# Technical Performance Measurement—A Program Manager's Barometer

## DCMA Pilots a Modified Approach to TPMs

MIKE FERRARO

Technical Performance Measurement has been in widespread use for many years and is recognized as a highly useful method that can identify deficiencies in meeting system requirements, provide early warning of program problems, and be used to monitor technical risks. However, its utility is dependent on proper Technical Performance Measure (TPM) structure and integration with other program management tools, such as the Earned Value Management System (EVMS).

In recent years research has focused on monitoring and obtaining TPM variances, similar to those generated for cost and schedule through the EVMS and providing direct linkage to EVMS control account reporting. This can enhance overall program management, but only if TPMs are established early and formatted properly. You also need a well defined program Work Breakdown Structure (WBS) that is directly associated with the Key Performance Parameters (KPPs) of the system being designed, with clear links to the associated EVMS control accounts.

### The Make-Up of Technical Performance Measures

So what makes up a TPM? Foremost, it needs to measure something of importance to the program—a KPP that is essential to proper system operation in order to meet a mission requirement. Some programs may track a few of these

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TPMs or maybe a few dozen. Contractors may have many more TPMs in order to track derived requirements and to ensure proper technical progress toward major system requirements. A typical KPP may be system or subsystem weight. A weight TPM may have an objective (defined as the goal or required value at the end of the technical effort) or both an objective and a threshold (defined as the limiting acceptable value that if not met can jeopardize the project). A TPM can also have tolerance bands that show the allowed variation, which is based on the projected estimation error.

**Problems are risks that have achieved a 100 percent probability. If possible, you want to manage risks and future issues, not manage problems and future impacts.**

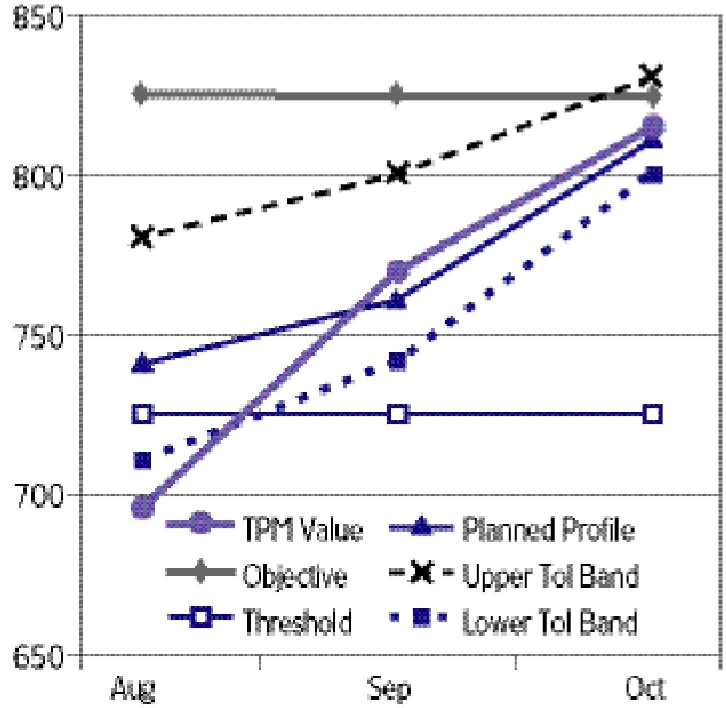


FIGURE 1. **Sample Technical Performance Measures (TPM) Chart**

Figure 1 shows a sample TPM chart. These can be simple or complex and come with various formats and methods of depiction. But most importantly, every TPM needs a planned profile, defined as: the projected time-phased achievement for the KPP from the beginning of the development (or re-planning effort) to the time the goal must be met. Without a planned profile there can be no meaningful technical variance calculated, and the risk in meeting the KPP will be underestimated because the time horizon is too long when only an objective or threshold value is used.

