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DEPARTMENT OF DEFENSE ACQUISITION MANAGEMENT METRICS

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The objective of this report was to research the realtionship, if any, between the number of test articles used in the Engineering and Manufacturing Development (EMD) Phase of a program acquisition, and the success of that program in EMD.

14. SUBJECT TERMS

Review of Related Literature; Methodology; Limitations of Study and Assumptions; Findings.

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Please see page 5-2

for

Primary Findings

Department of Defense Acquisition Management Metrics

DSMC Press Technical Report TR 1-99

Executive Brief

- Purpose and methodology of this research.
- Results of the research effort.

A Defense Systems Management College Research Project

What Is It?

- A research project documenting the cost and schedule overrun of programs during the Engineering and Manufacturing Development (EMD) phase.*
- Includes a performance rating for the system in EMD as determined by Operational Test results.*
- Compares Initial Operational Test and Evaluation (IOT&E)/ Operational Evaluation (OPEVAL) test reports issued by the Service Operational Test Agencies (OTAs) and the Beyond Low Rate Initial Production (BLRIP) test evaluations issued by the Director, Operational Test and Evaluation (DOT&E).
- Research is ongoing.

*On a sampling basis.

How It's Done

- Only Selected Acquisition Reports (SARs) and IOT&E, OPEVAL, and BLRIP test reports used as source data.
- Standard DoD decrements of 15% cost growth and 6 months schedule slip used to determine quantitative cost and schedule success ratings.
- A structured qualitative evaluation of operational test reports is used to determine performance success rating.
- A single success rating methodology has been devised to relate cost and schedule success to performance success for each program.
- Research now applied to each program completing EMD that had SARs, IOT&E, OPEVAL, and BLRIP reports rendered.

Who Does It?

- A collaborative effort between the Test and Evaluation Department and the Research Division at DSMC.
- Major sponsorship to date provided by the Office of the DOT&E.

Unique Aspects of the Research Methodology

- Only the highest levels of Department of Defense (DoD) program reporting documents are used as source data (SARs and final operational test reports).
- Combines performance (test) reporting with general management (cost and schedule) reporting in one evaluation system.
- Concerned only with the EMD phase of programs instead of total program life span.

Uses of this Research

- Provides the Office of the Secretary of Defense (OSD) and Services managerial information
  - Between 1980 and 1996 ('96 to date ongoing)
  - By any year groupings
  - By Service
- Can be used for managerial corrective actions.
- Can be used to baseline DoD acquisition system improvements.
- Data spreadsheet can be merged with other existing data bases.
- Data spreadsheet can/should be used by other DoD organizations and analysts.
- Correlates OTA test results with DOT&E test results.

Results

- Please see the attached.
  - Primary Findings are on page 5-2.
  - Ratio of Actual to Planned Costs and Schedules. Please see Figure 2.
  - Favorable comparison of DoD cost growths to other public and private sector major projects. Please see Figure 5.

Forecast for the Future

- To be discussed.

DEPARTMENT OF DEFENSE ACQUISITION MANAGEMENT METRICS

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October 1999

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ABSTRACT

The original operational test orientation of this research is noted in the Background paragraph of Chapter 1. To accomplish the original objectives it was necessary to acquire considerable data on the cost, schedule and performance success of programs within the Engineering and Manufacturing Development (EMD) phase of development. The current research used the original methodology and expands the results by including more recent programs and additional parameters. Hence this report contains program cost, schedule, and performance results by Service, and within three separate year groupings. It also contains a comparison between the Services' Operational Test Activity (OTA) test report and the Director Test and Evaluation (DOT&E) independent evaluation of the Service test report.

CHAPTER 1
INTRODUCTION

Background

In 1994, the Office of the Director, Operational Test and Evaluation (DOT&E), asked the Test and Evaluation Department (T&E Department) to research the relationship, if any, between the number of test articles used in the Engineering and Manufacturing Development (EMD) Phase of a program acquisition, and the success of that program in EMD. For major defense acquisition programs which include a Low Rate Initial Production (LRIP) effort within the EMD phase, the DOT&E is responsible for approving the number of test articles required for the Initial Operational Test and Evaluation (IOT&E)[1] accomplished near the end of EMD. Since 1991, Congressional Law requires the DOT&E to specify at Milestone II, the number of test articles required for this test.[2] The determination of test quantities is a difficult trade-off among several factors; the office of the DOT&E wanted to know if data was available that would help in making this important decision. Indications were that factual references or metrics relating to the subject were nonexistent.[3]

This research was completed and the results published in a Defense Systems Management College Technical Report dated May 1995,[4] hereafter called the original research report. The interest in the original research methodology and conclusions have resulted in a follow-on research effort described in this technical report.

Overview

This research extends the prior research in two important ways. In order to answer the specific T&E question it was necessary to devise a research methodology and accumulate considerable EMD program management data. This larger, general management data, including comparative Operational Test Activity (OTA)[5]/DOT&E operational test evaluations, has become the focus of current research. The initial research sought to identify the test article relationship to EMD program success in terms of cost and schedule overruns only. During dissemination of the results of the original research, the question "What about performance?" was asked. We originally established criteria for cost, schedule, and performance success, but collected no performance data. The current research adds performance data to the database; this is the second significant addition to the research methodology.

In most other respects this research uses the original research methodology. The original database for 24 programs that completed the EMD phase has been extended to 53 programs with 41 programs having nearly complete data within the database. Programs continue to be added as they near completion of their EMD phase.

All data used within this report are unclassified. The numbers of data points vary between parameters due to the non-availability of some data.

It is important to recognize that our research approach is a measure of EMD program management success in terms of cost, schedule and performance metrics rather than the eventual weapon

system success. There was no attempt to survey the effectiveness of the systems in their operational roles in the field.

The subsequent chapters of this report are organized as follows. Portions of the original research report that remain relevant are repeated. Chapter 2 discusses recent literature search efforts and repeats some of those from the original report. Chapter 3 essentially repeats the description of the original research methodology and an overview of the spreadsheet contained in Appendix C. Chapter 4 describes the limitations and assumptions implicit in this research. Chapter 5 is an analysis of the results of this effort. Chapter 6 is a discussion of opinions resulting from our viewpoint of the facts contained in the data bank.

Figure 1 is intended to show the relationship of the EMD phase, between Milestone II and Milestone III, to the total system acquisition and test and evaluation activities therein.

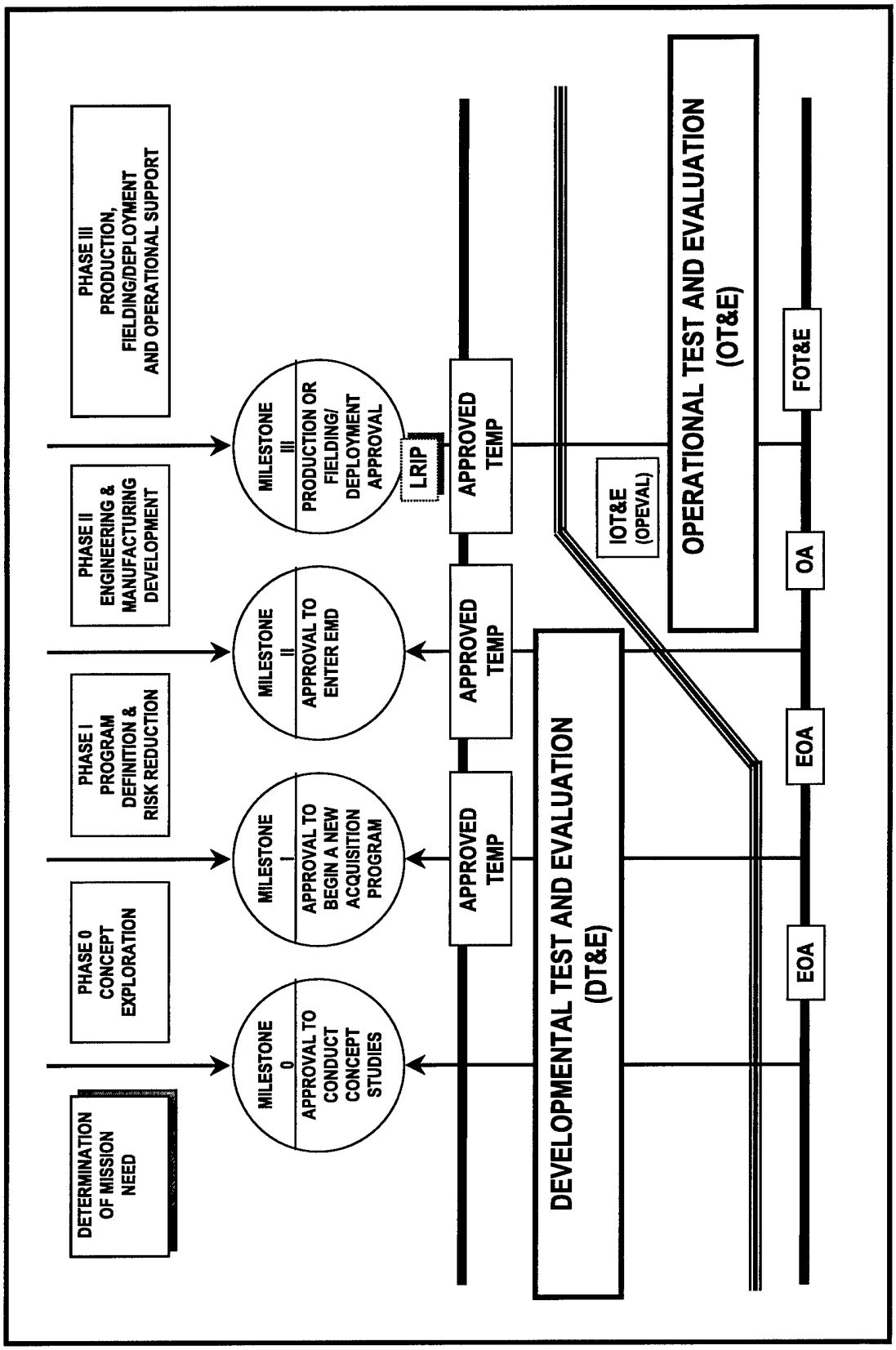


FIGURE 1. Test and Evaluation in the Acquisition Process

CHAPTER 2
REVIEW OF RELATED LITERATURE

Discussion

Most of the literature search conducted for this continuing research effort was accomplished in the original phase. The reader is referred to the original research report for details. Newer literature research is listed here together with prior research that remains directly relevant to current efforts. The Department of Defense (DoD) Directives, particularly those associated with the Selected Acquisition Report (SAR),[6] operational test reports, and other Government guidance documents were utilized. Some of the prior reports most relevant and useful are discussed below.

Related References

Rich and Dews' *Improving the Military Acquisition Process*,[7] contains a finding that is different than our own. It states for programs in the 1960s, cost overruns approximated 45 percent, schedule overruns 15 percent, and performance shortfalls 5 percent. "These findings support the conventional wisdom that when acquisition problems arise cost is the constant most easily relaxed and schedule is next, whereas, performance goals are adhered to most closely." Our own findings, detailed later, show average cost overrun of 40 percent, average schedule overrun of 62 percent, and an average performance success rating of 3.8 (76 percent) out of a possible 5.0 (100 percent) points. A possible explanation for this variance is the time period being used; 1960s by Rich and Dews, and the 1980s-1996 (mostly 1988-1996), used by us. In the former time period, the Cold War was raging, and each new weapon system was needed by the war fighter as soon as possible. In the later period, the Cold War was "won" and schedule became relatively less important than cost. In our studies performance has always had a higher success rating than cost or schedule, but our criteria system probably is different than Rich and Dews.

Drezner, et al.,[8] in a 1993 study of 128 weapon system programs three or more years into the Engineering and Manufacturing Development (EMD) phase concluded, "The weighted average cost growth of Development Estimate baseline programs, (Milestone (MS) II)...as of December 1990 is 20 percent." Our own study started at the same point but continued through all of EMD concluding with MS III actual cost data. When you consider that the average duration of the EMD phase for major programs is 7.4 years,[9] and a large degree of the cost overrun presumably occurs toward the end of EMD, Drezner's figure is close to our own higher figure, for the greater length of time.

Other studies comment on requirements generation and the program risk evaluation process, indicating both should be reviewed. Wiles[10] indicates the requirements generation and management process led to unrealistic operational requirements. Earlier, David Packard[11] stated all too often, requirements for new weapon systems have been overstated. Commenting on the Advanced Medium Range Air to Air Missile (AMRAAM) program's spotted history, Mayer's[12] comments "...the chief cause of AMRAAM's woes is that managers vastly over-sold the program in terms of cost and schedule."

Approximately 600 titles were extracted from the Defense Technical Information Center (DTIC) and other Acker Library research reference databases. An estimated 100 bibliographies were ordered, and approximately 105 reports were scanned or read in support of this research effort. With the exception of the dissimilar findings discussed previously, the great majority of prior research findings were either closely supportive, or generally supportive, of the findings of this research.

More recently, two articles have been prepared for publication based on this research. The first, "Management and Measurement" appeared in the May-June 1999 issue of *Program Manager* magazine. It suggested two major changes to the DoD acquisition system occurred in 1991 which considerably improved the operational test performance of systems in EMD. The second article "Baselining Acquisition Reform (AR)," is approved for publication in an upcoming *Acquisition Review Quarterly*. It suggests a date when AR first became effective in the field, and the cost, schedule and performance success levels at that time. At some future date using this research methodology, another measurement can be taken to record the degree of acquisition improvement that can be attributed to AR efforts.

CHAPTER 3
METHODOLOGY

Concept and Approach

As an underlying concept to this study, we used only official data available to DoD principals and staff at the Defense Acquisition Board (DAB) Milestone (MS) II and III meetings. The rationale was that acquisition decisions were based largely on this data, whether it was complete or incomplete, clear or hazy, right or wrong, with regard to estimates stated. We therefore limited our data sources to the program SARs for the years the program was in EMD, and the Initial Operational Test and Evaluation (IOT&E) reports of the Service OTAs and the Beyond Low Rate Initial production (BLRIP) independent evaluations issued by the DOT&E.

The current research is a follow-on effort to the original effort. So that newer data would be compatible with the original data, we felt the original criteria for cost, schedule and performance success must be maintained. Experience has shown us no problems have occurred using this approach.

For purposes of this research study, the success of a DoD acquisition program will be categorized in one of five ways. Either the program is Very Successful, Successful, Fairly Successful, Marginally Successful, or Not Successful. The subjective description of these categories follows. For the original report, only the portion of the definition relating to cost or schedule overruns apply. The remainder of the definitions apply to the current follow-on effort.

Very Successful (Score of 5)

There are few, if any, system shortcomings. The MS II program budget and program schedules were essentially adhered to.

The DOT&E MS III BLRIP report was positive. The Service IOT&E/OPEVAL report was positive, namely effective and suitable without caveat. (If not suitable, the deficiencies could be corrected without major impact—i.e., no SAR breach.)

Successful (Score of 4)

The ADM from MS II and MS III DABs was straightforward. There were system shortcomings. The MS II program budget and schedule were slipped, but not by more than 30 percent in cost and 12 months in schedule.

The DOT&E MS III BLRIP report was positive. The Service IOT&E/OPEVAL (Operational Evaluation) report was positive. The overall evaluation was effective and suitable, with perhaps a few marginally suitable parameters.

Fairly Successful (Score of 3)

The ADM from the MS II and MS III DABs contained problem statements. The program shortcomings were listed; a few could be critical. The MS II program budget and schedule had to be revised, but were within 45 percent of the MS II budget and no more than 18 months behind the MS II schedule.

The DOT&E MS III BLRIP report contained a few negative comments. The Service IOT&E/ OPEVAL report could be marginally effective and marginally suitable.

Marginally Successful (Score of 2)

The ADM from the MS II and MS III DABs indicated major performance and suitability problems existed. The program probably would be canceled on the basis of performance to date, but other external factors are being considered. The MS II program budget and schedule was revised more than once, and is now up to 60 percent overrun in cost and two years behind the original schedule.

The exit criteria of the MS II ADM were not completely met. An outcome of the MS III DAB would be to delay entry into full rate production.

The DOT&E MS III BLRIP report was marginally effective and/or marginally suitable. The Service IOT&E/OPEVAL recommended, at best, the system was potentially effective and potentially suitable.

Not Successful (Score of 1)

The ADM from the MS II DAB reluctantly approved the continuation of the program into EMD, or held the program in the Demonstration/Validation phase. The MS II budget is over 60 percent overrun, and the program is more than 2 years behind schedule. A DOT&E BLRIP report will say it is not effective and not suitable. This category would also include programs that have in fact been terminated.

For programs that have not had their MS III DAB review as yet, their success will be judged on the general approach discussed herein, and on the available official documentation.

Cost and Schedule criteria are objective; they use, in general, the standard DoD decrements for SAR reporting: 15 percent in cost growth and 6 months in schedule slippage. Performance evaluation is subjective, but controlled. Originally all performance success ratings were assigned by one researcher. Most recently, the performance success rating is to be assigned by a three-member Subject-Matter Expert (SME) Panel of T&E Department faculty members in accordance with established rating criteria and initial standardization procedures.

A standardized approach to present the data has been established. The major division in presenting the data is general management metrics followed by operational test metrics. Examples of

the former include cost and schedule overruns and of the latter, comparisons between OTA and DOT&E evaluations. Next within each category we list the overall metric for the years covered (1980-1996). Then the first sub-set of the metric is by year group (1980-1988, 1989-1992, 1993-1996), and then by individual Service.

In reviewing this data, particularly bar graphs, the reader is reminded that overrun data is the inverse of success data. For example, a bar graph showing a large overrun would be relatively tall. The associated success rating for this cost or schedule parameter would be relatively short.

