Reducing Life-Cycle Costs in ATE Technology Insertion

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Abstract - As the procurement dollars dwindle we are faced with an increasing need to maintain fleet support with fewer financial resources. The Navy has taken an innovative approach to decreasing life-cycle costs while addressing the testability requirement. By using cost control and performance measurement techniques practiced in the private sector and inserting commercial-off-the-shelf equipment into aging test sets they can be made reliable and supportable. Replacing a 1970's computer with an 80486 computer and the associated hardware is discussed. Decreasing documentation costs by digitizing the technical manuals and using a CALS compliant software developed by the Army is presented.

I. INTRODUCTION.

The Sparrow Missile Program was given the task of improving the test capability of the depot level tester AN/DPM-22(V)10 to test -7P and Vertical Launch missile configurations, as well as maintaining testing capability of the -7M missile configuration. The depot level tester has been reconfigured various times and the tester control computer's internal RAM capacity had been reached. To make matters more complex the supportability of the aging equipment was an increasing problem. An engineering team was assembled at NAWCWPNS-Point Mugu to investigate how using commercial-off-the-shelf (COTS) equipment could improve reliability and provide the extra control computer memory needed for increased testing capability.

The purpose of this paper is to discuss the tools the NAVY used to control expenditures, generate reports, discuss the COTS equipment used to improve reliability and the digitizing of the technical manuals to reduce long term documentation costs.

II. MANAGEMENT TOOLS

The project requirements were assessed by the team and a Work Breakdown Structure (WBS) was developed along with a WBS dictionary. The assessment included an estimate of each lower level task with a schedule of completion for each task, a detailed manloading chart by month per task was used as a guide to control costs that would meet schedule requirements. Where appropriate, the WBS was broken down to as much as six levels. Level 0 describes the overall program requirements. Level 1 was broken into the non-recurring and the recurring parts of the program. The Level 2 non-recurring part was divided into four sections: (1) Management & Analysis, (2) Test Station Upgrade, (3) TPS development, and (4) Integrated Logistics Support. The recurring part at Level 2 was divided into two categories of management and production for the retrofitting of additional test sets. The four sections from Level 2 were broken down further into lower levels to fully describe the various tasks associated with each level and to closely monitor progress. Figure 1 illustrates the WBS to six levels.

Using the WBS as a guideline a personnel organizational structure was created. This structure served two purposes: (1) identified individual responsibility, (2) linked the WBS task elements to personnel according to their capability. Work Orders (WOs) were developed to assign individual responsibility. The WOs tied the WBS structure to the organizational chart and completed the loop. The WO described the work required in accordance with the WBS dictionary, the period of performance according to schedule requirements, the estimated man-hours, and the deliverables required both on a periodic basis, as well as at completion. Figure 2 is an example of a typical work order.

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Figure 1. Work Breakdown Structure.

Figure 2. Work Order

Each WO was discussed with responsible personnel for complete understanding of the task requirements before signing the WO to acknowledge the commitment. Monthly status reports of each WBS element from the engineering team were required. The data in these reports was used as inputs into a program management software package, Performance Assessment Routine (PAR), to help determine the status of the program.

To monitor progress, a budget was developed using the manloading chart (see Figure 3) as the basis of cost and performance expectation.

The monthly engineering team status report was used by program management in conjunction with PAR to generate data used to evaluate the status of the project. The PAR program takes lower level data inputs (actual expenditure and percent complete) and compares the actual cost to previously budgeted estimate. PAR generates cost and schedule variance and performance index data. This process is continued until all results are known at the lowest level. The data generated at the lowest level is then inputted at the next higher level and PAR generates cost and schedule variance data. This process is continued at each higher level until a top level cost & schedule variance and performance data is derived. Figure 4 illustrates a typical PAR input data form. It should be pointed out that the task element estimates of manloading data (in dollar values), generated as a result of WBS, are pre-requisite inputs to PAR at all WBS levels for each reporting period.

A monthly report is prepared for the NAVAIR sponsor using the data generated by PAR. The report is a five part report and included: Executive Summary, Cost Reports down to WBS Level 2, Top Level Expenditure Profile Vs Current Funding Plot, Cost and Schedule
Variance Plot, Schedule Status and WBS Format reports. These monthly reports have provided an in-depth project cost/performance visibility to the sponsors that have rarely been seen in the past.

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Once the hardware to be replaced was selected the operating software needed to be determined. Various software packages were investigated to determine which would be most compatible with the old software being used. The original control computer operating system software was in HP TODS, test programs were in HP BASIC and the system drivers were in HP Assembler. With the selection of an Intel 80486 processor computer for tester control, the operating system software chosen was Microsoft (MS) DOS, the systems drivers used Microsoft Visual Basic and Assembler C, and Microsoft Visual Basic was chosen for the significant task of converting existing -7M missile configuration test programs. A translator was developed to automate the process of conversion to the new software where possible, and manual conversion was used for peculiar commands.

IV. TECHNICAL MANUALS

The cost of updating Technical Manuals for periodic updates traditionally has been exceedingly high and sometimes can surpass the cost of executing an Engineering Change Proposal (ECP). Updating test equipment for small changes is a common requirement and costs over the lifetime of a test system can be extremely high when Technical Manuals are also updated. This is a concern common to most sponsors. One way of reducing the cost of documentation when updating test equipment is to have the technical manuals in magnetic media.

The engineering team was challenged to find an alternative which would be cost effective yet not initially prohibitive. Various software packages were researched to determine which would be the best solution for the NAVY. Some of the packages researched included Ventura Publisher, Interleaf, World View and Interactive Authoring And Display System.
(IADS). The software chosen was IADS. IADS is a Microsoft Windows application CALS compliant software package which was developed by the ARMY and is public domain software.

Most of the original text in the Technical Manuals was in digital format with the drawings in paper media. The text was translated from its previous format to IADS compatibility. The text was arranged using the Definition Type Document (DTD) format developed by the Army. Drawings were scanned into CALS Group 4 format and then integrated with the text to create the new digital media Technical Manuals.

Technical Manuals were organized according to function and then broken down to subfunctions and broken down further as required (see Figure 5). Each subfunction was linked to its higher level corresponding subject using hotword technology. Drawings were linked directly to their subject. The new technical manuals were organized to be user friendly and easy to use, either on the station control computer system, or on a separate inexpensive computer and printer on a mobile cart.

V. CONCLUSION

The use of management tools and processes are essential elements to controlling costs and provide feedback to the sponsor on the program status. The use of COTS technology to enhance the performance of aging equipment and providing for future program requirements is critical to sponsors as DOD budgets decrease. Test station life-cycle costs can be reduced if alternative methods to updating the documentation are viewed from a total programmatic point of view. The use of the Interactive Authoring Display System to digitally represent the technical manuals for the AN/DPM-22(V)10 test station has reduced future update costs. The tools and methods used in this program provides the engineering team and program management with constructive feedback on the status of the program.

![Figure 5. IADS Flow Diagram](image-url)