Implementing EVM Data Analysis
Adding Value from a NASA Project Manager’s Perspective

Stacy M. Counts, Deputy Manager
Upper Stage Office, SE&I
NASA Marshall Space Flight Center

Data Analysis is one of the keys to an effective Earned Value Management (EVM) Process. Project Managers (PM) must continually evaluate data in assessing the health of their projects. Good analysis of data can assist PMs in making better decisions in managing projects. To better support our PMs, National Aeronautics and Space Administration (NASA) - Marshall Space Flight Center (MSFC) recently renewed its emphasis on sound EVM data analysis practices and processes. During this presentation we will discuss the approach that MSFC followed in implementing better data analysis across its Center. We will address our approach to effectively equip and support our projects in applying a sound data analysis process. In addition, the PM for the Space Station Biological Research Project will share her experiences of how effective data analysis can benefit a PM in the decision making process. The PM will discuss how the emphasis on data analysis has helped create a solid method for assessing the project’s performance. Using data analysis successfully can be an effective and efficient tool in today’s environment with increasing workloads and downsizing workforces.
Implementing EVM Data Analysis: Adding Value from a NASA Project Manager’s Perspective

Centrifuge Accommodation Module (CAM) with Centrifuge Facility and Gravitational Biology Facility

2.5 Meter Diameter Centrifuge

Life Sciences Glovebox

Habitat Holding Rack 1

Biological Research Project Space Station Module

Service System

Habitat Holding Rack 2

Jerald Kerby
NASA-MSFC
256-544-3243
jerald.g.kerby@nasa.gov

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Stacy Counts
NASA-MSFC
256-544-6004
stacy.counts@msfc.nasa.gov
Outline

- NASA/MSFC Organizations
- Project Analysis Office Overview
- Data Analysis Implementation
- HHR Project Overview
- Standard Report
- Benefits to Project
Project Analysis Office

- Diverse, complimentary skill mix
  - EVM Analysts
  - Schedule Analysts
  - Accountants & Auditors
  - Data Administrators
  - Software Developers
  - Engineers
Why Implement Data Analysis?

- Cancelled Projects
- Cost Control Team Recommendations
  - Need for better analytical tools
  - Need for better project analysis and data analysis
- MSFC Center Director’s Cost Control White Paper
- Better Data Analysis will enable MSFC Programs/Projects increased insight into performance
- COLSA Recommendations – Habitat Holding Racks (HHR) Specific
- The President’s Management Agenda – Fiscal Year 2002
Implementation Approach

**Three step approach**

- Equip
  - Tools
  - System
  - Knowledge

- Support
  - Standard Reports
    - 5 Pager
  - Training
  - Hands-on

- Assess
  - Spot Check for Process Discipline

**Products**

- wInsight
- Schedules
  - Filters
- Training - EV, wInsight, Schedule
- Policies, DRs, etc.

- CPRs
- Training – EV, wInsight, Schedule, Data analysis, etc.
- Schedule Support

- Summary Reports
Biological Research Project (BRP) Overview – Space Station Project

The Biological Research Project (BRP) is an integrated project team, with the mission to design and develop the systems required to support a wide range of fundamental gravitational biology research on Space Station. BRP has worked with International Partners to develop the first space-based life sciences research facility. Facility capabilities include “artificial gravity”, life support and monitoring for animal, plant, and insect research subjects.

Primary “host systems” are as follows:
- Centrifuge – built by JAXA
- Life Sciences Glovebox – built by JAXA
- Habitat Holding Racks (HHR) – built by Boeing-HSV
  - Boeing via MSFC to design, build, test, and integrate the BRP Habitat Holding Racks and supporting systems utilizing the EXPRESS Rack as the design basis.

Various animal and plant habitats as well as other life science experiments will be flown inside the host systems.
BRP - Habitat Holding Rack
BRP Habitats

- Advanced Animal Habitat
  - Research environment for laboratory mice and rats
- Aquatic Habitat
  - Research environment for small fresh water organisms
- Cell Culture Unit
  - Research environment for cell and tissue cultures
- Insect Habitat
- Avian Development Facility
  - Research environment for Japanese quail and domestic chicken eggs
- Plant Research Unit
  - For support of plant growth
SSBRP Science Objectives

- Perform research in gravitational biology on space station
  - Understand how biological specimens respond and adapt to micro gravity over single and multiple generations.
  - Determine effects of long-term fractional gravity on biological specimens
    - Learn how microgravity affects development, nervous system function, movement and behavior, growth, reproduction, aging, gene expression, and circadian rhythms.
  - Investigate effects of long-term space flight on biological specimens.
  - Perform long-duration studies of plant-growth to determine the affects of gravity on fundamental plant reproductive biology and development.
Likely Benefits To NASA