Spreadsheet Description

The database is maintained on an Excel spreadsheet with columns representing parameters recorded, and rows representing the number of programs entered to date. Currently about 8-12 new programs are added each year. The first 12 columns are called primary data, that is, the identification of programs and their EMD cost, schedule, and performance results. The remaining columns are expanded data, required to arrive at the program success ratings.

Taxonomy of weapon system types was created for use within the study and consists of:

A/C:	Aircraft
Veh:	Vehicle
Elec-EW-A:	Electronic-Electronic Warfare-Airborne
Elec-CNR-A:	Electronic-Comm/Nav/Radar-Airborne
Elec-CNR-G:	Electronic-Comm/Nav/Radar-Ground
Mis/Mu-A:	Missile/Munition-Airborne
Mis/Mu-G:	Missile/Munition-Ground

Consistent with the idea that all data should be that which are available to OSD-level decision makers, cost data for all systems were collected from the system SARs. As the period of interest was EMD, the RDT&E and Procurement costs were collected for the period from MS II through MS III. Planned costs were those reported in the SAR following MS II; actual costs were those reported in the SAR following MS III.

In theory, one could go to the program SARs and retrieve, rather directly, the planned and actual cost of EMD. In practice, the retrieval of costs from the SARs is not simple. For one thing, costs are reported in several places in the SAR: for example, sections 11, 13, 14 and 16. For another, costs are reported in both Base Year and in Then Year dollars; the inflators for each appropriation are not always explicit. And yet another, the costs are reported by fiscal year; EMD need not start or end in conjunction with fiscal years. This leaves the analyst with the problem of determining how much of a particular fiscal year's costs should be allocated to EMD for the database.

Base Year vs. Then Year. In principle, the use of Base Year figures will remove the effect of inflation on the figures, making it easier to perform analyses. In the case of the EMD database, the EMD costs are used as a ratio of planned to actual. For most programs, the same inflators will be

used in both sets of figures, thereby yielding the same results from either Base Year or Then Year figures. For those programs in which actual EMD fiscal years were significantly longer than planned, when inflation might have had an effect on the ratios, use of either figure will still identify a significant overrun. In addition, several programs changed their Base Year for SAR-reporting during EMD. This creates additional difficulties in using Base Year figures for the database. For all the above reasons, this analysis used Then Year costs.

SAR Section. Sections 11, 13 and 14 do not separate costs by fiscal year; it is not possible to determine costs for EMD alone from these figures. Section 16 is the sole portion of the SAR which records costs by fiscal year. Start of EMD (MS II), found in section 9, determines the earliest fiscal year to use. If MS II is in the middle of a fiscal year, costs can be prorated month for month. MS III determines the end of EMD. If MS III is in the middle of a fiscal year, the end of IOT&E can be used to determine the end of EMD expenditures. With the above adjustments, section 16 figures were used for the SAR cost data.

RDT&E Costs. For some programs it is difficult to determine what RDT&E costs during the period of EMD actually were incurred in development of the program. In particular, when the program includes several models, or includes preplanned product improvements, the program can incur RDT&E costs supporting these others projects during the period that the basic development is in EMD. An excellent example of this is the Joint Tactical Information Distribution System (JTIDS) program, in which class 2H/2M development was initiated before class 2 completed MS III. SAR data can not isolate the costs of the basic program, except in those cases where the program office identified the parts of the project separately in the SAR. Additionally, for programs with preplanned product improvements, total cost figures (such as are in sections 11, 13 or 14) will not define the basic development. In those instances where cost definition was not clear, best estimates of allocation to the basic development, year by year, were made.

Procurement Costs. The SARs do not separately identify the cost of LRIP production. The best approximation is to use all procurement costs for those years before MS III; this is predicated on the legal constraint against using full-rate production funds before that decision. Procurement costs also have the same separation problem as discussed for RDT&E above, for programs with several models; the same solution was used.

RDT&E vs. Procurement. There remains a significant problem in determining the costs to be used in calculating EMD Cost Overrun. For any program with more than a few LRIP items, the Procurement costs in EMD will be significantly (in some cases overwhelmingly) larger than RDT&E costs. This results in the program being scored for EMD Cost Overrun predominately by Procurement costs. The problem is that a large number of LRIP items may indicate a very bad program (they need to continue LRIP to keep the line warm while the program keeps trying to pass IOT&E, for example). A large number of LRIP items may also indicate a very good program (testing in EMD has been so successful the services demand the item in the field before MS III, for example). Thus, overwhelming RDT&E with Procurement EMD Costs produces equivocal data. For this reason, EMD costs for RDT&E and Procurement were entered separately in the database, with RDT&E costs alone being used for the EMD Cost Overrun calculation. Analysis of Procurement costs may still be performed, if desired, since the data are present in the database. It should be noted that a

sensitivity analysis was performed on the data from the systems reported in 1995. The result was that use of RDT&E costs alone produced the same EMD Cost Success factor, within a score 1 more or less, in 13 out of 14 programs (see Appendix B).

CHAPTER 4
LIMITATIONS OF STUDY AND ASSUMPTIONS

Limitations

By definition, this study concerns itself with the Engineering and Manufacturing Development (EMD) phase exclusively, since that is where LRIP resides.

The data for this study were restricted to that contained within the Selected Acquisition Report (SAR) for the years in which the program was in EMD, and the IOT&E and BLRIP operational test reports. This was an early, deliberate design decision. The rationale was we wanted to use only the data available to the decision makers at the time the decision was made.

In some instances, the data within the SARs were incomplete and in some cases the type of data contained within the SARs varied between programs. This is not considered unusual given the elapsed time since some of the programs had their DAB meetings and the dynamics of the process.

SAR reports are required for Acquisition Category I (ACAT I) programs only, whereas the programs within the database are for all programs that have completed EMD and are on the DOT&E Oversight List. Therefore it was not possible to obtain cost and schedule data for some programs.

Even for programs with SARs it was not always easy, or even possible, to extract cost data for the program which was initiated at MS II. Several programs were changed significantly during EMD, to the point that the cost figures for the initial program were lost in the actual reported costs. One example is the JTIDS, which shows the difficulties in abstracting cost data from the SARs of programs which have undergone significant restructuring. As initiated at MS II in 1981, this was a joint Army/Air Force demonstration program for class 2 terminals only, with a follow-on if the demonstration was successful. The Navy had its own program. In 1985 the Navy was directed to use the Air Force terminals. Also in 1985, the Army redirected its program to develop 2M (data only) terminals. In 1986 the Air Force added 2H terminals, initially for the E-3A only, with other platforms to be added later. One result of all this restructuring was that MS IIIA in 1989 was only for Navy/Air Force class 2 terminals. Throughout EMD the SAR cost data were revised and reordered to reflect these programmatic decisions. Comparing planned costs for EMD to actual costs, as well as comparing planned and actual schedule information, using only the SAR, was virtually impossible under these circumstances. In some cases a best-effort set of figures was derived; in others, no reasonably comparable set of figures was possible and no data were entered.

The degree to which software must be developed for a system is another important variable, which would affect program success. We had planned to include this as a variable, but discovered that the SARs contained very little data in this regard.

Program concurrency—the overlapping of program development and program production phases—is a concern. This study generated little data relevant to concurrency; although again, program concurrency intuitively would have a major impact on program EMD success.

The current research may be constrained by the decision to use the original research methodology. The reason for this decision has been explained earlier.

The basic intent of this research is to estimate the degree of accuracy by program managers between their planned and their actual cost, schedule, and performance figures. External influences, not necessarily under the control of the program manager, would confound this analysis. Probably some degree of external influence, usually attributed to Congress, does exist. J. Ronald Fox in his 1988[13] book listed other potential external inputs, such as: "...the DoD often sets optimistically low cost estimates for proposed programs.... Only much later does it become clear that these programs will require more money than originally estimated"[14] or "... "cut insurance" is another budgetary technique. In this case...DoD inflates the cost of selected programs to ensure that even after expected congressional cuts, desired funding levels will remain intact,"[15] and ..."There is simply no need to lie; one only has to be optimistic."[16] Any degree of situational estimating would have an impact on pure estimating accuracy.

Recently there have been major changes, improvements, etc. to the "5000 Series Acquisition Regulations" which regulate the mainstream DoD weapon systems development this research covers. This includes the large number of major improvements commonly called Acquisition Reform (AR) and pilot programs such as Advanced Concept Technology Demonstrator (ACTD). The effect and relation of these new initiatives on our research is not discussed.

Assumptions

In the established DoD acquisition system for ACAT I programs, the only oversight documents required on a routine basis by the Office of the Secretary of Defense (OSD) are the SARs and DOT&E BLRIP evaluation.

The validity of this study depended greatly on how important the data contained within the SARs was to the actual decisions made at DAB meetings. It was assumed the information was central and vital to the decision process.

This study is the only known research that attempts to combine and evaluate EMD cost and schedule together with performance as measured by OTA and DOT&E operational tests during EMD.

Also this study attempts to identify program EMD costs only. The SAR, using development and production estimate baselines, contain cost to date, and cost to complete for the entire program. It is assumed you cannot easily extract EMD costs only from the SARs.

CHAPTER 5
FINDINGS

Primary Findings

Table 1 lists the primary findings of this study. Most findings are discussed in greater detail later in this Chapter, and in Chapter 6. Also, several findings are illustrated in the figures used herein.

General Management Metrics

- The average cost and schedule overruns for 33 program whose EMD phase ended between 1980 and 1996 was 40 percent in cost and 62 percent in schedule.
- The degree of cost and schedule overruns can be directly related to the Cold War years, (pre-1989) and post Cold War.
- Large schedule overruns exceeded large cost overruns as shown in Figure 2.
- In Figure 2, if the nine programs whose cost or schedule overrun was greater than 100 percent are considered outliers, and excluded, the average cost overrun is 19 percent and average schedule overrun is 34 percent, approximately half the total averages.
- Figure 5 indicates the cost growth of DoD weapon systems in their development phase compares favorably with other Governmental and private industry complex projects development.
- The average duration of the EMD phase was shortest during the Cold War period, (pre-'89), at 6.5 years. The average duration was longest, 8.7 years, during '93-96. In '97 two programs had an average duration of 8.3 years.
- Excellent cost data correlation existed between the total program costs obtained from the "Blue Books" used in the original research and the surrogate total program costs obtained from the SARs.
- The software complexity of a program usually cannot be obtained from the SAR reports.
- It is too early to measure the success of AR. However this research provides an estimate of the DoD acquisition management success prior to AR initiatives, and at some future date can be used to similarly measure the improvements achieved.
- This research makes no attempt to evaluate the program's success in its operational role.

Operational Test Metrics

- The number of test articles used in EMD is not a valid indicator of the success of that program. The number of test hours during EMD would be a better metric, but this was not obtainable by this research.
- This research evaluation indicates a noticeable difference between performance evaluations by the OTAs and the independent evaluations of the DOT&E.
- The OTA operational test reports are usually more positive than the DOT&E evaluations.

TABLE 1. Primary Findings

General Management Metrics

Cost and Schedule Overruns. Figure 2 is an updated version of the same figure that appeared in the original research report. It shows cost and schedule overruns in the form of the ratio of actual cost or schedule to planned cost or schedule. A program that completed EMD essentially on cost and on schedule would have a ratio of 1:1 for both cost and schedule. Hence the smaller dotted line square in Figure 2 is the loci of all programs that came in on cost and on schedule. Data points inside this square indicate programs that under ran cost and schedule. The larger dotted line square is the loci of all programs with a ratio of 2:1; that is, programs that completed EMD with exactly a 100 percent overrun in cost and in schedule. To convert a ratio reading from Figure 2 into the applicable overrun, subtract 1, and multiply by 100. For the 33 programs contained in Figure 2, the average cost overrun was 40 percent and the average schedule overrun was 62 percent for the entire period from 1980 to 1996.

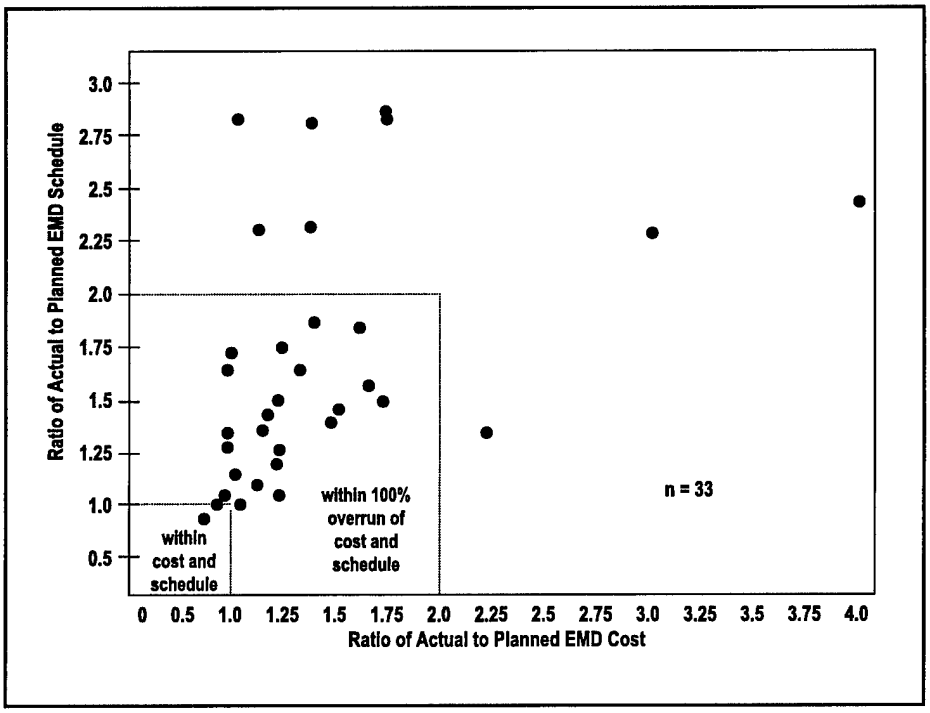


FIGURE 2. Ratio of Actual to Planned EMD Cost and Schedule

As indicated earlier, some valuable insight into trends and the dynamics of the DoD acquisition system can be obtained by recording this data in three separate-year groups, and to a lesser degree, by individual Service. Figure 3 shows the cost and schedule overrun averages for the three-year groups used in this report. An initial observation is that cost overruns were the greatest, and schedule overruns the least during the Cold War years ending in 1989. Since then, cost overruns have been less than schedule overruns. This cost overrun trend agrees with Rich and Dews' findings for programs in the 1960s, although our schedule overrun figure is higher. Figure 4 shows that U.S. Army programs had less cost and schedule overruns than the other Services. A superficial possible reason for this is the general perception that Army equipment is less complex than the other Services.

