrated system are refined and finalized. These include such aspects as Basis of Issue Plans (BOIP), personnel and equipment requirements, publications, integrated logistics support and modifications of doctrine, organization, and MOS.

Human factors engineering (HFE) testing. Assessing HFE by evaluating the man-equipment combination.

Independent evaluation, DT. The process by which the materiel developer examines development test data and test reports; extrapolates from other evidence, including experimental and analytical data; and uses engineering judgment to assess and evaluate the capabilities of the tested materiel system, including RAM. Each independent evaluation assesses the adequacy of testing and the validity of the test results.

Independent evaluation, OT. The process independent of the materiel developer and the using command which is used to examine the test design and test report; to extrapolate from other evidence, including experimental, historical, and analytical data; and which provides military judgment to assess or estimate the military utility and operational effectiveness of the tested system, including RAM. For OT, it is used to concentrate on the operational aspects of the materiel system and to consider other programed testing and comments on operational tests provided by participants in the materiel acquisition process. Each independent evaluation is used to assess the adequacy of testing and the validity of test results.

Independent evaluation plan. The materiel developer's or operational tester's internal master plan for the evaluation of a materiel system's technical or operational effectiveness.

Innovative testing. Small-scale tests conducted to develop concepts and/or requirements that later may be used to support changes to existing concepts or hardware.

Interoperability. Capability of two or more items or components of equipment to perform essentially the same function or to complement each other in a system, regardless of differences in technical

characteristics and with negligible additional training of personnel.

Item. An assembly or any combination of parts, subassemblies and assemblies mounted together in manufacture, assembly, maintenance, or rebuild.

Joint Service Operational Requirement (JSOR). A statement of need for the same end item of materiel for operational employment by the Army and at least one other US military service. Army-proposed JSOR usually are directed by higher authority and are prepared and processed following Required Operational Capability (ROC) procedures to the maximum extent practicable.

Joint testing. That development and user testing in which the Army participates with another service and which is conducted to evaluate Army items and systems or concepts having an interface with or requiring a test environment of another service; or items and systems, or concepts of another service which require testing in an Army environment.

Joint development testing. Development testing in which the Army participates with another service and which is conducted to evaluate Army items and systems having an interface or requiring a test environment of another service; or items and systems of another service which require testing in an Army environment.

Joint user testing. Testing in which the Army participates with one or more of the services to evaluate systems or concepts having an interface with or requiring a test environment of another service.

Letter of Agreement (LOA). A jointly prepared and authenticated document in which the combat developer and materiel developer outline the basic agreements for further investigation of a potential materiel system (AR 71–9).

Letter Requirement (LR). An abbreviated procedure for acquisition of low value items. It is jointly prepared and authenticated by the combat developer and the materiel developer (AR 71–9).

Logistician. The agency or command responsible for the surveillance of development items or systems for general use by the Army in the field in terms of reliability, maintainability, durability, and logistic supportability. For most equipment, the US Army Logistics Evaluation Agency performs this function (AR 10–25).

Low-rate initial production (LRIP). A low rate of output at the beginning of production to reduce the Government's exposure to large retrofit problems and costs while still providing adequate numbers of hard-tooled production items for final development and operational tests before a full production decision is made (AR 70–1).

Low-rate initial production items. Production items manufactured during LRIP for OT and DT III.

Maintainability. A characteristic of design and installation which provides inherently for an item to be retained in or restored to a specified condition within a given time, when it is maintained in accordance with prescribed procedures and resources (AR 702–3).

Maintenance test support package. An assemblage of support elements, provided before and used during development and operational testing and evaluation for validating organizational and direct and general support maintenance capability. The maintenance test support package includes all required draft equipment publications (operator through general support maintenance equipment manuals and "Equipment Serviceability Criteria" manuals); repair parts; accessories; special and common tools; test, support, calibration, and maintenance/calibration shop facilities; and personnel skill requirements.

Major systems. Systems which qualify for Defense Systems Acquisition Review Council (DSARC) review and others which are critically important to the Army, complicated, expensive, controversial, or, for any reason should involve the top management of the Army (AR 15–14).

Materiel developer (or developing agency). The command or agency responsible for research, development, and production validation of an item (including the system for its logistic support) which respond to DA objectives and requirements (table 6–1, AR 70–1).

Materiel requirement. An HQDA-approved requirement for a materiel item or system (e.g., an approved LOA, TDR, QMR, SDR, MN, ROC, TELER, or LR).

Measure of effectiveness (MOE). The quantitative expression (sometimes modified by subjective judgment) of the success of a system in achieving a specified objective.