### EVMS, Risk, and TPMs

The EVMS and the cost and schedule variances, as well as other measurement data they generate, are proven and useful tools for program management. Variance thresholds—generally a percent of Budgeted Cost of Work Scheduled or Budgeted Cost of Work Performed—are set to ensure significant problems are brought to management's attention. However, problems are risks that have achieved a 100 percent probability. Waiting until a problem shows up in the EVMS, no matter how quickly or often the data are generated, may be too late to form a preventive, strategic, long-term solution. If possible, you want to manage risks and future issues, not manage problems and future impacts.

In a 1995 paper titled "Technical Performance Measurement, Earned Value, and Risk Management: An Integrated Diagnostic Tool for Program Management," retired Navy Cmdr. Nick Pisano wrote:

> **"Currently reported earned value data contain invaluable planning and budget information with proven techniques for program management; however, shortcomings of the system are its emphasis on retrospection and lack of integration with technical achievement."**

Use of TPMs can help with the problem of retrospection since TPMs are indicators of current progress in meeting technical requirements. This also makes them much more effective as a risk management tool. Synergy and optimal use of TPMs comes from integration with

WBS to TPM Correlation DATE 06/10/01

| WBS | | | TPMs | TPM Coverage* | BCWP Affected by TPMs | TPM T.S. | New BCW "TPM Informed" |
|---|---|---|---|---|---|---|---|
| 2.1 | | | | | | | |
| Airframe | | | Airframe Weight | 0.50 | 125.0 | 0.97 | 121.25 |
| Structure | **Current** | **New** | Aircraft Weight | 0.05 | 12.5 | 0.97 | 12.13 |
| | **CUM** | | Weapons Weight | 0.20 | 50.0 | 1.00 | 50.00 |
| BAC | $300M | | Cooling System Wt | 0.03 | 7.5 | 0.78 | 5.85 |
| BCWP | 250 | 241.70 | Displays/Wiring Wt | 0.02 | 5.0 | 0.80 | 4.00 |
| BCWS | 257 | | Navigation Sys Wt | 0.05 | 12.5 | 0.99 | 12.38 |
| ACWP | 255 | | Radar Weight | 0.08 | 20.0 | 0.93 | 18.60 |
| CV% | -2.00 | -5.50 Y | TOTAL | **0.93** | 232.5 | | 224.20 |
| SV% | -2.72 | -5.95 Y | | | | | |
| | | | Other (not affected by TPMs) | 0.07 | 17.5 | 1.00 | 17.50 |
| | | | NEW TOTAL | 1.00 | 250.0 | | 241.70 |

*Quantification of WBS element Composite Technical Score **0.97**

FIGURE 2. **Initial Recalculation of Cost and Schedule Variances**

the EVMS, preferably a quantitative integration. But first, TPMs must be established and used to develop the allocation of resources to the EVMS control accounts.

### TPMs and the Integrated Baseline Review (IBR)

The draft March 2001 "Guide to the Integrated Baseline Review," published by the National Defense Industrial Association, talks about the need for the IBR to capture "the entire scope of technical work." To achieve the Statement of Work (SOW) and Statement of Objectives (SOO) requirements, the team doing the IBR must have familiarity with both documents, and the technical plan in place. This leads to an assessment of technical risk and eventually to allocation of the resources necessary to meet the technical requirements within the confines of the agreed-to schedule.

The end result is a Performance Measurement Baseline, which provides the Budgeted Cost of Work Scheduled and is the measure against which schedule and cost variances are calculated through the EVMS. However, capturing the scope of what needs to be done is not the same as capturing the time-phased performance that needs to be accomplished for requirements to be met.

According to the IBR Guide, before the IBR is performed you must identify technical risk—the ability of the project plan to meet requirements. In addition, to control risks you will need to maintain accurate performance data, integrated with cost and schedule. One way to do this is to establish time-phased TPMs prior to the IBR, use them as the basis for resource allocations, and track TPM variances from the planned profile as early indicators of cost and schedule, as well as technical progress and potential problems.