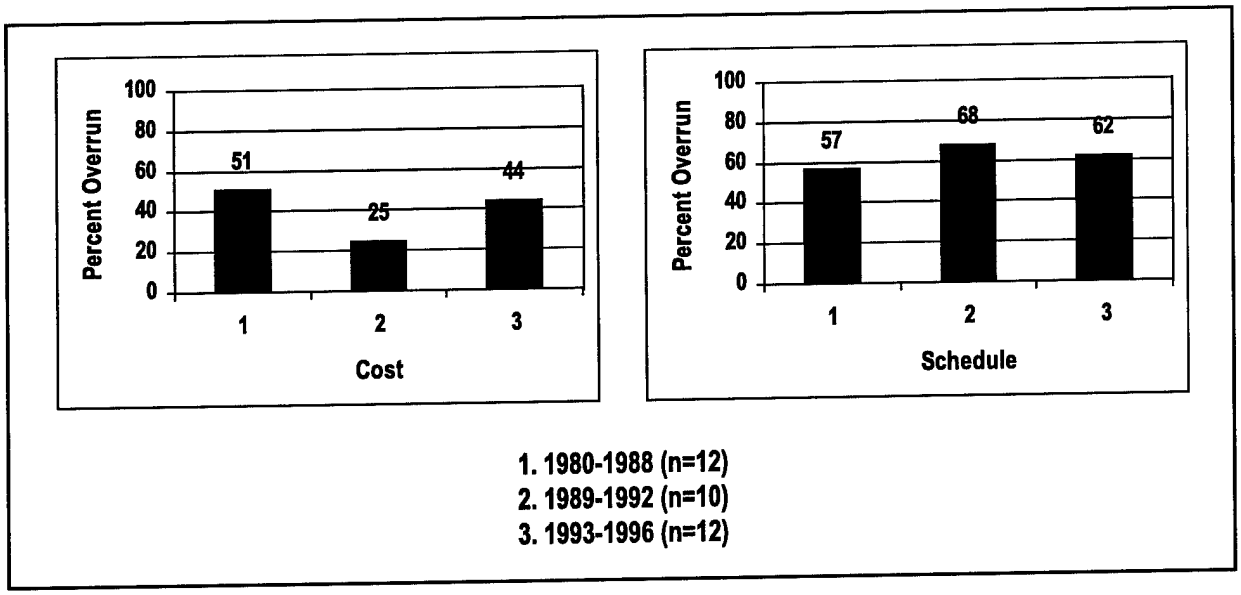


FIGURE 3. Average Cost and Schedule Overruns by Year EMD Phase Ended

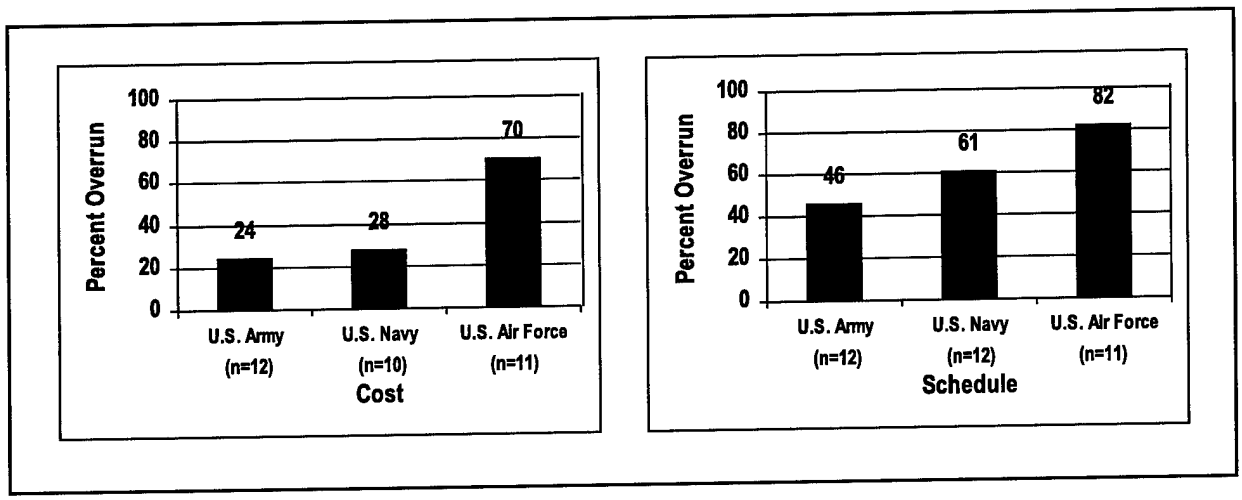
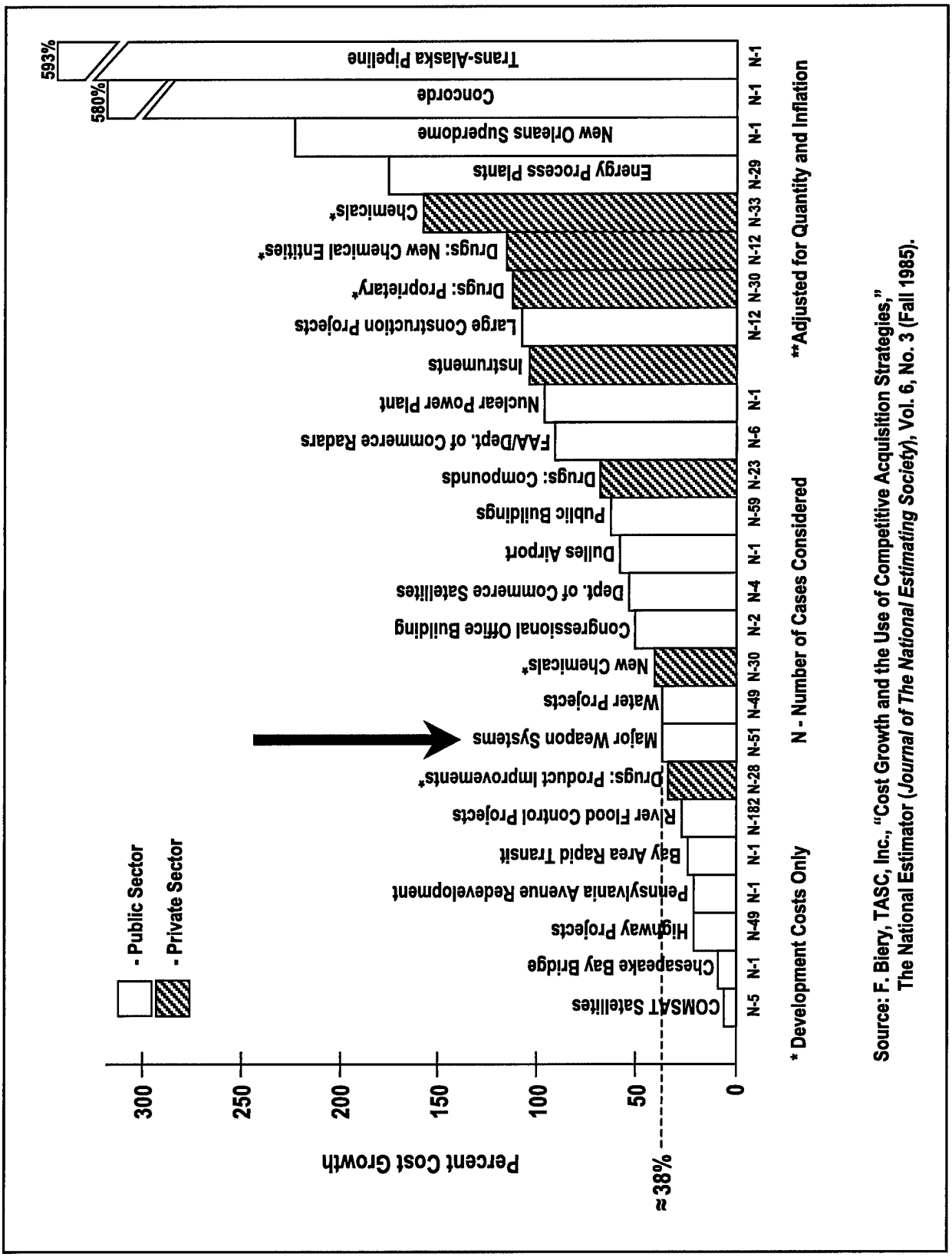


FIGURE 4. Average Cost and Schedule Overruns by Service

DoD average cost and schedule overruns of 40 percent and 62 percent at first glance may not appear to be good. However, when you factor in complexity of the development, and schedule pressures this in fact may not be too bad. In fact, when compared to other major projects, DoD acquisition cost management is among the best. Figure 5 shows DoD major weapon systems to have a cost overrun of approximately 38 percent, close to our 40 percent figure.

Lastly, if cost and schedule overruns are looked at in Total Quality Management (TQM) terms, and if 100 percent overruns are considered the statistical process control acceptable limits of a DoD acquisition system under control, the average cost overrun is halved to 19 percent and the average schedule overrun drops to 34 percent. That is, we eliminate the nine programs that had cost or schedule overruns of over 100 percent. Programs over the acceptable process control limits could be handled by some other extraordinary process. Our research methodology allows the control



* Development Costs Only

N - Number of Cases Considered

**Adjusted for Quantity and Inflation

Source: F. Biery, TASC, Inc., "Cost Growth and the Use of Competitive Acquisition Strategies," The National Estimator (*Journal of The National Estimating Society*), Vol. 6, No. 3 (Fall 1985).

FIGURE 5. Cost Growth in Major Program Projects (TASC)**

limits to be set at any acceptable level and the resultant average cost and schedule overruns can be obtained.

EMD Duration. The original research report indicated that for 24 programs completing EMD between the years 1980 and 1993, the average duration of the EMD phase was 7.4 years. The most recent addition to this data shows that for 37 programs (including the original 24), completing EMD between 1980 and 1997, the average duration of the EMD phase was 7.8 years. This summary data can be broken down into year groups as well as planned and actual duration, and the ratio of actual to planned duration. The latter may be a rough estimate of the realism of the original program planning. Table 2 shows this data.

Year EMD Completed	Average EMD Duration		
	Planned	Actual	Ratio
1980-1988 (n =12)	4.2 yrs	6.5 yrs	1.6
1989-1992 (n =11)	4.9 yrs	8.0 yrs	1.7
1993-1996 (n =12)	5.8 yrs	8.7 yrs	1.6
1997 (n = 1)	5.0 yrs	7.9 yrs	1.6

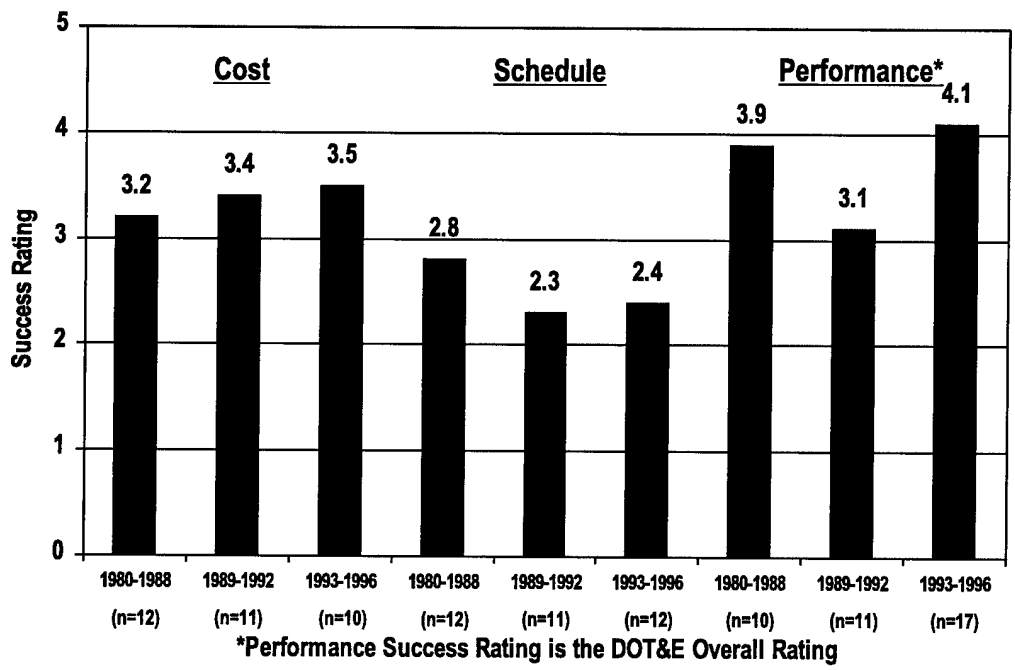
TABLE 2. Average EMD Duration

Success Ratings. Now we turn our attention to the inverse; cost, schedule and performance success rather than overruns. Table 3 contains the five success ratings used in this research. For each success rating level we indicate the number of programs in our spreadsheet that achieved that success rating in cost, in schedule, and in performance. For the performance rating we are using the success rating assigned to that program's DOT&E BLRIP report. This report goes directly to the Secretary of Defense and to the congressional committees concerned with DoD acquisition. In earlier times it was thought of as the "final exam." The average success ratings shown for the entire period 1980-1996, indicate performance is always rated highest and schedule is always rated lowest in success ratings. It seems reasonable to expect a high performance success rating since, after all, if the system did not essentially meet specifications it would not be accepted. Figure 6 (depicting the average success ratings by year the EMD phase ended) shows again that during the Cold War years schedule adherence was greater than more recent years. And, cost success has been greater in the post Cold War period. Figure 7 shows success ratings by Service. Relatively equal cost success ratings are shown for all Services. The Air Force appears to have the least schedule success and the greatest performance success.

Program Success Rating	Cost Success Rating	Schedule Success Rating	Performance Success Rating*
5. Very Successful (V.S.)	8	4	14
4. Successful (S.)	12	9	11
3. Fairly Successful (F.S.)	4	4	6
2. Marginally Successful (M.S.)	1	2	4
1. Not Successful (N.S.)	8	16	3
n =	33	35	38
Average Success Rating	3.3	2.5	3.8

*Performance Success Rating is the DOT&E Overall Rating

TABLE 3. Cost, Schedule and Performance Success Ratings
(Total Number of Programs Receiving Each Rating)



*Performance Success Rating is the DOT&E Overall Rating

FIGURE 6. Average Cost, Schedule and Performance*
Success Rating by Year EMD Phase Ended

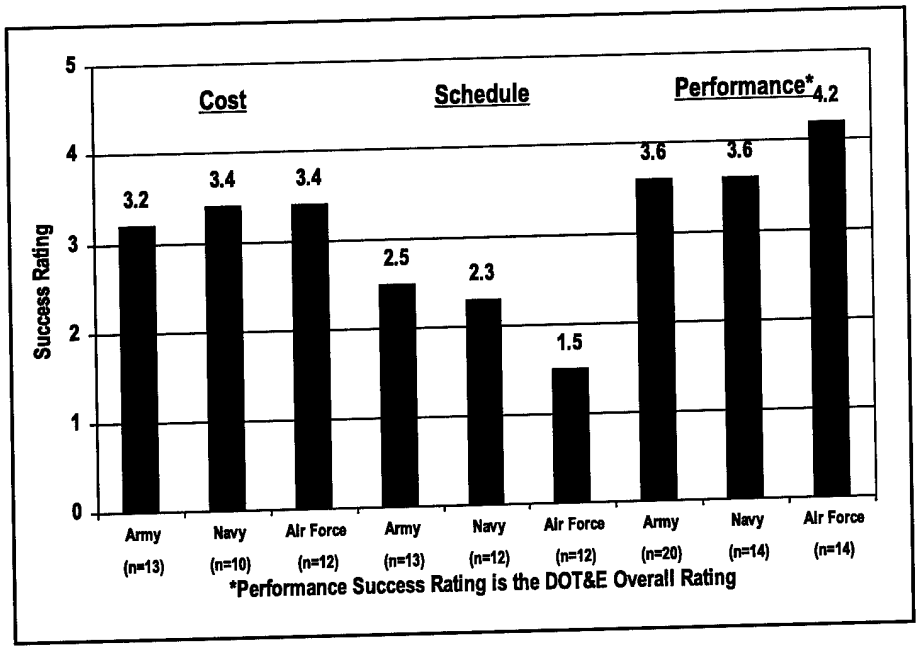


FIGURE 7. Average Cost, Schedule and Performance* Success Rating by Service

In our methodology we have assigned 5 points maximum for a Very Successful rating in cost, in schedule, and in performance. For the performance rating we are using the success rating assigned to that program's DOT&E BLRIP report. Thus, a "perfectly" successful program would achieve a total rating score of 15. A not successful program would achieve the minimum score possible of 3. Figure 8 shows the number of programs on the Y axis that have achieved the various total success ratings: 3 through 15 on the X axis. On first glance the majority of the programs have achieved success ratings of 9 or more.

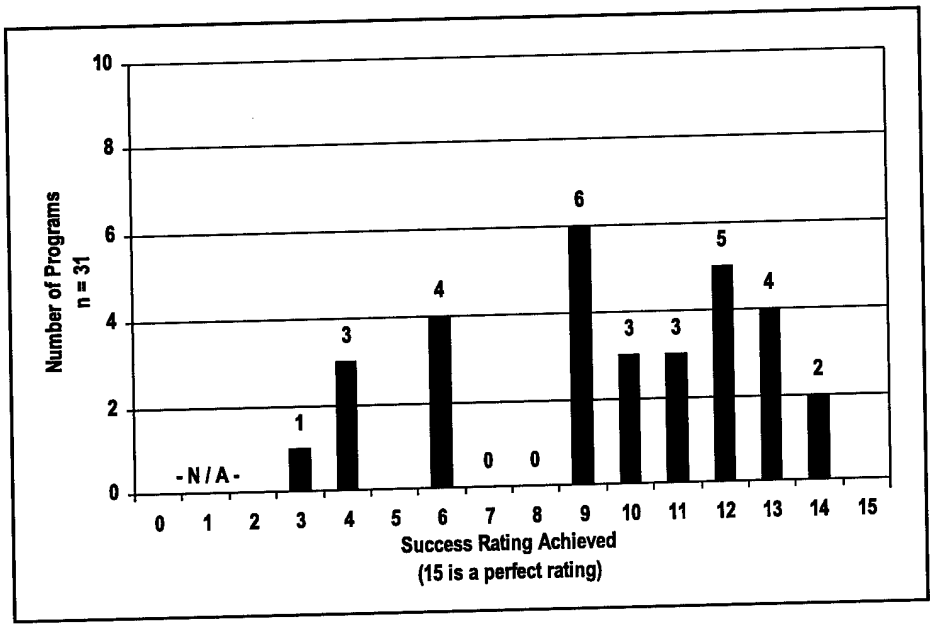


FIGURE 8. Overall EMD Success Rating

In our methodology we have assigned 5 points maximum for a Very Successful rating in cost, in schedule, and in performance. For the performance rating we are using the success rating assigned to that program's DOT&E BLRIP report. Thus, a "perfectly" successful program would achieve a total rating score of 15. A not successful program would achieve the minimum score possible of 3. Figure 8 shows the number of programs on the Y axis that have achieved the various total success ratings: 3 through 15 on the X axis. On first glance the majority of the programs have achieved success ratings of 9 or more.

Baselining Acquisition Reform. The methodology used in this research can be one method used to evaluate the effectiveness of the AR initiative. The process would consist of three steps. First, select the date that AR first was effective in the field, and measure the cost, schedule and performance success levels of DoD acquisition at that time. Second, over a period of time introduce the AR improvements/changes into the DoD acquisition system. And finally, at some appropriate later time remeasure the cost, schedule and performance success of the then DoD acquisition system.

The first step has already been accomplished and is completely detailed in an *Acquisition Review Quarterly* article approved for publication around January 2000. That article suggests that the date AR was first effective "in the workplace" was July, 1996, and at that time the DoD acquisition system, over the prior four years, had an average cost overrun of 46 percent and an average schedule overrun of 81 percent. Using this research success ratings of 5 down to 1, and showing percent equivalents we have the pre-AR baseline:

Parameter	Success Rating and Percent Equivalent	
Cost	3.5	(70 percent)
Schedule	2.1	(41 percent)
Performance	3.8	(76 percent)

In creating the database, it became clear that its usefulness in analyzing programs required that other parameters beyond cost, schedule and performance would be desirable. To identify what characteristics correlated with success in EMD, or with failure, possible causes had to be included in the collected data. In particular, six programmatics were included.