Mission assignee agency. An agency responsible for materiel management of items within specific Federal supply classification classes.

Nondevelopment programs. Items or systems available for procurement with no expenditure of RDTE funds.

Nonmajor systems. Those systems which do not meet the criteria for designation as major systems.

On-site user testing (OSUT). Testing performed to insure that certain items or systems that are not being acquired for the Army in the field are ready for operational use. OSUT has objectives similar to DT III and OT III but is conducted on equipment at the operational site.

Operational climatic testing. Tests addressing the upper and lower bands of the climatic spectrum. These tests will provide an assessment of operational suitability of a system under the climatic conditions it is most likely to encounter in actual usage.

Operational effectiveness (OE). The overall degree of mission accomplishment of a military system used by representative troops in the context of the organization, doctrine, tactics, threat, and environment in the planned operational employment of the system.

Operational Feasibility Testing (OFT). A limited category of FDTE conducted by the user to permit an operational evaluation of systems developed by another service, a foreign nation, or a commercial firm and to provide input for a new LOA, ROC, or LR; modification of a development plan (DP); or the initiation of a Product Improvement Proposal (PIP).

Operational tester. That command or agency responsible for the conduct of operational testing of items or systems. It derives program and budget information for operational testing (OT); writes the OT portion of the CTP; determines when, where, how, and by whom OT will be accomplished; prepares operational test design plans; conducts or directs OT; reports on test results; and provides independent evaluations.

Operational testing (OT). Testing and evaluation of materiel systems accomplished with typical user operators, crews, or units in as realistic an operational environment as possible to provide data for estimating:

a. The military utility, operational effectiveness, and operational suitability (including compatibility, interoperability, reliability, availability, maintainability, supportability, operational man (soldier)-machine interface, and training requirements) of new systems.

b. From the user viewpoint, the system's desirability considering systems already available and the operational benefits and/or burdens associated with the new system.

c. The need for modification to the system.

d. The adequacy of doctrine, organization, operating techniques, tactics, and

training for employment of the system; the adequacy of maintenance support for the system; and, when appropriate, its performance in a countermeasures environment.

Outline test plan (OTP). The formal document which contains appropriate administrative information; the test purpose, objective, scope, and tactical context; resource requirements; and cost estimates.

Performance criteria. The operational and/or technical capabilities established for an item of materiel at the time it is approved for development.

Physical characteristics. Those military characteristics of equipment which are primarily physical (e.g., weight, shape, volume, waterproofing, and sturdiness).

Pilot line items. Production items manufactured for OT and DT III and to confirm production feasibility. These could also be considered LRIP items should the pilot line be converted to the production line.

Preproduction prototypes. Those engineering development prototypes manufactured for OT and DT III prior to full production. They could also be the prototypes tested in OT and DT II.

Product improvement testing. Testing to insure suitability of the proposed product improvement for Army use.

Production and deployment phase. The fourth phase of the materiel life-cycle. During this phase, operational units are trained, equipment is procured to meet the authorized acquisition objective (AAO) and distributed in accordance with the major item distribution plan (MIDP), and logistical support is provided. Product improvements are applied to the equipment and/or support systems when they are required by operational experience or to employ new technology and doctrine. A table of organization and equipment (TOE), table of distribution and allowances (TDA), and common table of allowance (CTA) are refined or modified as required.

Proponent. An Army organization or staff which has been assigned primary responsibility for materiel or for subject matter in its area of interest (e.g., a proponent school, proponent staff agency, or proponent center).

Required Operational Capability (ROC). An HQDA document which states concisely (usually in four pages or less) the minimum essential operational, technical, logistical, and cost information necessary to initiate full-scale development or acquisition of a materiel system (AR 71–9).

Safety confirmation letter. A letter, separately issued by the development tester and the operational tester, to the materiel developer stating that the item or system conforms to all safety requirements and specifying precisely what those safety requirements are.

Safety engineering. An element of engineering involving the application of scientific and engineering principles for the timely identification and prevention or control of hazards within a system. Safety engineering draws upon professional knowledge in the mathematical, physical, and related scientific disciplines, together with the principles and methods of engineering design and analysis to specify, predict, and evaluate the safety of a system.

Safety release. A document provided by the materiel developer prior to any testing involving the use of troops. Each safety release will describe the specific hazards of the item or system and will include technical and operational limitations and precautions.

Safety statement. A formal, comprehensive safety report that summarizes the safety data that has been collected and evaluated during the life-cycle before

a test of an item. It expresses the considered judgment of the developing agency regarding the hazard potential of the item and any actions or precautions that are recommended to minimize these hazards and to reduce the exposure of personnel and equipment to them.