I know this is difficult. After all, how can one be expected to understand so early what the KPP progress should be at certain stages or milestones? What if our estimates are well off the mark and show that progress is not sufficient as measured by our plan? Our plan is just a best guess on eventual design performance, which is sometimes associated with highly technical issues that have never before been addressed. But, I would rather allocate resources against a preliminary technical performance plan, which contains the best expert estimates I can get, than against a work completion plan.

The technical performance plan can be modified as more information becomes available. These modifications can lead to early resource reallocations, if necessary. TPM tolerance bands can accommodate the uncertainty of early estimates. Techniques can be devised to increase estimate accuracy. If a forward-looking planned profile can't be determined, you can work backward from "must have" performance milestones.

The point is that once this has been accomplished, the link has been established between scheduled technical performance, scheduled work accomplishment, cost, and personnel allocations. Now technical performance, and cost and schedule variances can be integrated and used in a complementary fashion for comprehensive program management.

### What Will This Look Like?

Pisano and his team developed an approach to integrate technical performance by noting the technical variance, or percent deviation from expectation, and correlating it to a confidence level equivalent to the probability of achieving the TPM value by the next milestone. That confidence level (factor) was then applied to the earned value for the WBS element associated with the KPP for which the TPM was an indicator. His approach led to the development of a Technical Performance Measurement Software (TPMS) package that facilitated

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| WBS | CV% Current | CV% New "TPM Informed" | SV% Current | SV% New "TPM Informed" | No. of TPMs | TPM Cov. | Comp. Tech. Score |
|---|---|---|---|---|---|---|---|
| 1.1 Aircraft Weight | -1.67 | -4.65 | 1.69 | -1.21 | 7 | 1.00 | 0.97 |
| 2.1 Airframe Structure | -2.00 | -5.50 Y | -2.72 | -5.95 Y | 7 | 0.93 | 0.97 |
| 3.1 Weapons Load | -2.00 | -2.62 | 2.56 | 1.95 | 2 | 0.60 | 0.99 |
| 4.1 Cooling Capacity | -3.45 | -15.20 R | -3.33 | -13.19 R | 2 | 0.50 | 0.90 Y |
| 5.1 Display Functionality | -17.14 R | -18.16 R | -17.65 | -18.35 R | 1 | 0.10 | 0.99 |
| 6.1 Avionics Weight | -6.00 Y | -10.36 R | -4.76 | -8.52 Y | 2 | 0.95 | 0.96 |
| 7.1 Aircraft Endurance | -4.17 | -6.13 Y | 1.69 | -0.19 | 5 | 0.70 | 0.98 |
| 8.1 Aircraft Range | -4.71 | -5.98 Y | -2.30 | -3.47 | 3 | 0.60 | 0.92 |
| 9.1 Aircraft Speed | -13.33 R | -15.06 R | -7.41 Y | -8.80 Y | 3 | 0.60 | 0.99 |

FIGURE 3. **Initial Cost and Schedule Variances Summary**

| TECHNOLOGY READINESS LEVEL | DESCRIPTION |
|---|---|
| 1. Basic principles observed and reported. | Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties. |
| 2. Technology concept and/or application formulated. | Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies. |
| 3. Analytical and experimental critical function and/or characteristic proof of concept. | Active research and development is initiated. This includes analytical and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative. |
| 4. Component and/or breadboard validation in laboratory environment. | Basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in a laboratory. |
| 5. Component and/or breadboard validation in relevant environment. | Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include high-fidelity laboratory integration of components. |
| 6. System/subsystem model or prototype demonstration in a relevant environment. | Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment. |
| 7. System prototype demonstration in an operational environment. | Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft. |
| 8. Actual system completed and "flight qualified" through test and demonstration. | Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications. |
| 9. Actual system "flight proven" through successful mission operations. | Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under operational mission conditions. |

FIGURE 4. **Technology Readiness Levels**

linkage of TPMs to the WBS and EV control accounts.