Average Tenure of the Program Manager. It has been held for some time that programs would be more in control if program managers were stabilized in position. To be able to examine this, the number of program managers during EMD was recorded. Average tenure was calculated by dividing the actual duration of EMD by the number of program managers that program had during EMD. This method of analysis results in an average PM tenure that is lower than the actual PM tenure over the entire life of the program. Our average PM tenure for the 34 programs was 31 months. Ron Fox in his book[16] states "...PMs averaged approximately 27 months on a given program as either the program manager or deputy program manager." Also General Lawrence Skantze, Commander of the Air Force Systems Command, is quoted as saying Air Force PMs average 29 months in the job. Our research indicates the average PM tenure now is over 31 months, but we could find no correlation between PM tenure and program EMD success.

Type of Contract. There are many opinions about what type of EMD contract is most likely to promise successful completion. To include this in any future analysis, the type of contract awarded for EMD was recorded. Firm Fixed Price (FFP), Fixed Price Incentive Fee (FPIF) and Cost Plus Incentive Fee (CPIF) had overall average EMD program success ratings of 9.2, 9.4, and 11.5 respectively out of a maximum of 15 points. Cost Plus Award Fee (CPAF) programs were conspicuously less successful at 6.6 points.

Competition. The pros and cons of having competition during EMD have been argued for years. To assist in this discussion, the presence or absence of competition in EMD was recorded. Programs that had competition in EMD achieved an average program success rating of 8.6 while programs that had no competition in EMD had a success rating of 9.9. However, the spread of high and low ratings in both cases, as well as other confounding concerns requires further analysis.

Number of Associate Contractors. It is commonly held that the complexity of a program, and therefor the likelihood of encountering difficulties, is related to the number of associated contractors. To be able to include this parameter in analysis, this number for EMD was collected. Our research looked at 27 programs that utilized from zero to eleven associate contractors. With one exception, all programs achieved relatively high program success ratings regardless of the number of associate contractors used.

Number of Production Quantity Changes. It is generally agreed that the more programmatic changes there are in a program, the more likely it is that the program will experience difficulties. One quantity which often reflects program success or failure is the number of production items. Changes in this quantity can reflect budget decisions, performance in testing, or need for the item in the field. In order to include this as a reflection of program difficulty, the number of changes in production quantity was recorded. No meaningful conclusion could be drawn from analysis of this parameter.

SAR percent of Exception/Annual. Congress has established the SAR reporting requirements to include both routine (annual) and exception (breaches of cost or schedule baselines). The intent of exception reporting is to identify programs requiring special oversight. In order to analyze the success of this reporting requirement, it would be interesting to find if there is a correlation between the success of the program and the frequency of exception SAR reporting. Therefore, collected data included the number of annual SARs during EMD and the number of exception SARs during EMD. Since the analysis of this parameter should eliminate the variable of duration of EMD, the percent of exception SARs to annual SARs was calculated and included in the database. We discovered in the '80s several programs submitted quarterly SARs on a routine basis and our research to date did not distinguish between required exceptional SARs and routine quarterly SARs. For this reason, and others, no comment is made at this time.

Operational Test Metrics

Test Articles and Program Success. The original objective of this research was to determine the relationship, if any, between the number of test articles used in EMD and the success of that program in EMD. The original research report stated there was a tenuous positive correlation and went on to explain the many nuances and uncertainties associated with the relevant raw data. The current research

attempted to continue obtaining data in this area but uncertainties continued. For example, more recent SAR's contain the data "NFC," not fully configured. The presumption is they are units procured with engineering funds and used for testing, but this cannot be proven. Lastly, it was realized that the number of test articles was not as good a metric as the number of test hours. As a result, the conclusion is that the original and current research cannot provide an answer to the question.

Comparative Operational Test Data. The following sections discuss the comparison between the performance success ratings assigned to test reports issued by the Service OTAs and the performance success rating assigned to the independent BLIP evaluation report of the DOT&E. Both OTA test reports and DOT&E BLRIP evaluations discuss and evaluate Operational Effectiveness and Operational Suitability. Both generally have an overview/conclusions section. Therefore in our research we have assigned a success rating (5 down to 1), for operational effectiveness, operational suitability, and a subjective third rating for Overall Effectiveness. This latter rating attempts to evaluate and record the executive comments usually found in operational test reports or evaluations. Thus the maximum success rating for an OTA report or a DOT&E evaluation is 15; a score of 3 is minimum. This comparison between OTA and DOT&E is considered to be of interest to the management of both organizations. Also it provides data to resolve the perception a few years ago that "DOT&E routinely rubber stamps the results of IOT&Es."

Figure 9 shows the number of times/programs that OTA ratings agreed or disagreed with DOT&E evaluations. For example, out of 34 programs, there were 5 times/programs where the OTA performance success rating was exactly equal to the DOT&E evaluation. The predominant rating, in 10 times/programs was a difference of 2 success rating points between OTA and DOT&E. With equal ratings in only 5 of 31 instances, and with a surprising difference of 7 rating points (out of 15) in three cases, it seems difficult to say "DOT&E rubber stamps OTA reports." Figure 10 looks at the same difference in ratings by year the EMD phase ended. Figure 11 looks at the data by individual Service.

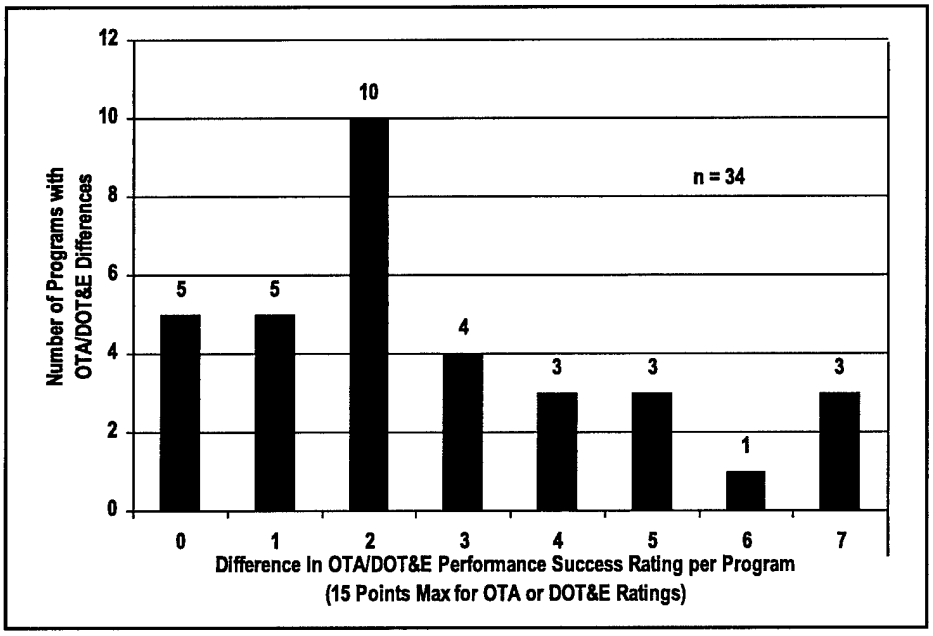


FIGURE 9. Analysis of OTA/DOT&E Performance Success Rating Differences

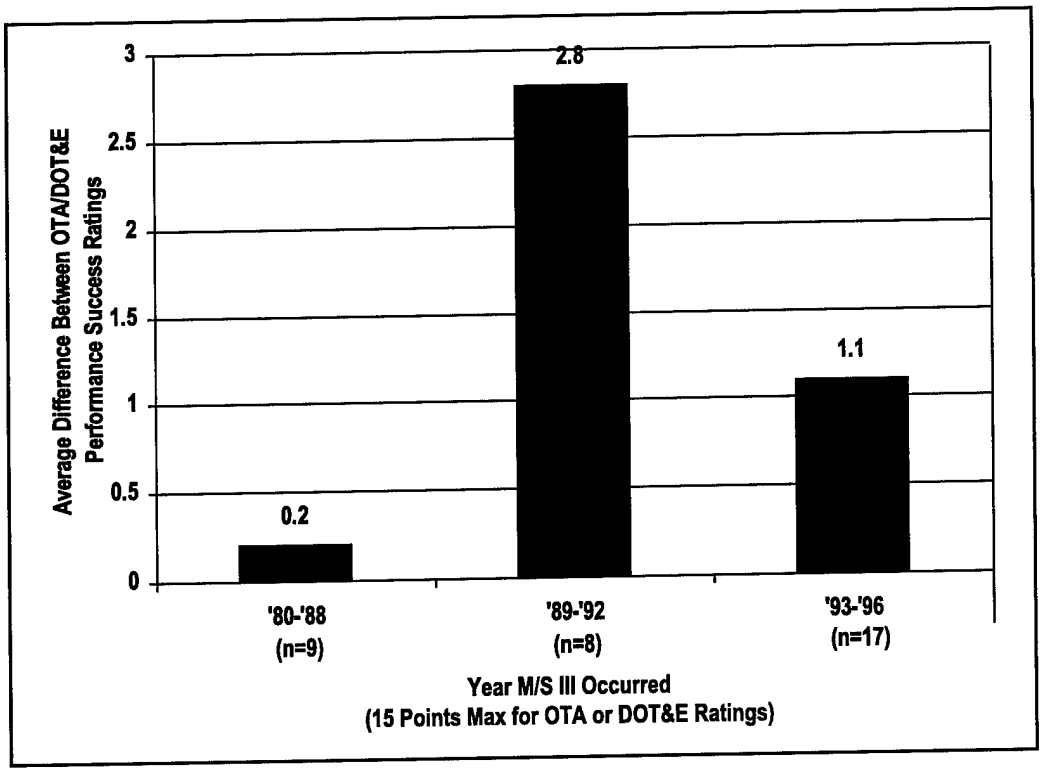


FIGURE 10. Analysis of the Average Difference Between OTA/DOT&E Performance Success Ratings—By Year EMD Phase Ended

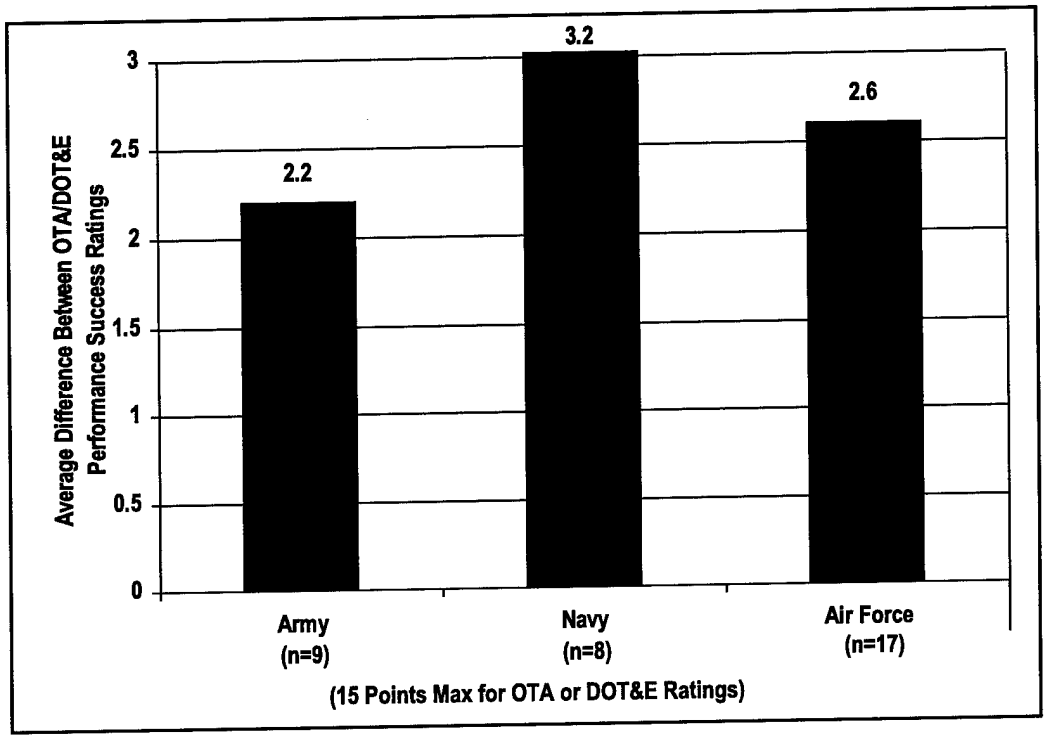


FIGURE 11. Analysis of the Average Difference Between OTA/DOT&E Performance Success Ratings—By Service

To date we have discussed relative differences between the success ratings the research team has assigned to IOT&E reports and BLRIP evaluations. What is not visible is which organization does the research team feels rates higher or lower? Figures 12-18 are designed to show this interesting data.[17] For the entire period, 1980-1996, Figure 12 shows the relative success ratings assigned by the research team to OTA reports and DOT&E evaluations. The diagonal line indicates equal success ratings assigned to a program's OTA and DOT&E evaluations. A data point above the line indicates the research team evaluated the OTA report more highly (positive) than the DOT&E evaluation. Below the line the reverse is true. An impression of Figure 12 is that the OTA reports were generally rated more positive. Also, where the DOT&E reports were rated more positive, the ratings were all at the upper range of the scale; 11 or more. Figures 13-15 show the same data by year the EMD phase ended. In Figure 14 for the time period 1989-1992, all data indicates the research team evaluated the OTA reports to be more positive than the DOT&E evaluations. Figures 16-18 indicate the same data by Service with no significant difference discernable.

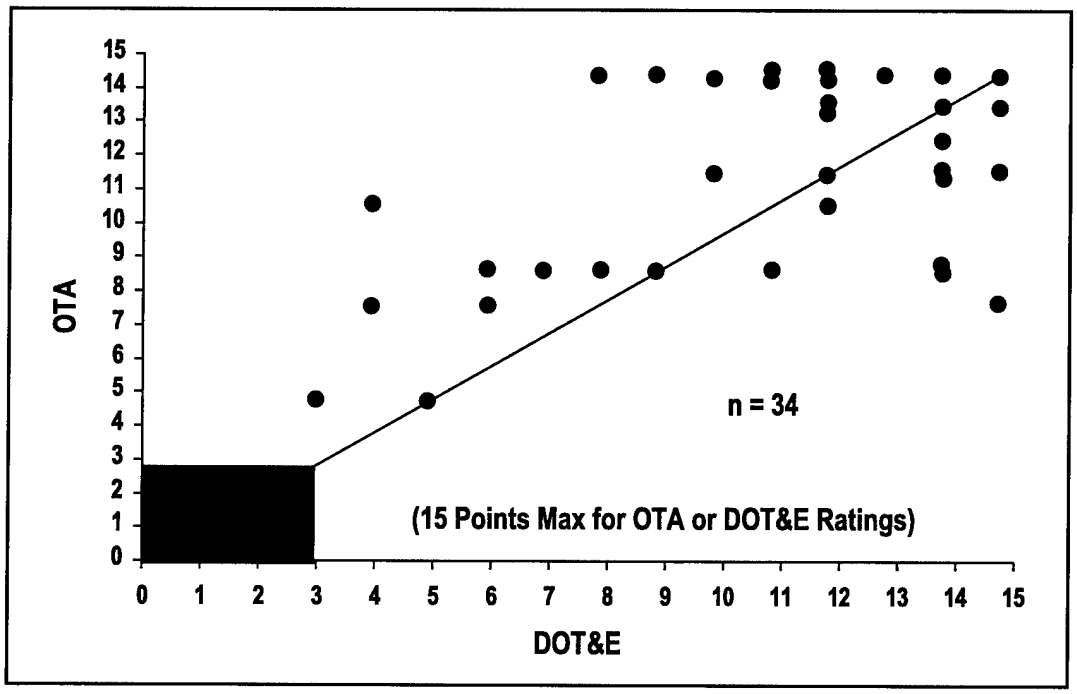


FIGURE 12. Analysis of OTA/DOT&E Performance Success Ratings

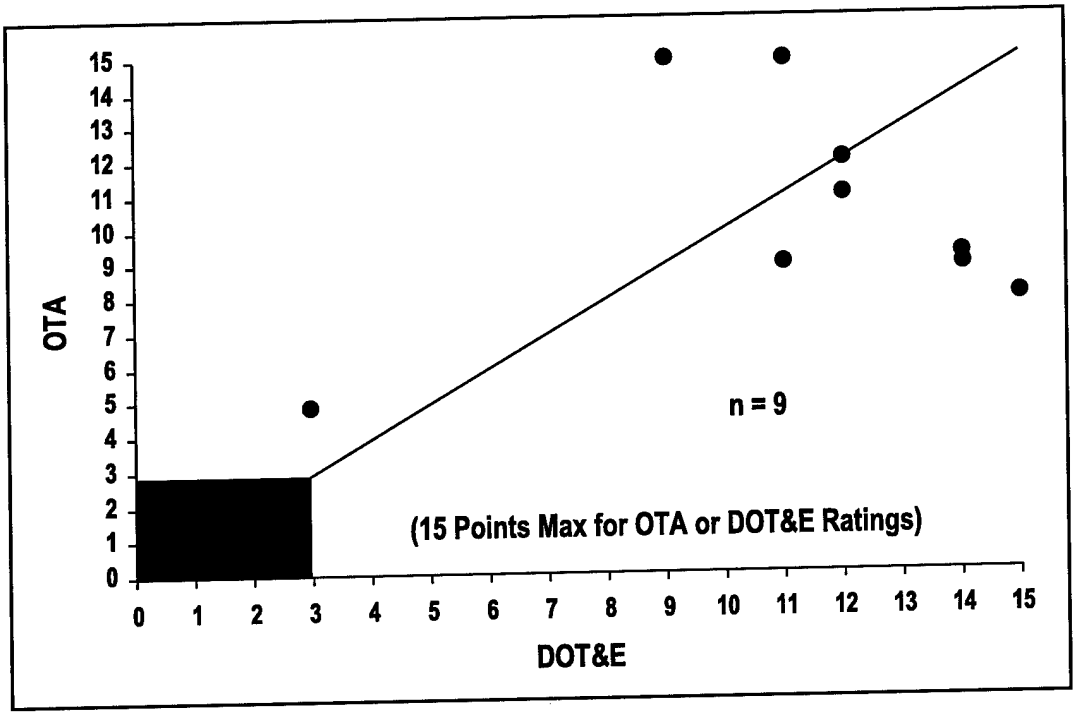


FIGURE 13. Analysis of OTA/DOT&E Performance Success Ratings for Programs whose EMD Phase Ended between 1980-88