Safety test. Testing to determine the degree of freedom of a system from those conditions that have the potential to cause injury or death to personnel or damage to, or loss of, equipment or property.

Special study group. A group normally composed of representatives of HQDA, combat developer, operational tester, materiel developer, logistician, trainer, and project manager designee which is convened to conduct analysis, insure inclusion of all alternatives within an analysis, monitor experimentation, or undertake other tasks that may require the concentration of special expertise for a short duration.

Special task force. A group normally composed of a chartered task force director and representatives of the user, materiel developer, trainer, combat developer, HQDA, operational tester, and a project manager designee. This task force conducts an in–depth investigation of the need for a system described in requirements documents and of any necessary alternative system designs, monitors experimentation, and arrives at a recommended approach to providing the system described in an approved ROC document.

Suitability. A subjective determination by a decision authority that developmental materiel does or does not meet minimum essential standards prerequisite to satisfactory field service use. The judgement may be based on the presence or absence of uncorrectable materiel deficiencies, and/or the number and assessed importance of correctable and uncorrectable shortcomings.

Technical evaluation. The study and investigation by a developing agency to determine the technical suitability of materiel, equipment, or a system for use in the military services.

Technical feasibility test. Testing to provide test data for a technical evaluation and assessment of items or systems developed by another service, foreign nation, or a commercial firm.

Test design plan (TDP). A formal document approved by the test organization which states the circumstances under which a test is executed, the data required from the test, and the means of analyzing test data.

Test directorate. A temporary organization formed to conduct a test. User test directorates have a test director, deputy directors, and other test personnel designated in an approved plan. A deputy test director (for DT or OT) directs elements of the test directorate executing data collection, test control, and analysis. Other deputies and elements of a test directorate may be concerned with test troops, system support, supervision of combat development concepts employed in the test, training, logistics, facilities, administration, and advisory and monitoring personnel.

Test objective. Some of the purposes for which the test is conducted embodying a logically related set of test-answerable and interdependent issues. The objective implies the scope of the inquiry.

Test organization. The organization responsible for conducting the testing (e.g., OTEA, contractor team, laboratory group, test boards, or proving ground directorate).

Test proponent. The command or agency designated by HQDA requiring test results.

Test report. A document that contains the data obtained from executing the test, describes the conditions that actually prevailed during testing and data collec-

tion, and contains an analysis of test results versus test objectives.

Test Schedule and Review Committee (TSARC). A DA committee which recommends test priorities; coordinates resources for support of user testing; resolves conflicts between test requirements and other missions; and recommends approval of the FYTP.

Test support unit. The command or agency that supports a test by providing military personnel and TOE units and a portion of the operational test directorate.

Test unit. The TOE unit or individuals designated for the test.

Threat support package. A statement of the actual expected threat for the tested system. It may also contain specially constructed threat hardware.

Trainer. The agency responsible for the development and conduct of the training which will provide the necessary skills to operate and maintain items and systems.

Training device. Any three-dimensional object developed, fabricated, or procured specifically for improving the learning process. Training devices may be either system devices or nonsystem devices.

a. System devices are designed for use with one system or item of equipment, including subassemblies and components (e.g., training devices for the TOW missile, M60-series tank, or the M16 rifle).

b. Nonsystem devices are designed to support general military training and/or for use with more than one system or item of equipment, including subassemblies and components.

Training test support package. Used to train user troops for testing and to plan data collection in the area of training requirements.

Type classification. Identifies the life-cycle status of a materiel system by the assignment of a type classification designation and records the status of a materiel system in relation to its overall life history as a guide to procurement, authorization, logistical support, assets, and readiness reporting.

Typical user troops. User operators, crews, or units of the type and qualifications of those expected to use and maintain the system when it is deployed.

User. That command, unit, or element which will be the recipient of the production item for use in accomplishing a designated mission and which will have the item included in its TOE or TDA.

User testing. A generic term encompassing operational testing (OT) and force development testing and experimentation (FDTE).

Validation phase. The second phase in the materiel life-cycle. This phase consists of those steps that are necessary to resolve or minimize special logistics problems identified during the conceptual phase, verify preliminary design and engineering, accomplish necessary planning, fully analyze trade-off proposals, and prepare contracts required for full-scale development. The validation phase may include the use of advanced development prototypes in development and operational tests. The validation process may be conducted using competitive or single contractors or by in-house laboratories.