### DCMA Begins Research of Its Own

At DCMA we started doing research in April of 2000 on this approach, and a similar one created by Kathryn Kulick, President and Principal Engineer of Technical Performance Measurement Associates, Inc., a company that uses Bayesian Networks to represent uncertainty through low-, optimal-, and high-performance estimates. In addition, we consulted with ANADAC, the company that developed TPMS for the Department of Defense and taught its use to selected Contract Management Offices. We talked extensively with Pisano, took the Technical Performance Management course from Kulick, and attended EVMS conferences. As a result, we came to the conclusion that a simplified approach to correlate and apply TPM performance (variances) to EV control accounts was needed.

### Excel Spreadsheet Developed

To begin, we developed an Excel spreadsheet that captured the basic premise of what we had learned. We then created a training exercise and worksheet, which started from program TPMs correlated to WBS elements, and then reversed the process to show each WBS element and all the TPMs that "covered" the work delineated in each WBS.

The coverage was estimated. What wasn't covered was put in an "other" category. We included earned value data such as Budget at Complete (BAC), Budgeted Cost of Work Performed (BCWP), Budgeted Cost of Work Scheduled (BCWS), Actual Cost of Work Performed (ACWP), and calculations for cost and schedule variances. Cost and schedule variances included both current cumulative and what would be new variances based on the effect of the TPMs. The amount of BCWP affected by the various TPMs was calculated by multiplying the coverage factor against the current BCWP.

The new BCWP, which in Pisano's paper becomes "TPM Informed," is obtained by multiplying the amount of BCWP affected by a particular TPM, by that TPM's technical score (one minus the TPM variance). This is repeated for each TPM, with the "other" category always having a technical score of 1.00. The new BCWPs for each TPM are added together to calculate a new cumulative BCWP, which is then used in recalculating the cost and schedule variances. The result looks like Figure 2 (p. 16). (Variances in the "yellow" range are followed by a "Y"; those in the "red" range are followed by an "R"; "green" variances are not labeled.)

Note that the "New" cost and schedule variances are in the "yellow" range because there were a number of TPMs that were not on their planned profiles. These produced technical variances which, when factored against the current, slightly negative cost and schedule variances, signaled a future "yellow" condition. This means that additional resources will have to be spent to get back on track, or productivity will have to improve to get the same technical progress from the money and time remaining. This becomes an early indicator of a risk condition and allows for replanning, re-budgeting, or re-scheduling to address the variances or, at the very least, shows that this technical effort needs to be tracked closely.

It is also a predictor, saying that the traditional earned value variances will show a "yellow" condition if the technical issues aren't addressed. Of course at that point, depending on the level of the WBS element or earned value control account, management will take action because the problem becomes evident in the traditional sense. Figure 3 on p. 16 summarizes the WBS elements used in our training.

One element of simplification in this approach was to let the technical score directly affect the earned value outcome without using an intermediary confidence factor as in previous approaches. We also aligned our individual and composite technical scores with the variance thresholds traditionally used for earned value: zero to minus five percent being "green," less than minus 5 percent to minus 10 percent being "yellow," and less than minus 10 percent being "red."

We believe this is a good starting baseline but recognize that the TPM banding (when a TPM should be considered "red," "yellow," or "green") and the TPM sensitivity (its impact on earned value) can be different for each TPM. If a TPM is going to be difficult to meet, you may want a generous tolerance band in the beginning—one that narrows as time progresses. Being 10 percent off your planned profile may be a "green" condition if you are three years removed from when the requirement needs to be met, but would be a deep "red" 35 months downstream.

You can also modify a TPM's impact on the earned value control account. Instead of a 1:1 ratio, double or triple the impact if you want to raise the effect of a TPM on the earned value outcome. In effect, you have established two indicators: one a technical indicator of TPM performance and the other a management indicator of program health based on the integration of cost, schedule, and technical performance.

## The Pilot Program

In April 2001 we began a nine-month pilot program with seven volunteer Contract Management Offices. After an intensive two-day training period in the overall concept and spreadsheet described earlier, the engineers working the pilot returned to gather data on their selected programs and work with the contractors and program offices.