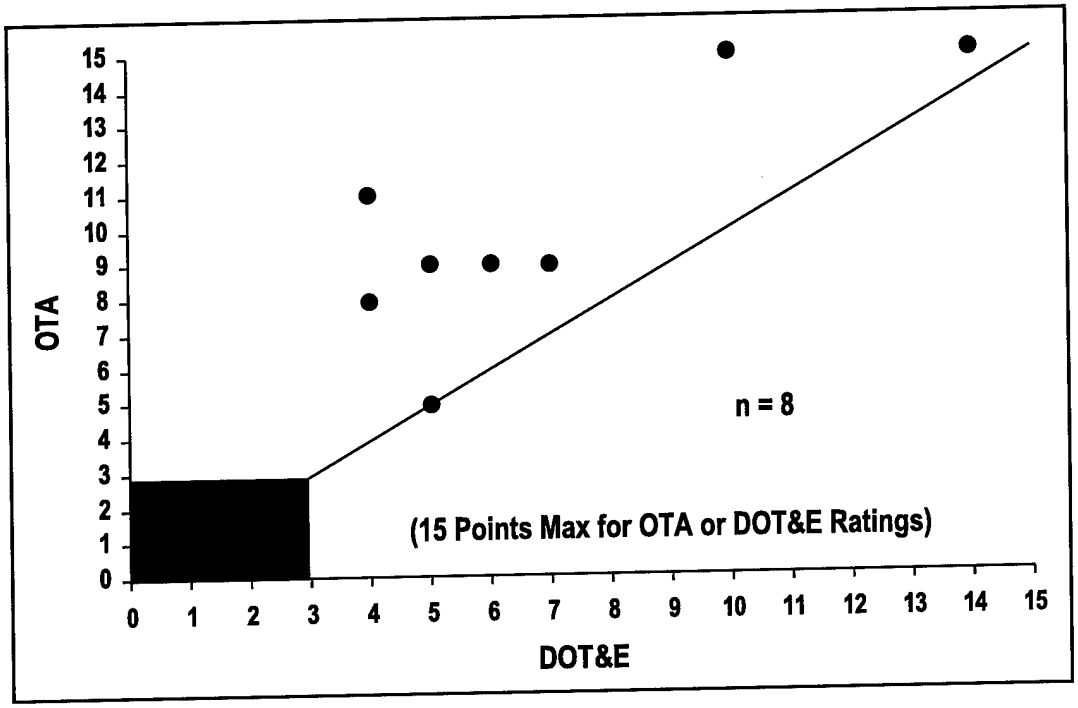


FIGURE 14. Analysis of OTA/DOT&E Performance Success Ratings for Programs whose EMD Phase Ended between 1989-92

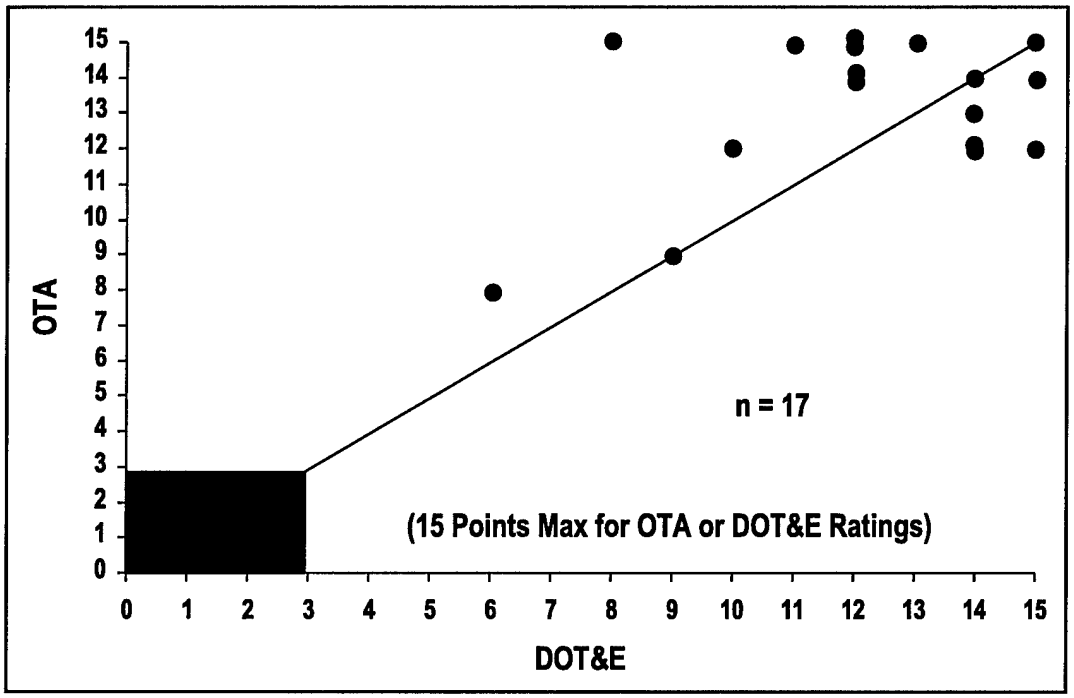


FIGURE 15. Analysis of OTA/DOT&E Performance Success Ratings for Programs whose EMD Phase Ended between 1993-96

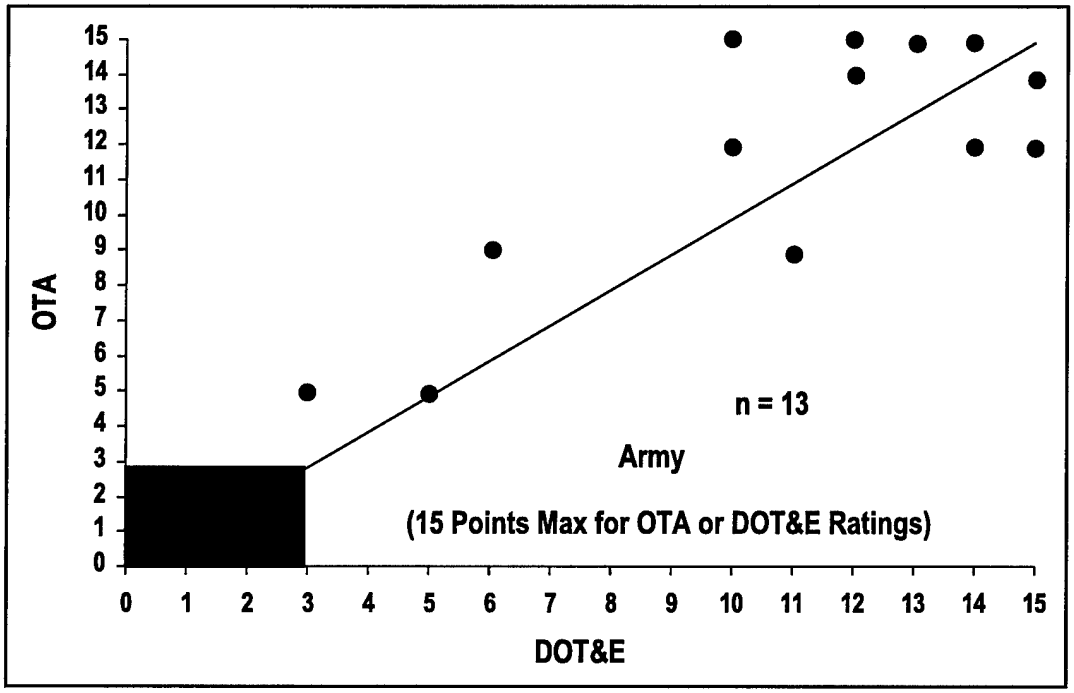


FIGURE 16. Analysis of OTA/DOT&E Performance Success Ratings for Programs for Service—Army

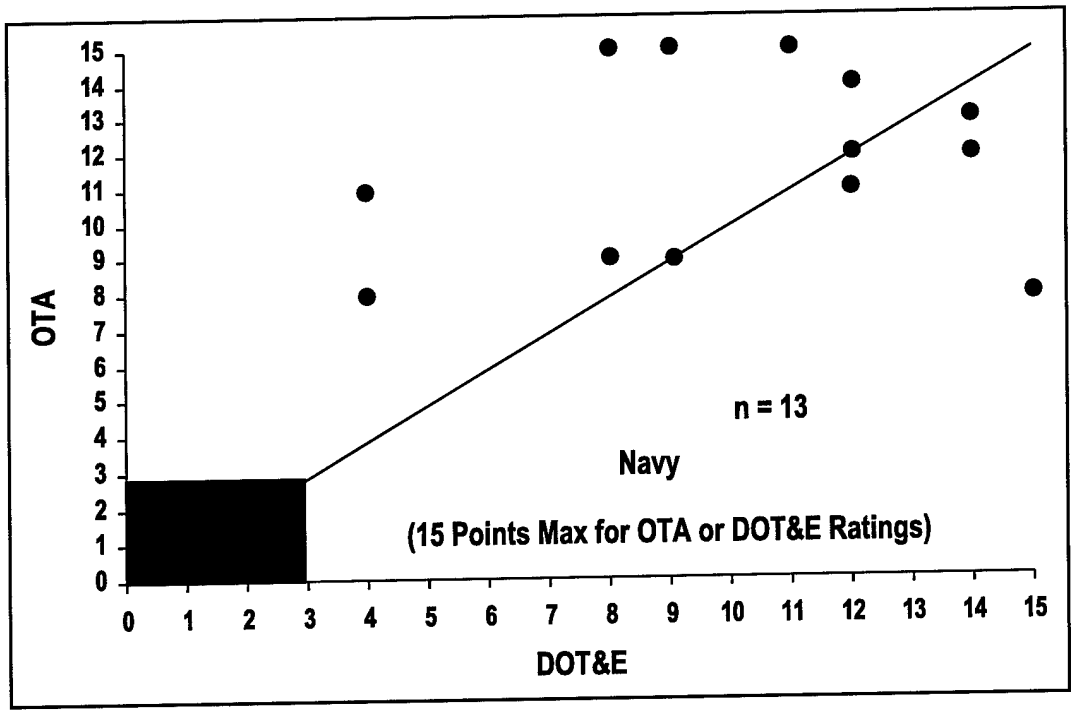


FIGURE 17. Analysis of OTA/DOT&E Performance Success Ratings for Programs for Service—Navy

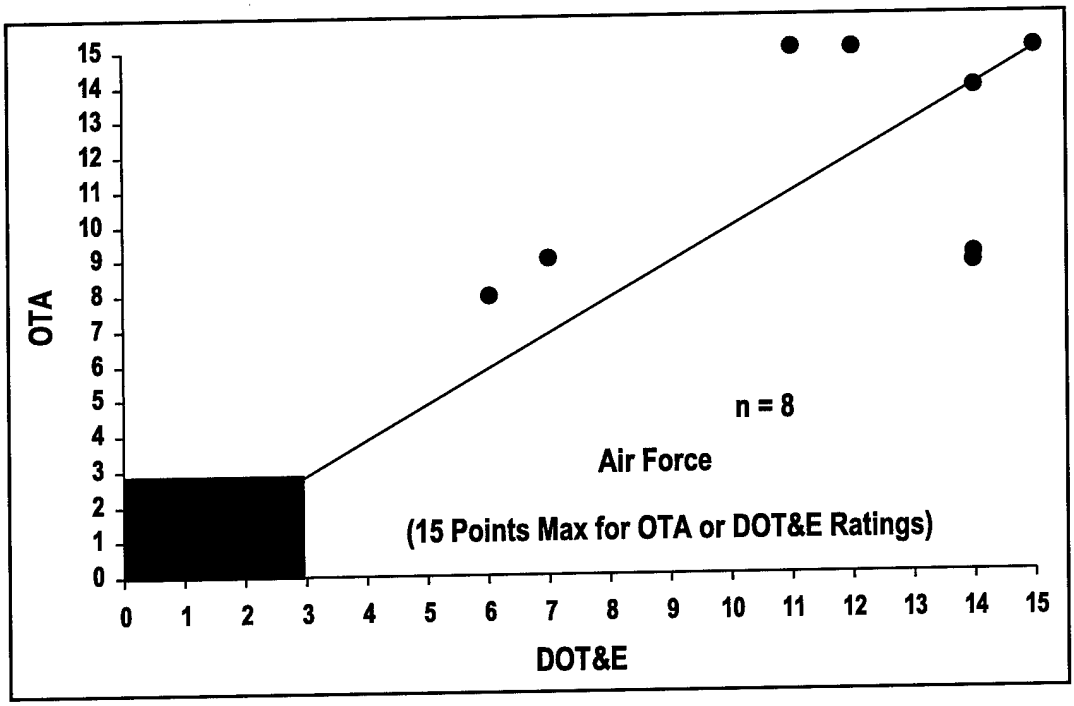


FIGURE 18. Analysis of OTA/DOT&E Performance Success Ratings for Programs for Service—Air Force

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- This trend data is informative and can be used to focus managerial change efforts. The end of the Cold War (1989) appears to have had a significant impact on cost and schedule data.

- The DoD 1980-1996 average EMD cost and schedule overruns were 40 percent and 62 percent respectively. This compares favorably with other government and private complex development projects.

- The duration of the EMD phase has increased since 1980-88, but in 1997 the only currently entered data shows a reversal trend.

Recommendations

- Review the SAR format and required contents. The preparation instructions for SARs state "The results of operational testing will take highest precedence in determination of demonstrated performance." However, there is little or no requirement to include OT periods in the SAR schedule section. The sample SAR included in the DoD instructions require reporting only "DT/OT II Complete." Also, the degree of software required within the developing system is an important consideration affecting program success. The SAR requires no specific comments about software.

- SARs are required for ACAT I programs only. A report similar to the SAR should be required for less than ACAT I programs listed on the DOT&E Oversight List.

- This research data is contained on an Excel spreadsheet which limits analysis. A prototype advanced database has been developed to allow for multi-variate regression analyses, but is not funded at the present time.

- This factual data should be combined with other databases, similar research efforts, and existing analyses to develop "leading indicators" that might be used to predict program developmental success. This would include a more sophisticated database for this research data.

- Research should be initiated to compare and contrast the results of the ACTD initiative with the results of other systems being developed under the 5000 series regulations.

At some future date, the success of the current AR initiative should be measured using the methodology and baseline developed by this research effort.

END NOTES

[1]The U.S. Navy and U.S. Marine Corps call this specific phase of Operational Testing (OT), Operational Evaluation (OPEVAL). In prior years the Office of the Secretary of Defense (OSD) called this particular test the "final dedicated phase of operational testing prior to Milestone (MS) III."

[2]United States Code, Title 10, Section 2399.

[3]Conversations between Dr. E. Seglie, Science Advisor to the Director of Operational Test and Evaluation (DOT&E) and Professor R. Reig, Defense Systems Management College (DSMC).

[4]Gailey, C.K., Reig, R.W., Weber, W., and George, L.R. (1995). *A Study of the Relationship Between Initial Production Test Articles used in a System Development Program and the Success of that Program* (The DSMC Press, TR2-95) Fort Belvoir, VA.

[5]Each Service has an Operational Test Activity whose Commander reports directly to the military chief of that Service. The OTA is independent of the Program Manager and the Developing Agency.

[6]Department of Defense (1991). *Defense Acquisition Management Documentation and Reports, Part 17, Selected Acquisition Report* (DoD 5000.2-M). Washington, DC.

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[13]Fox, J. Ronald. *The Defense Management Challenge: Weapons Acquisition.* Boston: Harvard Business School Press, 1988, p. 64.

[14]*Ibid*, p. 72.

[15]*Ibid*, p. 142.

[16]Fox, p. 64.

[17]We are indebted to Dr. E. Seglie, Science Advisor to the DOT&E for this display concept.

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AUTHORS NOTES

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Major W. J. Swank is a professor of engineering management at DSMC. He is a graduate of Ohio Northern University, Troy State University, the Air Command and Staff College, and the DSMC Program Management Course. He is a member of the DSMC Test and Evaluation Department and has experience is weapon systems development, test and evaluation, and aircraft maintenance.

Dr. Paul Alfieri is a professor of engineering management at DSMC. He is a graduate of Virginia Tech, The George Washington University, the Naval Postgraduate School, the United States Naval Academy, and the DSMC Program Management Course. Dr. Alfieri was the third chairman of the Test and Evaluation Department and is now the Course Director for the Advanced Test and Evaluation Course (TST-301). He has more than 30 years' experience in Navy Fleet operations, weapon system development (aircraft and missiles), program management, and acquisition, fielding and support of Navy materiel.

CDR Suycott is a professor of engineering management at DSMC. He is a graduate of the University of Missouri, the Naval Postgraduate School, the U.S. Naval Test Pilot School, and the DSMC Program Management Course. He is a member of the DSMC Test and Evaluation Department and has experience in weapon systems development, flight test and evaluation, systems engineering, program management, and naval aviation operations.

APPENDIX A
DEFINITIONS

Acquisition Category (ACAT)

ACAT I – programs are Major Defense Acquisition Programs (MDAPs). An MDAP is defined as a program estimated by the Under Secretary of Defense (Acquisition and Technology) (USD(A&T)) to require eventual expenditure for research, development, test, and evaluation of more than $355 million (fiscal year (FY) 96 constant dollars) or procurement of more than $2.135 billion (FY96 constant dollars), or those designated by the USD(A&T) to be ACAT I.