Appendix B

XM-1 DTI OUTLINE TEST PLAN

OUTLINE TEST PLAN (OTP) FOR DT I

Test Title: Development Test (DT) I, XM1 Tank System

Test Proponent: Project Manager, XM1 Tank System

Test Agency: Test and Evaluation Command

Test Location: Aberdeen Proving Ground, Maryland

Dates of Test: February - May 1976

1. References:

a. Department of the Army Approved Materiel Need (Engineering Development) (MN(ED)) for a Main Battle Tank, 31 January 1973.

b. Request for Proposal DDAE07-73-R0008, 23 February 1973.

c. Development Concept Paper (DCP) 117, 18 January 1973.

2. Purpose: To demonstrate fundamentally that technical risks associated with the XM1 Tank System have been identified and that solutions are in hand, and to provide comparative performance data on the two competing systems to the source selection process for the Full Scale Development (FSD) phase.

3. Objective: The primary objectives of DT I are to compare the existing and potential capability of the XM1 Tank designs to that of the M60A1E3, and to identify the better design. Demonstrated performance will be compared to the Materiel Need requirements. Specific test objectives will address selected aspects of the following to assure that critical and discriminatory factors are tested/evaluated.

a. Crew Survivability: To what degree do the competing prototypes provide improvement over the M60A1E3 in terms of armor protection (KE and HEAT), mine protection, compartmentalization of fuel and ammunition, anti-spall techniques, multi-hit protection and hit avoidance? To what degree do the prototypes reduce visual, noise, and infrared signatures? Which design is considered to provide the "better" crew survivability?

b. Firepower: To what degree do the competing prototypes provide improvements over the M60A1E3 with respect to surveillance and target acquisition performance (day only), first and subsequent round hit probabilities and time to hit and kill? (Includes all modes of stationary and moving tanks and targets). Which design is considered to possess the "better" firepower?

c. Mobility: To what degree do the competing prototypes provide improvements over the M60A1E3 with respect to cross-country mobility, acceleration, operation on 10% and 60% slopes, maximum sustained speeds, and fordability with and without kit? Do either or both of the competing prototypes provide an acceptable level of performance under various terrain conditions? Which design is considered to provide the "better" mobility?

d. RAM-D: Does either prototype exhibit potential of achieving at least

(1) 320 overall MMBF?

(2) 89% inherent availability?

(3) 1.25 maintenance ratio?

(4) 4,000 miles power train durability?

in production, and 85% of the RAM values and 100% of the power train durability value during DT II/OT II?

e. Fightability: (Human Factors and Military Utility) have man-machine interfaces been adequately designed? To what degree has crew functioning been included as a key design parameter in the competing design approaches? i.e. accessability of ammunition and controls, servicing of weapons, design of crew stations, ease of maintenance by operator and maintenance personnel, etc. What is the comparative military utility of the competitive designs? Which prototype, based on this assessment appears to be the most fightable design? (It is envisioned that this test objective will provide a point of departure for additional evaluation by OTEA during OT I).

f. Other Technical/Performance Characteristics: i.e., combat weight, width, height, safety, etc.

4. Scope:

a. Each of two competing contractors will build and deliver to the Government one complete prototype vehicle, one automotive test rig, one ballistic hull and one ballistic turret. The test will be conducted over a three month period concluding in May 1976. Since ASARC II is scheduled for June 1976, it will be essential that the time lag between testing and reporting of results be held to the absolute minimum.

b. Within the time and hardware constraints, the test cannot be a complete evaluation. Since the critical issue to be resolved by DT I is the degree of improvement over the current (1976) series tank, this test must concentrate on accomplishing the objectives outlined above. Essential to this process will be the availability of the final DT II/OT II test reports for the M60A1E3 tank. It is assumed that these data will be available.

c. It is envisioned that each of the four major deliverable items will be dedicated to the accomplishment of specific test objectives. That is, the ballistic hull and ballistic turret will be used to measure crew survivability, the automotive test rig to measure mobility performance and the prototype vehicle to measure firepower system accuracy and fightability. Both the automotive test rig and prototype vehicles will provide data for the RAM-D assessment.

d. To maximize results during DT I/OT I, component, safety and performance tests will be conducted in advance to the extent possible. This will allow DT I/OT I to concentrate more fully on a system evaluation.

e. The test as conceived will be predominantly engineering type tests, therefore, Aberdeen Proving Ground is selected as the location. Armor and Engineer Board personnel will, however participate in DT I.

f. A safety release will be published prior to initiation of OT I.

g. In that this test will be conducted during the validation and, therefore, the competitive phase of the program, special care will be taken to insure sensitive contract data is properly safeguarded. Procedures to accomplish this will be published prior to the testing.