Our intent was to choose a limited number of TPMs, determine the WBS element(s) and earned value control accounts associated with them, estimate the TPM coverage, and calculate the TPM variances and new cost/schedule variances. We hoped that once this was accomplished, we could track our "TPM Informed" earned value and the new cost and schedule variance, compare it to the traditional data, and show predictability.

By the end of the pilot, we were not able to show predictability because the chosen programs reflected inadequately structured or non-existent TPMs, an inadequate WBS structure, or unclear earned value-to-WBS relationships.

In addition, a number of programs were re-baselined, thus requiring us to do a restart, making the remaining timeframe inadequate to show any predictability. These findings form the basis of my earlier comments on TPM and program structure, requirements-to-WBS to EVMS linkages, and the necessity for a planned profile.

In rereading Pisano's paper, a finding from his first pilot project was:

> "...cost and schedule impact assessments could not always be clearly determined because there was not clear linkage between technical parameters and budgeted work packages via the WBS."

This continues to be an issue, as does the tendency to use system and subsystem end-of-program requirements to gauge progress rather than planned profiles. But the pilot sites also had positive benefits such as a more in-depth understanding of system requirements, better insight into risk assessment, development of a systematic approach to analyzing performance, and establishment of a common basis for technical discussion.

## Where We Are Now

Both during and after the pilot program, we briefed this approach and our continuing research in a number of forums such as the Integrated Program Management Conference in November 2001; the National Defense Industrial Association in February 2002; and the Lean Aerospace Initiative Plenary session in March 2002.

The briefings were well received and there was a lot of general interest.

WBS to TPM Correlation DATE 06/10/01

| WBS 2.1 | Contract MR% | | TPMs | TPM Impact* | BCWP Affected by TPMs | TPM T.S. | TRL % Risk | New BCWP "TPM Informed" |
|---|---|---|---|---|---|---|---|---|
| Airframe | | | Airframe Weight | 0.50 | 125.0 | 0.97 | 0.80 | 121.25 |
| Structure | **Current** | **New** | Aircraft Weight | 0.05 | 12.5 | 0.97 | 0.80 | 12.13 |
| | **CUM** | | Weapons Weight | 0.20 | 50.0 | 1.00 | 0.15 | 50.00 |
| BAC | $300M | | Cooling System Wt | 0.03 | 7.5 | 0.78 | 0.70 | 5.85 |
| BCWP | 250 | 235.33 | Displays/Wiring Wt | 0.02 | 5.0 | 0.80 | 0.70 | 4.00 |
| BCWS | 257 | | Navigation Sys Wt | 0.05 | 12.5 | 0.99 | 0.80 | 12.38 |
| ACWP | 255 | | Radar Weight | 0.08 | 20.0 | 0.93 | 0.80 | 18.60 |
| CV% | -2.00 | **-8.36 Y** | TOTAL | **0.93** | 232.5 | | | 224.20 |
| SV% | -2.72 | **-8.43 Y** | | | | | | |
| | | | Other (not affected by TPMs) | 0.07 | 17.5 | 1.00 | | 17.50 |
| | | | NEW TOTAL | 1.00 | 250.0 | | | 235.33 |

*Quantification of WBS element Composite Technical Score **0.90 Y**

FIGURE 5. **Recalculation of Cost and Schedule Variances Using TRL Risk Factor**

At each forum we asked for volunteer programs or contractors to help us establish a proof-of-concept pilot through a well-structured program that would address some of the previous issues. We are also working with Northrop Grumman El Segundo and their DCMA Contract Management Office, looking into the possibility of using part of the Global Hawk program.

As a result of the briefing at Northrop Grumman and subsequent research, we modified our approach and spreadsheet. We changed the column titled "TPM Coverage" to "TPM Impact" so as to convey the idea that it is both the amount of work covered in the WBS element and the effect that TPM has on the work to be accomplished.

We also added data to the spreadsheet from the General Accounting Office July 1999 report titled, "Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes." This report looked at a number of programs in various stages, both commercial and military, and found their cost and schedule performance was related to the maturity of the technology used during product development.