ACAT II – programs are defined as those acquisition programs that do not meet the criteria for an ACAT I program, but do meet the criteria for a major system. A major system is defined as a program estimated by the DoD Component Head to require eventual expenditure for research, development, test, and evaluation of more than $135M in FY96 constant dollars, or for procurement of more than $640M in FY96 constant dollars, or those designated by the DoD Component Head to be ACAT II.

ACAT III – programs are defined as those acquisition programs that do not meet the criteria for an ACAT I, or an ACAT II. The MDA is designated by the CAE and shall be at the lowest appropriate level. This category includes less-than-major AISs.

ACAT IV (Army only) – ACAT programs in the Army not otherwise designated as ACAT I, II or III are designated ACAT IV. ACAT IV programs are managed by a systems manager within a materiel command as opposed to ACAT I-III programs which are managed by a PM.

ACAT IV (Navy and Marine Corps only) – ACAT programs in the Navy and Marine Corps not otherwise designated as ACAT I, II or III are designated ACAT IV. There are two categories of ACAT IV programs: IVT and IVM. ACAT IVT programs require operational test and evaluation while ACAT IVM programs do not.

Advanced Concept Technology Demonstration (ACTD) – A means of demonstrating mature technology to address critical military needs. ACTDs themselves are not acquisition programs, but are designed to provide a residual, usable capability upon completion, and/or transition into acquisition programs. Funding is programmed to support two years in the field. ACTDs are funded with Advanced Technology Development (ATD) funds.

Acquisition Reform – An ongoing series of initiatives sponsored by OSD (especially USD(A&T) and DUSD(AR)) to streamline and tailor the acquisition process. Initiatives include statutory and regulatory reform, CAIV, reform of specifications and standards policy, preference for commercial items, electronic data interchange and the use of the IPPD/IPT management philosophy for systems development and oversight.

Beyond Low Rate Initial Production (BLRIP) – (See LRIP below). When a developing system seeks a decision to go into full rate production (FRP), the DOT&E must provide a report to Congress and the Secretary of Defense. This report is commonly called the "Beyond LRIP" report.

Blue Books – The name commonly given to the books prepared for the members of the Defense Acquisition Board (DAB) prior to Milestone Decision Meetings. They contained the major data such as planned cost and schedule for the system under review. These books were discontinued in 1993.

Cost As an Independent Variable (CAIV) – Methodologies used to acquire and operate affordable DoD systems by setting aggressive, achievable life cycle cost objectives, and managing achievement of these objectives by trading off performance and schedule, as necessary. Cost objectives balance mission needs with projected out-year resources, taking into account anticipated process improvements in both DoD and industry. CAIV has brought attention to the government's responsibilities for setting/adjusting life-cycle cost objectives and for evaluating requirements in terms of overall cost consequences.

Director, Operational Test and Evaluation (DOT&E) – The senior individual within the Office of the Secretary of Defense responsible for operational testing policy and oversight. This position is mandated by law, 10USC2366.

Initial Operational Test and Evaluation (IOT&E) – Operational test and evaluation conducted on production, or production representative articles, to determine whether systems are operationally effective and suitable, and which supports the decision to proceed beyond low rate initial production (LRIP). The Navy calls this test OPEVAL, Operational Evaluation.

Integrated Product and Process Development (IPPD) – A management technique that simultaneously integrates all essential acquisition activities through the use of multidisciplinary teams to optimize the design, manufacturing, and supportability processes. IPPD facilitates meeting cost and performance objectives from product concept through production, including field support. One of the key IPPD tenets is multidisciplinary teamwork through Integrated Product Teams (IPTs).

Integrated Product Team (IPT) – Team composed of representatives from appropriate functional disciplines working together to build successful programs, identify and resolve issues, and make sound and timely recommendations to facilitate decision making. There are three types of IPTs: overarching IPTs (OIPTs) focus on strategic guidance, program assessment, and issue resolution; working level IPTs (WIPTs) identify and resolve program issues, determine program status, and seek opportunities for acquisition reform; and program level IPTs focus on program execution and may include representatives from both government and after contract award industry.

Low-Rate Initial Production (LRIP) – The minimum number of systems (other than ships and satellites) to provide production representative articles for operational test and evaluation (OT&E), to establish an initial production base, and to permit an orderly increase in the production rate sufficient to lead to full-rate production upon successful completion of operational testing. For

major defense acquisition programs (MDAPs), LRIP quantities in excess of 10 percent of the acquisition objective must be reported in the selected acquisition report (SAR). For ships and satellites LRIP is the minimum quantity and rate that preserves the mobilization base.

Milestone Decision Authority (MDA) – The individual designated in accordance with criteria established by the USD(A&T), or by the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) (ASD (C^3I)) for automated information system (AIS) acquisition programs, to approve entry of an acquisition program into the next phase (DoD 5000.2-R).

Operational Test Activities (OTAs) – Each Service organizationally has an independent activity charged with the conduct and evaluation of operational testing within that Service. The Commander of the OTA is usually a two-star General or Flag officer.

Selected Acquisition Reports (SAR) – Standard, comprehensive, summary status reports on major defense acquisition programs (MDAPs) (Acquisition Category (ACAT) I) required for periodic submission to the Congress. They include key cost, schedule, and technical information.

DoD Directive (DoDD) 5000.1 "Defense Acquisition" – The principal DoD directive on acquisition, it states policies and principles for all DoD acquisition programs and identifies the Department's key acquisition officials and forums.

DoD Regulation 5000.2-R "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs" – Sets forth mandatory procedures for MDAPs and MAISs and, specifically where stated, for other than MDAPs or MAISs. Authorizes milestone decision authorities (MDAs) to tailor procedures as they see fit, consistent with statutory requirements.

APPENDIX B
CORRELATION OF COST DATA SOURCES

Cost Success as measured under the previous method, compared to Cost Success as measured under the present method.

Previous method (as used in the 1995 Technical Report) collected all the costs identifiable to EMD.

Present method collects only RDT&E Appropriation costs identifiable to EMD.

Cost Success assigns a rating (5 to 1) based on how close actual costs were to plan.

Rationale for change: using all EMD costs puts too much weight on Procurement Appropriation variance, since Procurement costs generally are much higher than RDT&E costs. Program cost success thus becomes LRIP success.

Program #	Previous Rating	Present Rating
8	5	5
9	5	5
11	5	5
12	4	4
13	5	4
14	5	4
15	5	4
16	4	4
17	2	2
19	3	4
20	5	5
21	1	1
22*	5	3
23	1	1

Programs with the same rating:	9	64%
Programs with the present rating 1 higher:	1	7%
Programs with the present rating 1 lower:	3	21%
*Programs whose ratings differ by 2:	1	7%

(this is B-1B, and the difference may be due to program redefinition)

Programs whose ratings differ by 0 or 1:	13	93%

APPENDIX C

Spreadsheet Column Descriptions

Notes

Spreadsheet

SPREADSHEET COLUMN DESCRIPTIONS

As of 1 July 1999

= Computer Generated Item

Primary Spreadsheet

Column No.	Description
1	Program Name
2	Program Number (Chronologically by MS III date)
3	System Type
4	The actual date of the MS III DAB or Full Rate Production (FRP) decision
5	Notes (see Table of Notes)
6	The DoD Component or Lead Service
7	The Program EMD budget success rating assigned (see the study criteria)
8	The actual percentage the program overran the planned EMD budget ((Col 21 – Col 20 divided by Col 20) X 100) *
9	The Program EMD schedule success rating assigned (see the study criteria)
10	The actual percentage the program overran the planned EMD schedule ((Col 17 – Col 16 divided by Col 16) X 100) *
11	The Program EMD performance success rating assigned by the T&E Dept. Subject-Matter Expert (SME) Panel after analyzing the Service Operational Test Activity (OTA) IOT&E or OPEVAL or TER report following study criteria. Success ratings for effectiveness, suitability, and overall success are assigned.
12	The Program EMD performance success rating assigned by the T&E Dept. SME Panel after analyzing the DOT&E BLRIP evaluation report. The same three success rating categories used for OTA reports are used here.

Expanded Spreadsheet

Column No.	Description
13	The actual date of the MS II DAB meeting
14	The planned date (at MS II) for the program MS III DAB
15	The actual date of the MS III DAB (or equivalent for the Full Rate Production (FRP) decision)
16	The planned duration of EMD in years (Col 14 – Col 13) *
17	The actual duration of EMD in years (Col 15 – Col 13) *
18	The ratio of actual duration of EMD to the planned duration (Col 17 divided by Col 16) *
19	The actual months the program overran the planned EMD schedule (Col 17 – Col 16) *
20	The planned RDT&E cost of EMD as estimated at MS II (TY$)
21	The actual RDT&E cost of EMD as reported at MS III (TY$)
22	The ratio of the actual RDT&E cost of EMD to the planned cost (Col 21 divided by Col 20) *
23	The planned EMD Procurement Cost as reported at MS II
24	The actual EMD Procurement Cost as reported at MS III
25	The total program Procurement Cost as reported at MS III
26	Percentage of EMD Procurement Costs to total Procurement Costs ((Col 24 divided by Col 25) X 100) *
27	The total actual program costs as reported at MS III (Col 21 + Col 25) *
28	Percentage of EMD costs to total program costs ((Col 21 + Col 24 divided by Col 25) X 100) *
29	The number of Program Managers assigned in EMD
30	The average tenure (years) of PMs assigned during EMD (Col 17 divided by Col 29)
31	The number of annual Selected Acquisition Reports (SARs) issued covering EMD
32	The number of Exception SARs during EMD
33	The percentage of Exception SARs to Annual SARs ((Col 32 divided by Col 31) X 100) *
34	The number of LRIP systems purchased in EMD with RDT&E funds and presumably used for testing
35	The number of LRIP systems purchased in EMD with Procurement funds, and presumably used for other than test purposes
36	The total LRIP systems purchased in EMD (Col 34 + Col 35) *
37	Total planned quantity at MS II
38	Total actual quantity at MS III
39	Percent change in quantity from MS II to MS III ((Col 37 – Col 38 divided by Col 37) X 100) *
40	Number of changes to planned procurement quantity during EMD

41 The percentage of LRIP RDT&E funded systems to the total actual procurement at MS III ((Col 34 divided by Col 38) X 100) *

42 The percentage of LRIP Procurement funded systems to the total actual procurement at MS III ((Col 35 divided by Col 38) X 100) *

43 The percentage of total LRIP systems purchased in EMD to total actual procurement at MS III ((Col 36 divided by Col 38) X 100) *

44 The percentage of RDT&E funded systems to total EMD systems ((Col 34 divided by Col 36) X 100) *

45 The system is being developed as a Multi-Service (Joint) program? Yes/No

46 Advanced Concept Technology Demonstration (ACTD) or a special exception program? Yes/No

47 The duration of ACTD in years

48 Yes indicates the DOT&E issued a "Beyond LRIP" report

49 Indicates whether the program is a major modification (Yes) or a new development (No) in EMD

50 Indicates whether the SARs or OT reports record the number of Software Lines of Code associated with the program

51 The Program Manager's estimate of (technical) risk as stated at MS II

52 Indicates whether the program used prime contractor competition in the Program Definition/Risk Reduction (PDRR) phase

53 Indicates whether the program used prime contractor competition in the EMD phase of the program

54 Indicates the type of contract used in EMD. (FFP= Firm Fixed Price, FPI = Fixed Price Incentive, CPIF = Cost Plus Incentive Fee, CPAF = Cost Plus Award Fee)

55 Number of associate contractors used at the prime system level, WBS Level II or III

56 Was Early Operational Assessments (EOA) or Operational Assessments (OA) used? Y/N

57 Was combined DT/OT used, and mentioned in the SARs or OT reports

58 Number of Critical Operational Issues, Effectiveness (COI(E)) shown in OT report

59 Number of Critical Operational Issues, Suitability (COI(S)) shown in the OT report

60 The planned start date of IOT&E/OPEVAL

61 The actual start date of IOT&E/OPEVAL

62 The planned end date of IOT&E/OPEVAL

63 The actual end date of IOT&E/OPEVAL

64 The ratio of the actual duration of the IOT&E/OPEVAL test to the planned duration (Col 61 to Col 63 time interval divided by Col 60 to Col 62 time interval) *

NOTES

7/1/99

X = Data not available; usually program had no SAR.
N/A = Data not applicable.

1. Service IOT&E or OPEVAL Report was not available.
2. Evaluation rating based on DOT&E Annual Report.
3. Anti-SATellite (ASAT); MS III was scheduled for Mar 88, but in Dec 87 the program was terminated due to Congressional moratorium on space testing.
4. TRI-service TACtical (TRITAC) switch; insufficient data in the FY86 DOT&E Annual Report to evaluate this program.
5. This is the first MAISARC program subject to evaluation by DOT&E.
6. SAR Production Baseline Estimate established at MS IIIA.
7. SINgle Channel Ground/Air Radio System (SINCGARS); this program had no EMD phase and therefore is not comparable.
8. BLRIP Report written and included in 1990 DOT&E Annual Report, but only submitted to Congress in February 1994.
9. Cost data from Blue Books; "EMD RDT&E $" are totals, not RDT&E only.
10. Joint Tactical Information Display System; OTA performance rating based on OPEVAL Report (OT-IIE) dated 19 October 1994.
11. Full Rate Production ADM issued 18 October 1995 without a formal DAB meeting.
12. Not used.
13. Not used.
14. Forward Area Air Defense Command, Control, Communication, Intelligence (FAAD C^3I) and Ground Based Sensor (GBS).
15. Advanced Field Artillery Tactical Data System (AFATDS).
16. OPEVAL results are from FOT&E dated 28 Feb 96.
17. Enhanced Position Location and Reporting System (EPLRS).
18. Joint Tactical Information Display System (JTIDS) Class 2 Terminals.
19. Airborne Warning and Control System-Radar System Improvement Program (AWACS-RSIP).
20. Joint Direct Attack Munition (JDAM).
21. DIVision Air Defense (DIVAD); this program was terminated on 27 Aug 85 after 64 units were delivered and 3 years after MS III.
22. IOT&E results are from System Assessment dated Nov 97.
23. Program didn't require a SAR; therefore, no cost, schedule or extended data base information is available.
24. Final SAR data currently not available.
25. This program was 91% through EMD before its first SAR was issued. No complete EMD trend data is available.
26. Not used.
27. Not used.
28. IOT&E data not available from SAR schedule.
29. This program had multiple cost and technical variations and aspects. It is difficult to analyze using SAR data only.
30. Combat Service Support Control System (CSSCS).

31. Ship Self-Defense System (SSDS).
32. Joint Stand-Off Weapon (JSOW).
33. Secure, Mobile, Anti-Jam, Reliable Tactical Terminal (SMART-T).
34. Close Combat Tactical Trainer (CCTT).
35. Army Tactical Missile System (ATACMS).
36. B-1B Block D Conventional Munitions Upgrade Program (CMUP).
37. Not used.
38. This program was terminated while in EMD. The data contained within the SARs make it difficult to determine cost and schedule overruns accurately. Analyst estimates are used and explained in the research office files. Cost and schedule success ratings, however, are accurate. Only RDT&E funds are shown in the SARs.
39. Costs are then-year RDT&E for a/c and Defensive Avionics System CORE program until terminated. No MS III stated in SAR; end of IOT&E used for schedule overrun.
40. MS IIIB DAB held May 91 resulted in approval to continue LRIP until the BLRIP report was submitted to Congress. This date is used to end EMD for this program.
41. This was an NDI program and the use of RDT&E funds for cost considerations may no be representative.
42. The production program was terminated. End of EMD is taken as the date the contract for remaining LRIP items was signed.
43. MS II date was Apr 83, but the first SAR was 12/89 due to special access program start.
44. Program featured NDI strategy and the SARs went from a planning estimate to the production estimate without a development estimate.
45. MS II was Sept 82, but the first SAR was 12/85.
46. MS II was Feb 80, but the first SAR was 12/83.

