ABSTRACT

The rapid growth of automatic test equipment (ATE) utilization has caused many problems. Some of the major problem areas with ATE are the proliferation of different configurations, software incompatibilities, erroneous test results, late deliveries of new equipment and high development costs. To solve these problems and centralize ATE management, USAF/RD in July 1976 established an independent program element (63247F) for the development of a family of Modular Automatic Test Equipment (MATE) and supporting tools. Through the ATE R&D efforts, future weapon system program offices will be provided a standard family of Modular Automatic Test Equipment (MATE) with appropriate standards and specifications. A standard MATE family will permit interchangeable modules (hardware and software) to be used at all levels of maintenance. The use of common ATE will reduce the problem of units passing tests at one level of maintenance and failing at another level. Accurate and repeatable testing will reduce the excessive cost of sending good components to depot for repair or in the worst case, returning bad items to supply for reissue. The use of common ATE modules will reduce the Life Cycle Cost (LCC) of support by several means such as (a) reducing the variety and quantity of dedicated ATE required at each base to support the various aircraft, missile and electronic combinations that each organization uses, (b) reducing the training requirements and personnel due to common controls and input/output displays, (c) reducing the variety and quantity of test equipment parts in the supply system, and (d) reducing the acquisition cost due to competitive procurement of smaller interchangeable modules in lieu of sole source buys of numerous large test stations.

INTRODUCTION

The rapidly increasing complexity and miniaturization of electronics has driven the Air Force towards the development and acquisition of substantial amounts of Automatic Test Equipment (ATE). During the past few years this rapid growth of ATE has created many problems. Some of the major problem areas with ATE are proliferation of different configurations, software incompatibilities, erroneous test results, late delivery of new equipment, and high development cost. Estimates taken from recent years indicate the Air Force spends over $1 billion per year on support equipment and has a current investment valued at over $10 billion. Seventy to eighty percent of this money is attributable to ATE. The causes for these problems are varied but the significant one has been concern of the program offices with placing their system in the operational inventory on schedule and on cost. Therefore, the support equipment has been given secondary consideration in many programs. The program offices have not been willing or able to expend extra R&D time or funds to develop standard or interchangeable ATE due to pressing schedules. Each program office has required its contractors to develop new support equipment including ATE for its own systems. The results have been a rapid proliferation of ATE throughout the Air Force inventory and in some cases "reinventing the wheel". To remove this funding/schedule hurdle from the program offices, USAF/RD directed the establishment of a program element to develop a family of Modular Automatic Test Equipment (MATE). Through this effort, future weapon system program offices will be provided a standard family of Modular Automatic Test Equipment (MATE) with appropriate standards and specifications. A standard MATE family will permit interchangeable modules (hardware and software) to be used at all levels of maintenance. The use of common ATE will reduce the problem of units passing tests at one level of maintenance and failing at another level. Accurate and repeatable testing will reduce the excessive cost of sending good components to depot for repair or in the worst case, returning bad items to supply for reissue. The use of common ATE modules will reduce the Life Cycle Cost (LCC) of support by several means such as (a) reducing the variety and quantity of dedicated ATE required at each base to support the various aircraft, missile and electronic combinations that each organization uses, (b) reducing the training requirements and personnel due to common controls and input/output displays, (c) reducing the variety and quantity of test equipment parts in the supply system, and (d) reducing the acquisition cost due to competitive procurement of smaller interchangeable modules in lieu of sole source buys of numerous large test stations.