5. Test Resource Requirements:

a. Test Items: From each of two contractors, one complete prototype, one automotive test rig and one ballistic hull and turret.

b. Comparison Item: Two M60A1E3 tanks. (M60A1E3 DT II/ OT II) test results will be used to the maximum practicable extent and actual vehicles will be used only to such extent as may be required for a valid comparison).

c. Ammunition: To be determined.

d. Military Personnel Requirements: Requirements to be provided by US Army TECOM by position, grade, qualification, number and inclusion dates.

e. Contractor Support: Maintenance and spare part support at test site.

f. Pre-test Training: Operator and maintenance training prior to initiation of test.

g. Facilities and Other: None

6. Test Milestones:

a.	Draft detailed test plan:	Feb 75
b.	Approved and coordinated detailed test plan:	Aug 75
c.	Ballistic hull and ballistic turret delivered:	Oct 75
d.	Automotive test rigs, prototype vehicles, special tools, test equipment and deep-water fording kit delivered:	Jan 76
e.	Comparison Items:	Nov 75
f.	Contractor training completed: when does it start? FALL 1975	Jan 76
g.	Start DT I:	Feb 76
h.	Complete DT I:	May 76
i.	DT report:	Jun 76

7. Cost Summary: The following RDT&E funds are required for APG (Armor and Engineer Board is funded on level of effort basis and is, therefore, not included at this time):

FY74	$30,000 Planning ✓ spent $6,000 published ✓
FY75	$30,000 Planning ✓ Sent
FY76	~~$400,000~~ ~~460,000~~ 506,000 Test Conduct

NOTE: Estimates are in current dollars and rates and expected Institutional funding rates.

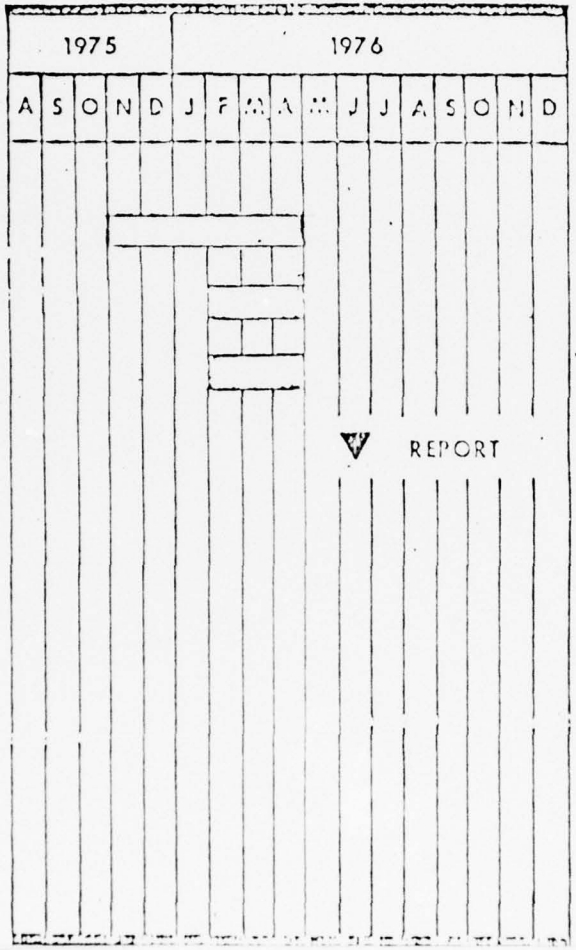
8. Point of Contact:

HQ, TECOM, Mr. Don Resch, AMSTE-BB
Autovon: 870-5266/4008

XM1, PMO, MAJ J. Logan, AMCPM-GCM-ST
Autovon: 273-1639/1684

DT I SCHEDULE

XM1



(Ballistic) HULL & TURRET

(Firepower) PROTOTYPE

(Mobility) TEST RIG

IV.E.1.6

Appendix C

XM-1 OTI OUTLINE TEST PLAN

OUTLINE TEST PLAN (OTP)

DATE: 7 Mar 74

TEST TITLE: New Army Battle Tank (XM1) Operational Test I (Short Title: XM1 OT I) (OT 031)

TEST TYPE: Operational Test I (OT I)

COMMAND/AGENCY HAVING OT RESPONSIBILITY: US Army Operational Test and Evaluation Agency (OTEA)

TEST INSTALLATION: Aberdeen Proving Ground, MD

TEST ORGANIZATION: OTEA

TEST UNIT: Tank Crews (4 ea)

DA STAFF PROPONENT: DAFD-SDF

TEST LOCATION: Aberdeen Proving Ground, MD

TEST DATES: February - May 1976

1. REFERENCES.

a. Department of the Army Approved Materiel Need (Engineering Development) for a Main Battle Tank, dated 31 January 1973.

b. DAFD-SDY Letter, subject: Letter of Instructions (LOI) for Implementing New Materiel Acquisition Guidelines, dated 23 August 1972.

c. DOD Directive 5000.3, subject: Test and Evaluation, dated 19 January 1973.