1	2	3	4	5	6	7	8	9
Program	Program Number	System Type	MS III Date Actual	Notes	Service	Cost Success	Cost Percent Overrun	Schedule Success
ALCM	1	Mis/Mu-A	Apr-80	2, 9	Navy	3	45	4
TTC-39 (TRI-TAC Switch)	2	Elec-CNR-G	Jul-80	4, 9, 23	Army	1	71	2
SGT YORK gun (DIVAD)	3	Mis/Mu-G	May-82	9, 21	Army	1	64	2
JTIDS (Class 2 terminals)	4	Elec-CNR-A	Oct-93	9	AF	1	319	1
AV-8B (Harrier II)	5	Aircraft	May-85	9	Navy	4	27	4
OH-58D/AHIP	6	Elec-CNR-A	Oct-85	9	Army	4	13	4
Maverick AGM-65D (IIR)	7	Mis/Mu-A	Mar-86	9	AF	4	7	1
LANTIRN (Nav & Tgt)	8	Elec-CNR-A	Nov-86	9	AF	5	-5	2
Trident II msl (D-5)	9	Mis/Mu-G	Apr-87	2	Navy	5	-7	4
Tomahawk (TASM & TLAM-C)	10	Mis/Mu-G	Sep-87	9	Navy	1	68	1
CV HELO (SH-60F)	11	Elec-CNR-A	Mar-88	1	Navy	5	-8	5
ASAT (AF)	12	Mis/Mu-A	Mar-88	3, 46	AF	4	20	3
MK 48 ADCAP	13	Mis/Mu-G	Jan-89	45	Navy	4	13	1
Avenger (Ped Mtd Stinger)	14	Mis/Mu-G	Apr-90	44	Army	4	16	4
ATACMS	15	Mis/Mu-G	Nov-90		Army	4	12	3
ACM	16	Mis/Mu-A	Jul-91	1, 43	AF	4	4	3
MK 50 Torpedo (ALWT)	17	Mis/Mu-G	Sep-91	2, 42	Navy	2	48	1
Navstar GPS/U.E.	18	Elec-CNR-A	Jan-92	1, 9, 29	AF	5	-1	1
AMRAAM	19	Mis/Mu-A	Apr-92	1, 40	AF	4	16	1
PLS (FHTV) (NDI)	20	Vehicle	Dec-92	41	Army	5	-5	2
FAADS LOS-F-H (ADATS)	21	Mis/Mu-G	Dec-92	2	Army	1	63	1
B-1B Lancer (ALQ-161)	22	Elec-EW-A	Dec-92	2, 36, 39	AF	3	41	1
ASPJ (ALQ-165)	23	Elec-EW-A	Dec-92	30, 38	Navy	1	65	1
CHCS S/W Ver 4.01	24	AIS	Dec-92	1, 5, 23	OSD	X	X	X
VLASROC	25	Mis/Mu-G	May-93	23	Navy	X	X	X
NESP (AN/VSC-38V)	26	Elec-CNR-G	May-93	6, 25	Navy	X	X	4
Paladin M109A6	27	Vehicle	Jun-93	23	Army	X	X	X
SINCGARS	28	Elec-CNR-G	Sep-93	7	Army	X	X	X
Rolling Airframe Missile	29	Mis/Mu-G	Dec-93	8, 23	Navy	X	X	X
M1A2 Tank	30	Vehicle	Apr-94	29	Army	4	12	5
T45TS	31	Aircraft	Jan-95	28	Navy	4	29	1
JTIDS (Cl 2/2H)	32	Elec-CNR-A						
FAAD C3I and GBS	33	Elec-CNR-G	Apr-95	14, 29	Army	4	31	1
FMTV	34	Vehicle	Aug-95		Army	3	39	1
Longbow Apache (AH-1)	35	Elec-CNR-A	Oct-95	11	Army	5	-37	5
C-17A	36	Aircraft	Nov-95	6	AF	3	38	1
AFATDS	37	Elec-CNR-G	Dec-95	15	Army	5	3	2
Mk 48 ADCAPS Mods	38	Mis/Mu-G	Mar-96	16, 23	Navy	X	X	1
SFW	39	Mis/Mu-A	Jun-96		AF	1	125	2
Std Msl (SM-2) Blk III	40	Mis/Mu-G	Jul-96		Navy	5	3	1
JSTARS	41	Elec-CNR-A	Sep-96		AF	1	201	1
EPLRS	42	Elec-CNR-G	Mar-97	17, 23	Army	X	X	X
CSSCS	43	Elec-CNR-G	Apr-97	23, 30	Army			
Javelin	44	Mis/Mu-G	May-97	22	Army	1	63	1
AWACS-RSIP	45	Elec-CNR-A	Sep-97	19, 24	AF	4	10	2
SSDS	46	Elec-CNR-G	Mar-98	23, 24, 31		X	X	X
JSOW	47	Mis/Mu-A	Oct-98	24, 32	AF			
SMART-T	48	Elec-CNR-G	Nov-98	24, 33	Army			
CCTT	49	Elec-CNR-G	Dec-98	24, 34	Army	X	X	X
JDAM	50	Mis/Mu-A		20, 24				
E-2C Update	51	Aircraft		9	Navy			
ATACMS Blk I	52	Mis/Mu-G		24, 35	Army			
B-1B Blk D CMUP	53	Elec-CNR-A		24, 36				

1	10	11			12		
Program	Schedule Percent Overrun	IOT&E/ OPEVAL Results			DOT&E/ BLRIP Evaluation		
		11a Effec	*11b* Suit	*11c* Overall	*12a* Effec	*12b* Suit	*12c* Overall
ALCM	28	2	3	3	5	5	5
TTC-39 (TRI-TAC Switch)	42	2	3	3			
SGT YORK gun (DIVAD)	59	2	2	1	1	1	1
JTIDS (Class 2 terminals)	136	5	5	5	4	3	4
AV-8B (Harrier II)	1	4	3	4	4	4	4
OH-58D/AHIP	11	3	3	3	4	3	4
Maverick AGM-65D (IIR)	175	4	2	3	5	4	5
LANTIRN (Nav & Tgt)	34	4	2	3	5	4	5
Trident II msl (D-5)	2	5	5	5	3	3	3
Tomahawk (TASM & TLAM-C)	167	4	4	4	4	4	4
CV HELO (SH-60F)	0				5	2	4
ASAT (AF)	23	X	X	X	X	X	X
MK 48 ADCAP	48	4	3	4	2	1	1
Avenger (Ped Mtd Stinger)	18	5	5	5	3	4	3
ATACMS	33	5	5	5	4	5	5
ACM	15				5	4	5
MK 50 Torpedo (ALWT)	46	3	3	3	2	3	3
Navstar GPS/U.E.	30				5	4	5
AMRAAM	127				5	4	5
PLS (FHTV) (NDI)	58	4	2	3	3	1	2
FAADS LOS-F-H (ADATS)	78	2	1	2	2	1	2
B-1B Lancer (ALQ-161)	130	4	2	3	2	3	2
ASPJ (ALQ-165)	170	3	2	3	1	2	1
CHCS S/W Ver 4.01	X	X	X	X	4	4	4
VLASROC	X	5	5	5	2	3	3
NESP (AN/VSC-38V)	4	5	5	5	4	3	4
Paladin M109A6	X	5	3	4	5	5	5
SINCGARS	X	5	4	5	4	4	4
Rolling Airframe Missile	X	2	4	3	3	3	3
M1A2 Tank	0	5	3	4	5	2	3
T45TS	70	4	5	5	3	5	4
JTIDS (Cl 2/2H)							
FAAD C3I and GBS	59	5	5	5	4	5	4
FMTV	172	4	4	4	5	4	5
Longbow Apache (AH-1)	-17	5	5	5	4	4	4
C-17A	79	5	5	5	5	5	5
AFATDS 2	36	4	5	5	5	5	5
Mk 48 ADCAPS Mods	131	5	4	4	5	4	5
SFW	20	5	5	5	3	5	4
Std Msl (SM-2) Blk III	67	3	5	4	4	5	5
JSTARS	130	3	2	3	2	2	2
EPLRS	X	4	3	3	3	5	4
CSSCS					2	3	3
Javelin	58	5	2	4	5	5	5
AWACS-RSIP	32				5	4	5
SSDS	X				4	4	4
JSOW					4	3	3
SMART-T					3	2	2
CCTT	X				4	2	3
JDAM							
E-2C Update							
ATACMS Blk I					4	5	5
B-1B Blk D CMUP					4	5	4

1	13	14	15	16	17	18	19
Program	**MS II Date Actual**	**MS III Date Plan**	**MS III Date Actual**	**EMD Plan Years**	**EMD Actual Years**	**EMD Duration Actual/Plan**	**EMD Overrun Months**
ALCM	Jan-77	Aug-79	Apr-80	2.57	3.28	**1.28**	9
TTC-39 (TRI-TAC Switch)	Apr-74	Sep-78	Jul-80	4.39	6.24	**1.42**	22
SGT YORK gun (DIVAD)	Nov-77	Sep-80	May-82	2.83	4.50	**1.59**	20
JTIDS (Class 2 terminals)	Jan-81	Jun-86	Oct-93	5.42	12.75	**2.35**	88
AV-8B (Harrier II)	Jul-79	Apr-85	May-85	5.75	5.83	**1.01**	1
OH-58D/AHIP	Apr-82	Jun-85	Oct-85	3.17	3.50	**1.11**	4
Maverick AGM-65D (IIR)	Sep-76	Mar-80	Mar-86	3.43	9.43	**2.75**	72
LANTIRN (Nav & Tgt)	Dec-79	Feb-85	Oct-86	5.17	6.92	**1.34**	21
Trident II msl (D-5)	Oct-83	Mar-87	Apr-87	3.41	3.50	**1.02**	1
Tomahawk (TASM & TLAM-C)	Jan-77	Jan-81	Sep-87	3.99	10.65	**2.67**	80
CV HELO (SH-60F)	Feb-85	Mar-88	Mar-88	3.08	3.08	**1.00**	0
ASAT (AF)	Feb-80	Sep-86	Mar-88	6.58	8.08	**1.23**	18
MK 48 ADCAP	Sep-82	Jan-87	Jan-89	4.33	6.39	**1.48**	25
Avenger (Ped Mtd Stinger)	Mar-86	Sep-89	Apr-90	3.50	4.11	**1.18**	7
ATACMS	Feb-86	Sep-89	Nov-90	3.53	4.70	**1.33**	14
ACM	Apr-83	Jun-90	Jul-91	7.16	8.25	**1.15**	13
MK 50 Torpedo (ALWT)	Jan-84	Apr-89	Sep-91	5.20	7.61	**1.46**	29
Navstar GPS/U.E.	Jun-79	Mar-89	Jan-92	9.75	12.64	**1.30**	35
AMRAAM	Sep-82	Dec-86	Apr-92	4.25	9.64	**2.27**	65
PLS (FHTV) (NDI)	May-88	Apr-91	Dec-92	2.86	4.52	**1.58**	20
FAADS LOS-F-H (ADATS)	Nov-86	Apr-90	Dec-92	3.41	6.08	**1.78**	32
B-1B Lancer (ALQ-161)	Mar-82	Nov-86	Dec-92	4.67	10.75	**2.30**	73
ASPJ (ALQ-165)	Jul-79	Jul-84	Dec-92	4.96	13.37	**2.70**	101
CHCS S/W Ver 4.01			Dec-92				
VLASROC	X	X	May-93	X	X	**X**	X
NESP (AN/VSC-38V)	Jan-82	Dec-92	May-93	10.92	11.33	**1.04**	5
Paladin M109A6	X	X	Jun-93	X	X	X	X
SINCGARS	X	X	Sep-93	X	X	X	X
Rolling Airframe Missile	X	X	Dec-93	X	X	X	X
M1A2 Tank	Dec-88	Apr-94	Apr-94	5.33	5.33	**1.00**	0
T45TS	Sep-84	Oct-90	Jan-95	6.08	10.33	**1.70**	51
JTIDS (Cl 2/2H)							
FAAD C3I and GBS	Jul-86	Jan-92	Apr-95	5.50	8.75	**1.59**	39
FMTV	May-88	Jan-91	Aug-95	2.67	7.25	**2.72**	55
Longbow Apache (AH-1)	Dec-90	Oct-96	Oct-95	5.83	4.83	**0.83**	-12
C-17A	Feb-85	Feb-91	Nov-95	6.00	10.75	**1.79**	57
AFATDS	Sep-89	Apr-94	Dec-95	4.58	6.25	**1.36**	20
Mk 48 ADCAPS Mods	Sep-82	Jul-88	Mar-96	5.83	13.50	**2.31**	92
SFW	Nov-85	Sep-94	Jun-96	8.83	10.58	**1.20**	21
Std Msl (SM-2) Blk III	Jun-89	Sep-93	Jul-96	4.25	7.08	**1.67**	34
JSTARS	Apr-88	Dec-91	Sep-96	3.67	8.42	**2.30**	57
EPLRS			Mar-97				
CSSCS			Apr-97				
Javelin	Jun-89	Jun-94	May-97	5.00	7.92	**1.58**	35
AWACS-RSIP	Dec-88	X	Sep-97	X	8.75	X	X
SSDS			Mar-98				
JSOW			Oct-98				
SMART-T			Nov-98				
CCTT			Dec-98				
JDAM		Apr-99					
E-2C Update		Nov-99					
ATACMS Blk I		May-01					
B-1B Blk D CMUP		Aug-01					

1	20	21	22	23	24	25
Program	EMD RDTE $TY Plan	EMD RDTE $TY Actual	EMD RDTE $TY Actual/Plan	EMD Proc $ Plan	EMD Proc $ Actual	Proc $ Total Program
ALCM	546	789	1.45			
TTC-39 (TRI-TAC Switch)	105	180	1.71			
SGT YORK gun (DIVAD)	163	267	1.64			
JTIDS (Class 2 terminals)	309	1,296	4.19			
AV-8B (Harrier II)	873	1,113	1.27			
OH-58D/AHIP	210	237	1.13			
Maverick AGM-65D (IIR)	100	107	1.07			
LANTIRN (Nav & Tgt)	512.3	488.7	0.95			
Trident II msl (D-5)	6,657.2	6,158.2	0.93			
Tomahawk (TASM & TLAM-C)	783	1,316	1.68			
CV HELO (SH-60F)	34.8	32.1	0.92			
ASAT (AF)	1,031.3	1,240.2	1.20			
MK 48 ADCAP	551.6	623.5	1.13			
Avenger (Ped Mtd Stinger)	9.2	10.7	1.16			
ATACMS	338.3	380.5	1.12			
ACM	1,402.7	1,455.2	1.04			
MK 50 Torpedo (ALWT)	709.9	1,049.8	1.48			
Navstar GPS/U.E.	942	937	0.99			
AMRAAM	645.9	748.8	1.16			
PLS (FHTV) (NDI)	35.3	33.5	0.95	377.8	193.6	1,604.10
FAADS LOS-F-H (ADATS)	281.6	459.3	1.63			
B-1B Lancer (ALQ-161)	2,904.0	4,088.1	1.41	X	X	X
ASPJ (ALQ-165)	341.0	561.0	1.65	X	X	X
CHCS S/W Ver 4.01	X	X	X	X	X	X
VLASROC	X	X	X	X	X	X
NESP (AN/VSC-38V)	X	X	X	X	X	X
Paladin M109A6	X	X	X	X	X	X
SINCGARS	X	X	X	X	X	X
Rolling Airframe Missile	X	X	X	X	X	X
M1A2 Tank	399.4	446.6	1.12			
T45TS	517.8	669.1	1.29	1,260.5	2,358.4	
JTIDS (Cl 2/2H)						
FAAD C3I and GBS	308.9	403.4	1.31	40.8	14.0	
FMTV	64.1	89.0	1.39	310.9	932.9	
Longbow Apache (AH-1)	598.9	377.3	0.63	498.1	41.3	
C-17A	3,934.7	5,424.3	1.38	73,239.7	11,205.9	
AFATDS	245.1	252.1	1.03	122.0	141.3	
Mk 48 ADCAPS Mods	X	X	X	X	X	X
SFW	79.4	178.5	2.25	1,526.7	269.3	1,604.10
Std Msl (SM-2) Blk III	266.3	274.1	1.03			
JSTARS	657.1	1,975.7	3.01			
EPLRS	X	X	X	X	X	X
CSSCS						
Javelin	364.7	593.8	1.63			
AWACS-RSIP	384.3	424.4	1.10			
SSDS	X	X	X	X	X	X
JSOW						
SMART-T						
CCTT	X	X	X	X	X	X
JDAM						
E-2C Update						
ATACMS Blk I						
B-1B Blk D CMUP						

1	26	27	28	29	30	31
Program	**Proc $ % EMD/Total**	**$ Total Program**	**$ % EMD/Total**	**PM Number**	**PM Average Tenure**	**SARs Annual Number**
ALCM				1	3.3	4
TTC-39 (TRI-TAC Switch)						
SGT YORK gun (DIVAD)				3	1.5	7
JTIDS (Class 2 terminals)						
AV-8B (Harrier II)				3	1.9	5
OH-58D/AHIP				2	1.8	4
Maverick AGM-65D (IIR)				5	1.9	11
LANTIRN (Nav & Tgt)				4	1.7	6
Trident II msl (D-5)				2	1.7	5
Tomahawk (TASM & TLAM-C)				4	2.7	11
CV HELO (SH-60F)				1	3.1	3
ASAT (AF)				3	2.7	5
MK 48 ADCAP				2	3.2	5
Avenger (Ped Mtd Stinger)				4	1.0	4
ATACMS				2	2.4	5
ACM				1	8.2	4
MK 50 Torpedo (ALWT)				5	1.5	9
Navstar GPS/U.E.				5	2.5	13
AMRAAM				4	2.4	8
PLS (FHTV) (NDI)	12%			2	2.3	4
FAADS LOS-F-H (ADATS)				2	3.0	4
B-1B Lancer (ALQ-161)	X	X	X	6	1.8	11
ASPJ (ALQ-165)	X	X	X	3	4.5	10
CHCS S/W Ver 4.01	X	X	X			
VLASROC	X	X	X	X	X	X
NESP (AN/VSC-38V)	X	X	X	X	X	2
Paladin M109A6	X	X	X	X	X	X
SINCGARS	X	X	X	X	X	X
Rolling Airframe Missile	X	X	X	X	X	X
M1A2 Tank				3	1.8	7
T45TS				3	3.4	11
JTIDS (Cl 2/2H)						
FAAD C3I and GBS				3	2.9	10
FMTV				3	2.4	8
Longbow Apache (AH-1)				3	1.6	7
C-17A				5	2.2	11
AFATDS				2	3.1	7
Mk 48 ADCAPS Mods	X	X	X	4	3.4	10
SFW	17%	1,883.6	#REF!	5	2.1	11
Std Msl (SM-2) Blk III				2	3.5	8
JSTARS				4	2.1	8
EPLRS	X	X	X	X	X	N/A
CSSCS						
Javelin				3	2.6	9
AWACS-RSIP				4	2.2	8
SSDS	X	X	X	X	X	N/A
JSOW						
SMART-T						
CCTT	X	X	X	X	X	N/A
JDAM						
E-2C Update						
ATACMS Blk I						
B-1B Blk D CMUP						