The report came to the conclusion that "technology maturity can be measured and its consequences for products can be forecast." In general, those technologies introduced at a Technology Readiness Level (TRL) of 5 or lower encountered maturation difficulties and contributed to problems in product development that, in the report's stated examples, resulted in 60 to 120 percent increases in cost and schedule. Those products whose technologies reached a TRL of about 6 or 7 or higher were better able to meet cost, schedule, and performance requirements, and in the report's stated examples, had zero increases in cost and schedule.

In addition, the report correlated the lower TRLs with a higher risk for product launch, and conversely, technologies with high TRLs were better able to meet product objectives, or what might be considered KPPs. Figure 4 on p. 17 lists the TRLs and their definitions.

We decided to use this research in our spreadsheet by applying the general observations from the report to our TPM technical scores. We went back and estimated what the TRL would be for the technology supporting each TPM. Then, we used an arithmetic progression from .6 to 1.2 associated with TRLs of 6 to 1 (with a jump from TRL 2 to 1 of .2 in the risk factor) and labeled it TRL Risk Factor. The factor applies only to that portion of the technical score less than 1.00, so that a technical score of .97 with a TRL Risk Factor of 1.0 would mean a 6 percent reduction in the affected BCWP for an effective technical score of .94. Since there is some risk for TRLs

SUMMARY DATE: 06/10/01

| WBS | CV% Current | CV% New* | SV% Current | SV% New* | No. of TPMs | TPM Cov. | Comp. Tech. Score |
|---|---|---|---|---|---|---|---|
| 1.1 Aircraft Weight | -1.67 | -7.04 Y | 1.69 | -3.41 | 7 | 1.00 | 0.95 |
| 2.1 Airframe Structure | -2.00 | -8.36 Y | -2.72 | -8.43 Y | 7 | 0.93 | 0.94 Y |
| 3.1 Weapons Load | -2.00 | -3.11 | 2.56 | 1.46 | 2 | 0.60 | 0.99 |
| 4.1 Cooling Capacity | -3.45 | -25.15 R | -3.33 | -20.10 R | 2 | 0.50 | 0.83 R |
| 5.1 Display Functionality | -17.14 R | -21.27 R | -17.65 R | -20.45 R | 1 | 0.10 | 0.97 |
| 6.1 Avionics Weight | -6.00 Y | -14.11 R | -4.76 | -11.53 R | 2 | 0.95 | 0.93 Y |
| 7.1 Aircraft Endurance | -4.17 | -7.75 Y | 1.69 | -1.69 | 5 | 0.70 | 0.97 |
| 8.1 Aircraft Range | -4.71 | -7.02 Y | -2.30 | -4.41 | 3 | 0.60 | 0.96 |
| 9.1 Aircraft Speed | -13.33 R | -16.48 | -7.41 Y | -9.91 Y | 3 | 0.60 | 0.97 |
| *TPM informed with TRL factor | | Without TRL factor | | Without TRL factor | | | |
| 1.1 Aircraft Weight | -1.67 | -4.65 | 1.69 | -1.21 | 7 | 1.00 | 0.97 |
| 2.1 Airframe Structure | -2.00 | -5.50 Y | -2.72 | -5.95 Y | 7 | 0.93 | 0.97 |
| 3.1 Weapons Load | -2.00 | -2.62 | 2.56 | 1.95 | 2 | 0.60 | 0.99 |
| 4.1 Cooling Capacity | -3.45 | -15.20 R | -3.33 | -13.19 R | 2 | 0.50 | 0.90 Y |
| 5.1 Display Functionality | -17.14 R | -18.16 R | -17.65 R | -18.35 R | 1 | 0.10 | 0.99 |
| 6.1 Avionics Weight | -6.00 Y | -10.36 R | -4.76 | -8.52 Y | 2 | 0.95 | 0.95 |
| 7.1 Aircraft Endurance | -4.17 | -6.13 Y | 1.69 | -0.19 | 5 | 0.70 | 0.98 |
| 8.1 Aircraft Range | -4.71 | -5.98 Y | -2.30 | -3.47 | 3 | 0.60 | 0.99 |
| 9.1 Aircraft Speed | -13.33 R | -15.06 R | -7.41 Y | -8.90 Y | 3 | 0.60 | 0.99 |