2. PURPOSE. To provide data and associated analysis on the operational effectiveness and military utility of the XM1 to the Army Systems Acquisition Review Council (ASARC II) on which to base a decision concerning full scale development.

3. OBJECTIVES.

a. Objective 1: To assess the operational effectiveness of the two candidate systems.

b. Objective 2: To provide information on the operational survivability of the two candidate systems.

c. Objective 3: To provide information relative to the adequacy of proposed personnel qualifications, training and selection criteria.

d. Objective 4: To provide information on the capability of typical tank crews to operate and maintain the candidate tanks and logistical support concepts.

4. SCOPE AND TACTICAL CONTEXT.

a. Scope. XM1 OT I will be combined with Developmental Test I (DT I) at Aberdeen Proving Ground, MD. OT I will consist of typical user troops operating two candidate prototypes and firing the weapons systems using test facilities available. The two candidates will be compared with the ~~latest production model of the~~ M60 A1 ~~series~~ tank ~~if possible in the time available.~~ Tank crews will be rotated, operating all three tanks, during the conduct of test scenarios under similar test conditions. Vehicles will be loaded with appropriate ammunition or dummy rounds of comparable space and weight, radios, tools, and crew equipment. The content of DT I/OT I will be predicated on test techniques which best respond to critical criteria and discriminators.

b. Tactical Context. The tactical scenario for this test will be based upon the appropriate detailed scenario developed by TRADOC. However, DT I/OT I will be largely limited to the nontactical environment of engineering testing. OT subtests will be conducted under operational conditions which are as realistic as practicable.

c. Environmental Impact. Environmental impact of this test is not considered to be significant. In addition, an addressal of the environmental impact of the system will be included in the test report and highlighted in the Independent Evaluation.

d. Preservation of Competition. In that this test will be conducted during the validation and therefore the competitive phase of the program, special care will be taken to insure sensitive contract data is properly safeguarded. Procedures to accomplish this will be published prior to the testing.

5. TEST RESOURCE REQUIREMENTS.

a. Test Directorate.

(1) Personnel Requirements:

POSITION	GRADE	QUALIFICATION	NUMBER	INCLUSIVE DATES	SOURCE
Test Director	06		1	4Jan-10May76	AMC
Dep Test Director for OT	05	AR	1	4Jan-10May76	OTEA
Test Design Adv	DAC/04	ORSA	1	*	OTEA
Chief Analyst	04	AR	1	4Jan-10May76	OTEA
Asst Analyst	02/03	AR	1	15Jan-10May76	FORSCOM
Chief Data Collector	03	AR	1	4Jan-10May76	OTEA
Data Collectors	E6	AR	4	25Jan- 1May76	FORSCOM
Analyst	DAC	ORSA	1	*	OTEA
Admin NCO	E7		1	25Jan- 1May76	FORSCOM
Clerk/Typist	Civ		1	4Jan-10May76	Local Hire
Photographic Adv	E7		1	*	OTEA
Combat Development Adv	04		1	*	TRADOC
Human Factor Adv	DAC		1	*	HEL
Maintenance Adv	WO/DAC		1	*	LDSRA
Training Adv	04		1	*	TRADOC
Driver/RTO	E5		2	4Jan-10May76	FORSCOM
Driver	E4		2	25Jan- 1May76	FORSCOM

* Intermittently as required. Parent agencies may send additional personnel as desired.

NOTE: Clearance for access to ~~Secret~~ Conf. materiel required for all personnel except drivers.

(2) Special Equipment Requirements: None.

b. Player Participants.*

(1)

UNIT/ELEMENT	STRENGTH	INCLUSIVE DATES	SOURCE
Tank Crews consisting of			
Tank Commanders (E6)	4	25 Jan-1 May 76	FORSCOM
Gunners (E5)	4	25 Jan-1 May 76	FORSCOM
Drivers (E4/E5)	4	25 Jan-1 May 76	FORSCOM
Loaders (E3/E4)	4	25 Jan-1 May 76	FORSCOM

* Secret Clearance required.

(2) Training Implications: There will be little benefit to unit readiness derived from this test. However, a limited amount of individual and crew proficiency should be realized from participation in the test.

c. Test Facilities/Base Operations Support.

(1) Test faciltiies will be provided by TECOM for DT I. There will be no additional requirements for OT I.