1	32	33	34	35	36	37	38
Program	SARs Except Number	SARs % Except/Ann	LRIP RDTE $	LRIP Proc $	LRIP Total	Proc Plan	Proc Actual
ALCM	9	225%	24	48	72	3,424	3,424
TTC-39 (TRI-TAC Switch)			9	0	9		126
SGT YORK gun (DIVAD)	17	21	4	20	24	618	146
JTIDS (Class 2 terminals)			20	164	184	1,700	
AV-8B (Harrier II)	7	140%	6	48	54	336	336
OH-58D/AHIP	1	25%	5	16	21	578	578
Maverick AGM-65D (IIR)	21	191%	70	1,100	1,170	31,078	66,664
LANTIRN (Nav & Tgt)	1	17%	6	0	6	658	700
Trident II msl (D-5)	0	0%	28	21	49	734	815
Tomahawk (TASM & TLAM-C)	17	155%	81	168	249	1,082	3,994
CV HELO (SH-60F)	1	33%	0	7	7	175	175
ASAT (AF)	2	40%	11	0	11	112	0
MK 48 ADCAP	1	20%	48	303	351	3,305	3,305
Avenger (Ped Mtd Stinger)	2	50%	0	260	260	1,207	1,207
ATACMS	1	20%	50	170	220	1,000	1,542
ACM	3	75%	25	40	65	1,436	975
MK 50 Torpedo (ALWT)	3	33%	90	615	705	7,743	827
Navstar GPS/U.E.	12	92%	464	2,148	2,612	27,210	119,695
AMRAAM	3	38%	128	4,545	4,673	17,217	15,450
PLS (FHTV) (NDI)	2	50%	27	504	531	4,333	2,691
FAADS LOS-F-H (ADATS)	1	25%	4	10	14	562	0
B-1B Lancer (ALQ-161)	2	18%	3		3	100	100
ASPJ (ALQ-165)	1	10%	32	100	132	1,066	100
CHCS S/W Ver 4.01							
VLASROC	X	X	X	100	X	300	438
NESP (AN/VSC-38V)	0	0%	7	116	123	386	371
Paladin M109A6	X	X	X	X	X	X	X
SINCGARS	X	X	X	X	X	X	X
Rolling Airframe Missile	X	X	X	X	X	X	X
M1A2 Tank	0	0%	29	62	91	2,926	1,060
T45TS	3	27%	2	60	62	300	187
JTIDS (Cl 2/2H)							
FAAD C3I and GBS	4	40%			0		
FMTV	4	50%	147	2,000	2,147	119,542	85,488
Longbow Apache (AH-1)	2	29%	10		10	227	227
C-17A	3	27%	1	10	11	210	120
AFATDS	1	14%	142			3,184	5,191
Mk 48 ADCAPS Mods	1	10%	X	X	X	X	X
SFW	4	36%	155	513	668	14,000	5,084
Std Msl (SM-2) Blk III	1	13%	88			10,866	11,505
JSTARS	3	38%	3	5	8	21	19
EPLRS	N/A	N/A	33	X	X	X	4,417
CSSCS							
Javelin	2	22%	54	70,550	70,604		
AWACS-RSIP	1	13%	5	4	9	34	32
SSDS	N/A	N/A	X	X	X	X	X
JSOW							
SMART-T							
CCTT	N/A	N/A	X	X	X	X	X
JDAM					0		
E-2C Update					0		
ATACMS Blk I							
B-1B Blk D CMUP							

1	39	40	41	42	43	44	45
Program	Proc % Change Plan/Actual	Proc No. Change	LRIP RDTE Total %	LRIP Proc Total %	LRIP Total/Total %	LRIP RDTE/ Total %	Joint
ALCM	0.0%	0	0.7%	1.4%	2.1%	33.3%	Yes
TTC-39 (TRI-TAC Switch)			7.1%	0.0%	7.1%	100.0%	X
SGT YORK gun (DIVAD)		2	2.7%	13.7%	16.4%	16.7%	No
JTIDS (Class 2 terminals)			1.2%	9.6%	10.8%	10.9%	Yes
AV-8B (Harrier II)	0.0%	0	1.8%	14.3%	16.1%	11.1%	No
OH-58D/AHIP	0.0%	0	0.9%	2.8%	3.6%	23.8%	No
Maverick AGM-65D (IIR)	95.2%	2	0.1%	1.8%	1.9%	6.0%	No
LANTIRN (Nav & Tgt)	6.4%	2	0.9%	0.0%	0.9%	100.0%	No
Trident II msl (D-5)	11.0%	3	3.4%	2.6%	6.0%	57.1%	No
Tomahawk (TASM & TLAM-C)	269.1%		2.0%	4.2%	6.2%	32.5%	Yes
CV HELO (SH-60F)	0.0%		0.0%	4.0%	4.0%	0.0%	No
ASAT (AF)	-100.0%	2				100.0%	No
MK 48 ADCAP	0.0%	0	1.5%	9.2%	10.6%	13.7%	No
Avenger (Ped Mtd Stinger)	0.0%	0	0.0%	21.5%	21.5%	0.0%	No
ATACMS	54.2%	3	3.2%	11.0%	14.3%	22.7%	No
ACM	-32.1%	1	2.6%	4.1%	6.7%	38.5%	No
MK 50 Torpedo (ALWT)	-89.3%	4	10.9%	74.4%	85.2%	12.8%	No
Navstar GPS/U.E.	339.9%	6	0.4%	1.8%	2.2%	17.8%	Yes
AMRAAM	-10.3%	2	0.8%	29.4%	30.2%	2.7%	Yes
PLS (FHTV) (NDI)	-37.9%	2	1.0%	18.7%	19.7%	5.1%	No
FAADS LOS-F-H (ADATS)	-100.0%	2				28.6%	No
B-1B Lancer (ALQ-161)	0.0%	0	3.0%	0.0%	3.0%	100.0%	No
ASPJ (ALQ-165)	-90.6%	4	32.0%	100.0%	132.0%	24.2%	Yes
CHCS S/W Ver 4.01							
VLASROC	46.0%	X	X	X	X	X	No
NESP (AN/VSC-38V)	-3.9%	3	1.9%	31.3%	33.2%	5.7%	No
Paladin M109A6	X	X	X	X	X	X	No
SINCGARS	X	X	X	X	X	X	No
Rolling Airframe Missile	X	X	X	X	X	X	
M1A2 Tank	-63.8%	2	2.7%	5.8%	8.6%	31.9%	No
T45TS	-37.7%	6	1.1%	32.1%	33.2%	3.2%	No
JTIDS (Cl 2/2H)							
FAAD C3I and GBS							No
FMTV	-28.5%	3	0.2%	2.3%	2.5%	6.8%	No
Longbow Apache (AH-1)	0.0%	0	4.4%	0.0%	4.4%	100.0%	No
C-17A	-42.9%	3	0.8%	8.3%	9.2%	9.1%	No
AFATDS	63.0%	4	2.7%				No
Mk 48 ADCAPS Mods	X	X	X	X	X	X	No
SFW	-63.7%	4	3.0%	10.1%	13.1%	23.2%	No
Std Msl (SM-2) Blk III	5.9%	5					No
JSTARS	-9.5%	1					Yes
EPLRS	X	X	X	X	X	X	No
CSSCS							
Javelin					6.8%		Yes
AWACS-RSIP	-5.9%	2					No
SSDS	X	X	X	X	X	X	No
JSOW							
SMART-T							
CCTT	X	X	X	X	X	X	No
JDAM							Yes
E-2C Update							No
ATACMS Blk I							
B-1B Blk D CMUP							

1	46	47	48	49	50	51	52	53
Program	ACTD	ACTD Duration	BLRIP	Mod	S/W LOC	Tech Risk	PDRR Compet	EMD Compet
ALCM	No	N/A	Yes	No	X	Mod	Yes	Yes
TTC-39 (TRI-TAC Switch)			No	No		Low	Yes	No
SGT YORK gun (DIVAD)	No	N/A	Yes	No	X	Med	No	Yes
JTIDS (Class 2 terminals)	X	X	No	No	X			No
AV-8B (Harrier II)	No	N/A	Yes	Yes	X	Med	No	No
OH-58D/AHIP	No	N/A	Yes	No	X	Low	No	No
Maverick AGM-65D (IIR)	No	N/A	Yes	Yes	X	Low	No	No
LANTIRN (Nav & Tgt)	No	N/A	Yes	No	X	X	Yes	No
Trident II msl (D-5)	No	N/A	Yes	No	X	Low	No	No
Tomahawk (TASM & TLAM-C)	No	N/A	Yes	No	X	X	Yes	Yes
CV HELO (SH-60F)	No	N/A	Yes	Yes	X	Low	No	Yes
ASAT (AF)	No	N/A	No	No	X	X	No	No
MK 48 ADCAP	No	N/A	Yes	Yes	X	X	No	Yes
Avenger (Ped Mtd Stinger)	No	N/A	Yes	No	X	X	No	No
ATACMS	No	N/A	Yes	No	X	Low	Yes	Yes
ACM	No	N/A	Yes	No	X	X	Yes	No
MK 50 Torpedo (ALWT)	No	N/A	Yes	No	X	Low	Yes	Yes
Navstar GPS/U.E.	No	N/A	Yes	No	X	Low	Yes	Yes
AMRAAM	No	N/A	Yes	No	56K	Low	Yes	Yes
PLS (FHTV) (NDI)	No	N/A	Yes	No	X	X	Yes	No
FAADS LOS-F-H (ADATS)	No	N/A	No	No	X	X	Yes	Yes
B-1B Lancer (ALQ-161)	No	N/A	Yes	No	X	X	No	No
ASPJ (ALQ-165)	No	N/A	Yes	No	X	Low	Yes	Yes
CHCS S/W Ver 4.01								
VLASROC	No	N/A	Yes	Yes	X	X	X	X
NESP (AN/VSC-38V)	No	N/A	Yes	No	X	Med	Yes	Yes
Paladin M109A6	No	N/A	Yes	No	X	X	X	X
SINCGARS	No	N/A	Yes	No	X	X	Yes	Yes
Rolling Airframe Missile	No	N/A	Yes	No	X	X	X	X
M1A2 Tank	No	N/A	Yes	Yes	X	X	N/R	No
T45TS	No	N/A	Yes	No	X	X	Yes	Yes
JTIDS (Cl 2/2H)								
FAAD C3I and GBS	No	N/A	Yes	No	X	X		No
FMTV	No	N/A	Yes	No		X	X	Yes
Longbow Apache (AH-1)	No	N/A	Yes	Yes	X	X	Yes	Yes
C-17A	No	N/A	Yes	No	X	X		No
AFATDS	No	N/A	Yes	No	Yes	Yes	No	No
Mk 48 ADCAPS Mods	No	N/A	Yes	Yes	X	X	X	Yes
SFW	No	N/A	Yes	No				
Std Msl (SM-2) Blk III	No	N/A	Yes	Yes	X	X		Yes
JSTARS	No	N/A	Yes	No	Yes	X	X	No
EPLRS	No	N/A	Yes	No	X	X	X	X
CSSCS								
Javelin	No	N/A	Yes	No	X	X	Yes	Yes
AWACS-RSIP	No	N/A	Yes	Yes	X	X	No	No
SSDS	No	N/A	Yes	No	X	X	X	X
JSOW								
SMART-T								
CCTT	No	N/A	Yes	No	X	X	X	X
JDAM								
E-2C Update								
ATACMS Blk I								
B-1B Blk D CMUP								

1	54	55	56	57	58	59	60
Program	**EMD Kr**	**Subs**	**EOA/OA**	**DT/OT**	**COI(E) Number**	**COI(S) Number**	**IOT&E Start Plan**
ALCM	FPIF	2	No	No			Jan-80
TTC-39 (TRI-TAC Switch)	CPIF	1					Oct-79
SGT YORK gun (DIVAD)	FFP	Yes	No	No			Jun-80
JTIDS (Class 2 terminals)		2					Jul-87
AV-8B (Harrier II)	CPIF	2	No				Oct-83
OH-58D/AHIP	FPIF	1					Jul-84
Maverick AGM-65D (IIR)	FPIF	1	No				Nov-82
LANTIRN (Nav & Tgt)	FFP	1					Jul-87
Trident II msl (D-5)	CPIF	11	No				
Tomahawk (TASM & TLAM-C)	CPAF	7	No	Yes			Feb-80
CV HELO (SH-60F)	FFP	1	Yes				Nov-87
ASAT (AF)	CPIF	3	No	No	X	X	Jan-88
MK 48 ADCAP	CPAF	2	Yes	No			
Avenger (Ped Mtd Stinger)	FFP						Apr-89
ATACMS	FPIF	1					Sep-89
ACM	FPIF	3					
MK 50 Torpedo (ALWT)	CPAF	3	Yes	No			Dec-89
Navstar GPS/U.E.	FPIF	0	Yes	Yes			Jan-87
AMRAAM	CPIF	1	No	Yes			Oct-87
PLS (FHTV) (NDI)	FFP	3	Yes	Yes			Jul-91
FAADS LOS-F-H (ADATS)	FFP	1					Mar-98
B-1B Lancer (ALQ-161)	FPIF	2	No	Yes			Oct-84
ASPJ (ALQ-165)	CPAF	2	No	Yes			Jan-84
CHCS S/W Ver 4.01							
VLASROC	X	X	X	X	4	11	
NESP (AN/VSC-38V)	FFP	X	Yes	Yes			
Paladin M109A6	X	X			5	3	
SINCGARS	CPIF	X					
Rolling Airframe Missile	X	X	Yes	Yes	5	12	
M1A2 Tank	CPIF	5	Yes	No			Feb-89
T45TS	FFP	X	No	Yes	9	10	
JTIDS (Cl 2/2H)							
FAAD C3I and GBS	CPIF	1		Yes			Sep-90
FMTV	FFP	1	Yes	X	4	5	Jul-92
Longbow Apache (AH-1)	CPIF				3	3	Jan-95
C-17A	FPIF	8	Yes	Yes	5	8	Jan-93
AFATDS	CPAF		Yes	Yes	2	2	Jan-94
Mk 48 ADCAPS Mods	CPAF	X	Yes	Yes			
SFW	FPIF			Yes			Jul-90
Std Msl (SM-2) Blk III	FFP/PI	0	No	Yes	4	8	Jun-93
JSTARS	FPIF	1	Yes	Yes	3	1	Dec-94
EPLRS	X	X	Yes	Yes	4	7	
CSSCS							
Javelin	FPI	1	Yes	Yes			Sep-93
AWACS-RSIP	FPIF	2					Dec-93
SSDS	X	X					
JSOW							
SMART-T							
CCTT	X	X					
JDAM							
E-2C Update							
ATACMS Blk I							
B-1B Blk D CMUP							

1	61	62	63	64
Program	IOT&E Start Actual	IOTA&E End Plan	IOT&E End Actual Act/Plan	IOT&E Duration
ALCM	Apr-80	Dec-80	Feb-84	4.20
TTC-39 (TRI-TAC Switch)		Jun-80		
SGT YORK gun (DIVAD)	Jun-80	Sep-80	Nov-80	1.65
JTIDS (Class 2 terminals)	Jun-88	Jan-90	Apr-91	1.13
AV-8B (Harrier II)	Sep-84	Dec-83	Mar-85	2.97
OH-58D/AHIP	Jan-84	Jan-85	Dec-84	1.84
Maverick AGM-65D (IIR)	Jun-84	Jan-84	Aug-86	1.86
LANTIRN (Nav & Tgt)	Dec-92	May-92		
Trident II msl (D-5)				
Tomahawk (TASM & TLAM-C)	Feb-83	Sep-80	Apr-85	3.70
CV HELO (SH-60F)	Nov-87	Dec-87	Jan-88	2.00
ASAT (AF)	X	X	X	
MK 48 ADCAP	Dec-87	Apr-88	May-88	
Avenger (Ped Mtd Stinger)		Aug-89	Sep-89	
ATACMS	Mar-90	Jan-90	Jun-90	0.75
ACM		May-90	Aug-90	1.00
MK 50 Torpedo (ALWT)	Jul-90	Sep-90	Jun-92	2.56
Navstar GPS/U.E.	Jun-93	Aug-87		
AMRAAM		Apr-93		
PLS (FHTV) (NDI)	May-92	Dec-91	Aug-92	0.60
FAADS LOS-F-H (ADATS)		Nov-98		
B-1B Lancer (ALQ-161)	Mar-87	Jun-90		
ASPJ (ALQ-165)	Jun-88	Sep-86	Jul-92	1.53
CHCS S/W Ver 4.01				
VLASROC	Aug-90		Aug-90	
NESP (AN/VSC-38V)	Aug-92		Aug-92	
Paladin M109A6				
SINCGARS	May-90		Jun-90	
Rolling Airframe Missile				
M1A2 Tank	Sep-93	Dec-93	Dec-93	0.33
T45TS		Mar-90	May-4	
JTIDS (Cl 2/2H)				
FAAD C3I and GBS	Sep-94	Jun-91	Dec-94	0.33
FMTV	Apr-95	Feb-93	Jul-95	0.42
Longbow Apache (AH-1)		Mar-95	Mar-95	
C-17A	Jan-95	Aug-93	Jun-95	0.71
AFATDS	Jul-95	Feb-94	Sep-95	2.00
Mk 48 ADCAPS Mods				
SFW				
Std Msl (SM-2) Blk III			Apr-96	
JSTARS	Dec-95	Aug-95	Mar-96	0.37
EPLRS	Jul-96		Dec-96	
CSSCS				
Javelin	Aug-95	Sep-94	Jun-96	
AWACS-RSIP	Aug-95	Mar-94	Oct-96	4.74
SSDS				
JSOW				
SMART-T				
CCTT				
JDAM				
E-2C Update				
ATACMS Blk I				
B-1B Blk D CMUP				