MODULAR AUTOMATIC TEST EQUIPMENT DEVELOPMENT PROGRAM

The Air Force has taken management action to attack these major problems by creating within the Aeronautical Systems Division (ASD), the Support Equipment System Program Office jointly manned by resources from Air Force Systems Command and the newly formed Acquisition Logistics Division of the Air Force Logistics Command. Both the Department of the Army, Automatic Test Support System (ATSS), DARCOM, Ft Monmouth, New Jersey and the Naval Material Command NAVMAT, Washington, D.C. are planning to support the MATE program via a collocation of technical personnel to the MATE program office. Hence, the MATE program is intended to be a coordinated inter-service effort with appropriate review and consideration of current and future DoD R&D efforts. The Electronic Systems Division (ESD), Space and
Missile Systems Organization (SAMSO) and the Armament Development Test Center (ADTC) will also centralize their support equipment management activities following the ASD lead. AFLC has centralized ATE logistics management at the San Antonio Air Logistics Center (SAALC), whereby a corporate memory for ATE logistics management is being accumulated, thus improving the Air Force logistic support capability for ATE. As the Support Equipment System Program Office continues to grow, it too will create a corporate memory for support equipment management, development, acquisition, and support. Lessons learned will be accumulated and passed on to new programs.

The Air Force MATE program, conceived in July 1976, is to develop a family of modular automatic test equipment, plus supporting tools, to support all future weapon/electronic systems at all levels of maintenance. Since the MATE program is independent of a particular weapon system, it is not driven by weapon system scheduling or funding constraints. MATE will ultimately produce a qualified test system which will be tailored and reconfigured for each peculiar weapon system by assembling the proper hardware and software modules needed to perform the specific tests. MATE will not be a single station that will test everything. Once developed, the equipment will be available early in the weapon system schedule, thereby permitting its use during the development of the electronic systems and negating the need for developing/acquiring duplicative special test equipment.

The objectives of the MATE program are to:

a. Reduce the Life Cycle Cost of Weapon System Support. This can be achieved by conducting manual versus BIT versus ATE tradeoffs, procuring modules through competitive purchases, using a standard DOD test language and ATE programming aids, considering system testability during the conceptual phase, measuring only essential parameters, utilizing commercial equipment where possible and incorporating the use of standard electronic modules (SERDs).

b. Reduce Proliferation of ATE. Consideration will be given to establishing architecture for standard test modules, developing standard interfaces, requiring all new ATE and electronic programs to use the developed MATE and supporting the Test Requirement Documents (TRDs) and Support Equipment Recommendation Data (SERDs) outline test requirements.

c. Improve ATE Management. All ASD ATE R&D will be coordinated/approved by the Support Equipment SPO. Logistics support will be conducted by San Antonio ALC. ATE over Built In Test (BIT) over manual test must be justified, as well as improving Air Force/Navy/Army ATE coordination and recognition of avionics interchangeability.

d. Improve ATE Policy and Documentation. Ensure USAF/AFSC policy is clear regarding Support Equipment SPO responsibilities, develop Unit Under Test (UUT) testability guidelines, develop preferred UUT functions and test procedures, develop specifications and standards and develop ATE versus BIT versus manual test guidelines.

e. Improve ATE Procurement Practices. This will require a review of the Armed Service Procurement Regulations (ASPRs), assuring the test module specifications are competitive, having an early definition of requirements and establishing procedures to permit rapid ATE acquisition.

These objectives are to be achieved through an incremental program during the period of FY 78 - FY 86. The MATE System has been subdivided into the following ancillary efforts:

a. MATE Initial Segment. On 30 June 1978, dual contracts were awarded to Westinghouse Electric Corporation (Defense and Electronic Systems Center, Integrated Logistics Support Division) and Sperry Rand Corporation (Sperry Systems Management). This initial effort of approximately 33 months will result in the following end products:

(1) Electronic Test Equipment Acquisition Guide. The Electronic Test Equipment Acquisition Guide shall be comprised of all standards, specifications, manuals, handbooks, procedures, time-lines, computer programs and manual or automatic data systems required to define responsibilities, identify decision points and perform life cycle costing trade studies for making timely decisions and plans which lead to acquiring an effective low cost support system for a weapon system. This document shall contain configuration control procedures for relating weapon system changes during the entire acquisition cycle to the support system that will support the weapon system.