(2) Base Operations Support: (To be provided by AMC (TECOM)).

(a) Office space and normal office equipment for approximately fifteen test directorate personnel and a briefing/classroom for approximately thirty-five personnel will be required from 4 January 1976 through 10 May 1976. Telephone service will include access to AUTOVON and local off-post.

(b) Mess, medical, billeting, supply, housekeeping, administration, laundry, and troop welfare support for the test directorate and player personnel will be required for the duration of the test. Emergency medical evacuation by helicopter should be available on call.

(c) Normal maintenance support for facilities and equipment used by the test directorate, except for vehicles which will be performed by the unit tasked to provide the vehicles.

(d) Allocation of one FM radio frequency for test administration and control.

(3) Test Directorate Support:

DESCRIPTION	QUANTITY	INCLUSIVE DATES	SOURCE
M109 2 1/2 ton van	1	1 Feb- 1 May 76	AMC(TECOM)
M151A2 1/4 ton truck with AN/VRC-46 radio	2 ea	1 Feb- 1 May 76	AMC(TECOM)
M35 2 1/2 ton cargo truck	1	1 Feb- 1 May 76	AMC(TECOM)

d. Item(s) to be Tested.

(1) Test Items:

Description	Appn	Total Req For OT	Nr Avail Exist Sources	Inclusive Dates	Source
XM1 (Contr #1)	RDTE	1	1	15Jan-1May76	AMC
XM1 (Contr #2)	RDTE	1	1	15Jan-1May76	AMC
*Ammunition (ea candidate)	RDTE	12 rds		15Jan-1May76	AMC

* Required if candidate systems use new development weapons. ← NO AMMO REQ FOR OTEA 11-22-75

(2) Support Requirements: All support requirements will be provided by TECOM as part of DT I. Maintenance support of test items will be performed by contractor.

e. Data Collection, Processing and Analysis.

(1) Data Collection/Processing Systems:

Instrumentation/System	Quantity	Inclusive Dates	Source
Programmable Desk Calculator	1	4Jan76-10May76	OTEA
Hand-held Battery Powered Calculators	4	4Jan76-10May76	OTEA
Stopwatches	6	4Jan76-10May76	OTEA

(2) Contract or Other Services: None

f. Ammunition, Missiles and Pyrotechnics. None necessary for OT beyond DT requirements which will be provided by AMC (TECOM).

g. POL Supplies.

Description	Quantity	Location
Diesel	Under Review	APG, MD
MOGAS	Under Review	APG, MD

h. Other Resource Requirements.

(1) Test Support Package:

(a) Draft special texts for operation and maintenance will be

provided by AMC (development contractor) to OTEA by 1 November 1975. (Five copies)

(b) Threat Support Package. Threat support for the test, to include the threat portion of the selected tactical scenario, will be provided by TRADOC.

(2) Special Pretest Troop Training: OT player personnel will participate in the contractor training to be provided for DT I. Number of personnel to attend will be determined by OTEA/TECOM.

(3) Simulators, Targets and Other Special Equipment: To be provided by TECOM as part of DT I.

(4) Contract Studies or Support: None.

(5) Photographic/Pictorial Services: The film for this test is DA Special Briefing Film (SBF) 73-65. DA has designated AMC to provide the motion picture and still photographic support for this test on a reimbursable basis. In turn, AMC has designated as the film production facility White Sands Missile Range (WSMR) Pictorial Facility. WSMR will task the appropriate photographic support facility at the test location for required services. The test will require a 7-minute color sound 16mm motion picture briefing film as well as color transparency and black and white and color print documentation, of each test phase.

(6) Other: One M60A1E3 tank will be required for comparison testing and will be provided by AMC for DT I. If adequate data is available from M60A1E3 DT II/OT II this requirement will be reevaluated.

6. TEST MILESTONES.

a. Draft Test Design Plan Completed	28 Feb 75
b. Test Support Package to OTEA	1 Nov 75
d. Establish OT I Test Directorate at Test Site	5 Jan 76
e. Detailed Test Plan completed	31 Jan 76
f. DT I/OT I begins	1 Feb 76
g. Interim Test Report (DT I/OT I)	15 Apr 76

h.	OT I completed	1 May 76
i.	Test Report completed	12 May 76
j.	Independent Evaluation completed	16 Jun 76
k.	ASARC II	~~30~~ 16 Jun 76