FIGURE 6. **Comparison of Cost and Schedule Summaries With and Without the TRL Factor**

that are 7 or higher, we took the percent management reserve as an indicator of the perceived risk and applied it to all the TRLs we assumed to be in this range. The new WBS to TPM Correlation is in Figure 5 and the new Data Summary in Figure 6 (see preceding page).

Note that there were only minor changes in the color-coding, although most of the numbers turned more negative because the TPMs were not on their planned profiles and the TRLs were fairly high. This shows that if you have TPMs that are not meeting their estimated planned progress and the supporting technology is less mature (higher risk), you can expect a larger impact on cost and schedule for the earned value control accounts supporting this work effort.

Once again, you get an earlier indication of potential problems.

### Lastly, Systems Engineering

The role of systems engineering in this process cannot be over emphasized. According to the Defense Systems Management College, *Systems Engineering Fundamentals Guide* of January 2001, the WBS is a product of the systems engineering process. So are requirements analysis and traceability, functional analysis and allocation of verifiable performance requirements, and also system verification. These functions are all critical to the establishment of the technical baseline, KPPs, and the TPMs that are an indicator of technical baseline integrity.

Almost invariably, when a program gets in trouble, the analysis of what went wrong includes inadequate or non-existent systems engineering. This is simply due to not recognizing the need for proper planning and the role systems engineering plays in reducing uncertainty and performance risk. I believe if well-structured programs use systems engineering to provide properly developed TPMs that allow for computation of technical variance, this can complement and modify, through a quantitative link, the earned value cost and schedule variances that are used for program management. This will make for a well-defined technical baseline that can provide the basis for cost and schedule revisions and be an early determinant of risk and future problems.

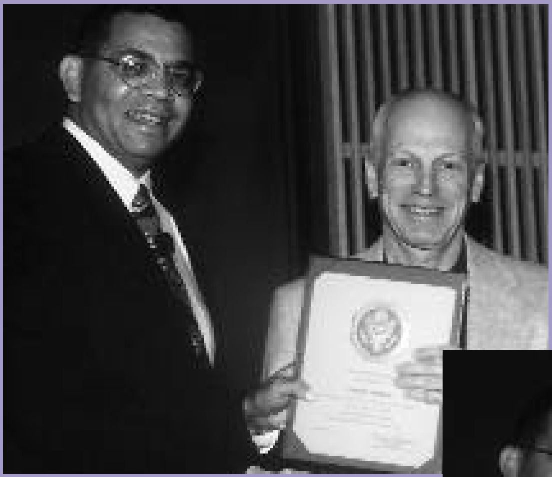
Then technical estimates will be used in a systematic, integrated fashion to help program managers address the right issues, anticipate the right challenges, and make the right decisions.

Editor's Note: Ferraro welcomes questions or comments on this article. Contact him at mferraro@hq.dcma.mil.

## Two DAU Civilians Earn 35-Year Service Awards

### Lou Jones and Dennis Cox Recognized at Dec. 11 Ceremony

During a ceremony conducted in Howell Auditorium on Dec. 11, 2002, DAU President Frank Anderson Jr. presented Lou Jones and Dennis Cox, DAU Operations Group, with certificates in recognition of 35 years' federal civilian service. Jones is a member of the Information Technology Department and is the longest-serving federal civilian employee at DAU. Cox works in the Contracting and Logistics Department.



DAU President Frank Anderson Jr. (left), presents Lou Jones a certificate recognizing his 35 years of federal civilian service.

Anderson (left) presents Dennis Cox a certificate recognizing his 35 years of federal civilian service.

Photos by Richard Mattox