(2) MATE Development Guide. The MATE Development Guide shall be comprised of all standards, specifications, manuals, handbooks, procedures, computer programs and data systems required to integrate, design, build and test a MATE System which meets specified functional, performance and operational requirements and for the design, qualification and fabrication of software, instruments, devices, interface adapters and auxiliary items for MATE Systems.

(3) Avionics Testability Design Guide. The Avionics Testability Design Guide shall be comprised of all standards, specifications, manuals, handbooks and procedures required by the avionics design engineers to design avionics which better lend themselves to testing.

(4) MATE Production/Operational Guide. The MATE Production/Operational Guide shall be comprised of standards, manuals, handbooks and procedures required to use MATE test systems, to
maintain configuration control of MATE test systems, data systems and equipment supported by MATE and to obtain feedback from Air Force operational organizations to maintain MATE data systems current.

b. MATE Follow-on. A prototype MATE System will be developed and the evaluation and refinement of the MATE initial segment end products will continue. New MATE hardware and software will be developed as requirements are identified.

c. Programming Aids. This effort entails four subtasks all targeted at improving the generation of test programs. Included is the development and/or enhancement of Automatic Test Generators (ATGs). Currently, efforts have been initiated to develop an analog automatic test generation system. Future efforts will involve the enhancement of digital ATGs and the development of a hybrid (digital and analog combined) ATG. In addition, a reconfigurable Unit Under Test (UUT) Simulator program is planned. The UUT Simulator will be designed for utilization during the initial development of test programs, and the subsequent validation and verification of such programs as well as a training aid for Automatic Test Equipment (ATE) operators.

d. Software Verification and Validation. This effort is also divided into four subtasks to improve the methods by which the Air Force manages ATE software development and acquisition. The first task is to improve Test Program Set (TPS) contracting techniques and documentation. The second subtask is designed to provide software verification and validation tools and procedures. The two remaining subtasks are concerned with providing cost trade models for TPS software verification and validation and TPS cost tracking tools and procedures.

e. Management Enhancement. This effort deals with the development of documents and handbooks required to enhance the use of specifications, standards and procedures evolving from previous segments of the MATE program.

CONCLUSION

During the period that will be required to develop the projected long-term MATE program concepts to improve ATE, much can be accomplished. The way can be prepared to allow our management systems to respond to and assimilate the new approaches as they are generated. Additionally, more effective use can be made of existing tools in the ATE planning of current acquisition programs.

The reduction of the implementation risk of new concepts should be of primary concern to the ATE community. Our management systems do not easily adapt themselves to doing business in new ways. We must prepare ourselves now so that effective use of the new concepts will be possible. Several key areas must be addressed to accomplish this.

a. Everyone from the circuit board designer to officials at the highest level of government and industry must be made fully aware of the potential payoff improved ATE concepts have to offer. ATE must become a natural consideration at all levels, just as capability and new technology are now.

b. Acquisition planning activities must be evaluated with adequate emphasis on support considerations. New emerging economic analysis methods must be incorporated into the evaluation and planning process to properly trade off short-term costs versus long-term savings associated with ATE.

c. Increased, high level support is essential to insure that adequate resources are applied to acquisition programs so that potential ATE benefits can be achieved. Pressure to trade off this long-term savings by early cost-cutting must be reduced.

Many available ATE planning aids, although not entirely adequate in many instances, are not being used to their full potential. Little benefit will be gained in developing new, more powerful techniques for ATE planning, if they will not be used. Escalating ATE priority in the acquisition process will be another extremely effective means to insure the proper emphasis on ATE considerations in current program planning.

Finally, once motivation and priority become a common place element for ATE in the weapon system acquisition process, a commitment to supply the necessary resources to the program office must be made by the highest levels of our policy-making machinery. Without this commitment to guarantee equal posture of ATE considerations in the program offices, little progress can be made. ATE must be considered on an equal footing with weapon system cost, schedule and performance at all levels of our defense community.