7. COST SUMMARY. ($ in thousands. Supported by cost estimate attached).

	FY 76
OMA	$83.296
RDTE	0
PEMA	0
TOTAL	$83.3

8. POINTS OF CONTACT.

AGENCY	MAILING ADDRESS	LOCATION	TELEPHONE
OTEA	FDTE-ZG FDTE-PO-OB FDTE-OS	Ft Belvoir, VA 22060	AV-354-1991 354-6172 354-1370
TECOM	AMSTE-BB	APG, MD 21005	AV-870-5266 4977/3788
PM	ATTN: ~~PM-XM~~; AMCPM-GCM-ST	Warren, MI 48090	AV-273-2169
DASSO	DAFD-SDF	Wash, DC 20310	AV-225-0421 0422
TRADOC	ATCD-CF	Ft Monroe, VA 23651	AV-680-2172
OCRD	DARD-DDC	Wash, DC 20310	AV-225-4049 222-2252
USA Army Center & School	~~ATSAR-CD-TO~~ ATSL-CD-OT	Ft. Knox, KY 40121	AV-464-6433
MASSTER	DCofS; Opns & Plans; Plans Div	Ft Hood, TX 76544	AV-737-9965

AGENCY	MAILING ADDRESS	LOCATION	SOURCE
USAFORSCOM	AFOP-RE	Ft McPherson, GA 30330	AV-588-3121 2220
DCSLOG	DALO-MAA	Wash, DC 20310	AV-227-6202
AMC	AMCRD-UA	Alexandria, VA 22304	AV-284-9523

9. COORDINATION. This OTP will be discussed with the commands/agencies listed in paragraph 8 prior to the Working Group TSARC.

DATE COST ESTIMATE PREPARED: 20 April 1973

TITLE: XM-1 OTI OTP DATED: 7 March 197[illegible]

Fund requirements reflected below provide for direct costs of the test ment only. Estimates below are based upon, and provide funds to support, only those resources required in paragraph 5 of the outline test plan.

CATEGORY OF COST	APPN	P/B BY	P/E or LINE ITEM NR.	$ in Thousands FY 76	FY	FY
1. Test Dirctorate	OMA	OTEA		37.8		
2. Player Participants	OMA	OTEA		15.0		
3. Test Facilities/ Base Ops Spt	OMA	OTEA		14.5		
4. Item(s) to be Tested*						
a. Procurement of Prod. Items						
b. Support of Prod. Items						
c. Support of Prototype Items						
5. Data Collection, Processing, and Analysis						
a. Purchase of Instrument Sys						
b. Other (Equip Rental, Contract Support, etc.)	OMA	OTEA		2.0		
6. Ammunition/ Missiles (Excludes Items to be Tested)						
7. Other Costs						
a. Pretest Training	OMA	OTEA		0		
b. Simulators, Targets, and Special Equipment	OMA	OTEA		0		
c. Photographic Support	OMA	OTEA		14.0		
d. Other	OMA	OTEA		0		
8. Total						
a. OMA				83.3		
b. RDTE				0		
c. PEMA				0		
d. Grand Total				83.3		

* Cost of prototypes are not included. Applicable costing information may be obtained by referring to the appropriate financial plan of the system Development Plan.

STUDY PROJECT PLANNING FORM 16 Aug 76

PARTICIPANT:	ADVISOR:	DATE:
LT Hugh Williamson (USA)	Mel Roberson	17 Aug 76

STUDY PROJECT TITLE: The Organization for Test and Evaluation of the XM1 Tank Project.

OVERALL PURPOSE OF PROJECT: (What plan to learn and Why)

To learn how T&E management tasks are accomplished within the XM1 Tank office so that I may be better prepared for my next assignment to that office.

SPECIFIC STUDY PROJECT GOALS: (to be achieved or questions to be answered)

To learn how T&E is planned, coordinated, executed and controlled by the XM1 T&E Office.

REPORT OPTION: Formal Report

STUDY METHODS TO BE USED AND DATA SOURCES:

1. Review of organizational structural documents.
2. Review of T&E plans.
3. Review of Test reports and evaluations.
4. Personal interviews with DA, DARCOM, and OTEA test officials.
5. Telephone interviews with XM1 T&E officials.
6. Analysis of research and interviews.

TENTATIVE OUTLINE OF PROJECT REPORT: (Be as specific as possible.)

I. Introduction. Purpose, scope, definitions, and organization of report.
II. Organization and procedures of the XM1 T&E Office.
III. Analysis and discussion.
IV. Conclusions
V. Recommendations (if any)

KEY MILESTONES: (Update as necessary.)

Week 9 – Document review completed
Week 11 – Interviews completed
Week 14 – Draft report completed
Week 14 – Draft to reviewer
Week 15 – Draft to typist
Week 17 – Report completed

Progress review milestones: Weeks 11, 14, 15. (Include schedule to typist.)