Science Advances
- Determination of minimum gravity levels for normal biological function
- New developmental and evolutionary biology research capabilities in space
- Better understanding of gravity's impact on astronaut health and performance
- Enhanced international leadership in gravitational biology

Technology Advances
- Miniaturized, high-reliability biosensors
- Advanced, wireless data collection
- Intelligent, automated data systems
- Advanced telescience for remote access by researchers
- Advanced plant growth techniques for space missions
Likely Benefits To Public

Science Advances
- Better understanding and treatment of bone, muscle, and balance disorders
- Better understanding of optimal plant growth
- New educational and training opportunities for future scientists

Technology Advances
- Advanced biomedical technologies
- Advanced agricultural techniques
- Cutting edge technologies for commercialization by U.S. industry
- Advanced telemedicine for remote access to health care
Biological Research Project
Funding Profile

April 1996 Program Operating Plan (POP) Submit $X
April 1998 POP Submit 8% increase
November 2000 78% increase
September 2001 (reduced scope) 17% decrease
January 2002 9.6% increase
Present 11% increase

Contract End/Flight Hardware delivery on October 31, 2004
HHR Project Content History

END ITEMS

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification Rack</td>
<td>1</td>
</tr>
<tr>
<td>Flight Racks</td>
<td>2</td>
</tr>
<tr>
<td>Suitcase Simulators</td>
<td>2</td>
</tr>
<tr>
<td>Habitat Fluid Transfer System</td>
<td>3</td>
</tr>
<tr>
<td>Closeout Covers</td>
<td>3</td>
</tr>
<tr>
<td>Habitat Functional Simulator Suite</td>
<td>2 (one added in PCP 1186)</td>
</tr>
<tr>
<td>Habitat Mass Simulator Complement</td>
<td>1 set</td>
</tr>
<tr>
<td>Transportation Racks</td>
<td>2</td>
</tr>
<tr>
<td>ARC Trainer</td>
<td>1</td>
</tr>
<tr>
<td>JSC Trainer</td>
<td>1</td>
</tr>
<tr>
<td>Habitat Checkout Units</td>
<td>4</td>
</tr>
<tr>
<td>Rack Interface Support Equipment</td>
<td>1</td>
</tr>
<tr>
<td>Spares</td>
<td>2 sets</td>
</tr>
<tr>
<td>Portable User Operations Station</td>
<td>1</td>
</tr>
<tr>
<td>Command/Telemetry Databases</td>
<td>1</td>
</tr>
</tbody>
</table>

TASKS

Habitat Physical Integration
Analytical Integration
Integrated Rack KSC Support
Passive Damping/Rack Isolation Analysis
User Operations Facility Display Development
Centrifuge/Glovebox Developer Support
User Operations Facility Console Operations
Standard 5 Pager
SAMPLE DATA

SCHEDULE PERFORMANCE

COST PERFORMANCE

TO MEET BUDGET AT COMPLETION (BAC)

TO MEET CONTRACTOR'S LATEST REVISED ESTIMATE (LRE)

Performance Indicator Key
Worse than -10%
Between -10% and -5%
Better than -5%
Change Threshold = 5%

At Completion Indicator Key
TCPI > CPI by more than 5%
TCPI > CPI by less than 5%
TCPI < CPI

HHR Worse than -5% = Red
EVM Implementation Process for HHR

- Mini-IBR (Integrated Baseline Review)
  - Audits across project functions
    - Resources
    - Schedule
- Re-established schedule for current environment and performance
- Adjusted EAC according to new schedule
- Monthly meetings with Contractor to review EVM data
# EVM Quick-Look Report

## SAMPLE DATA

Dollars in Thousands

<table>
<thead>
<tr>
<th>$ in Thousands</th>
<th>BCWS</th>
<th>BCWP</th>
<th>ACWP</th>
<th>Schedule Variance</th>
<th>Cost Variance</th>
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</thead>
<tbody>
<tr>
<td>Current Pd.</td>
<td>1,645</td>
<td>1,509</td>
<td>1,707</td>
<td>-136 -8.3%</td>
<td>-198 -13.1%</td>
</tr>
<tr>
<td>Cumulative</td>
<td>7,279</td>
<td>6,851</td>
<td>7,350</td>
<td>-428 -5.9%</td>
<td>-499 -7.3%</td>
</tr>
</tbody>
</table>

### NASA Ktr.

- **BAC**: 20,796
- **EAC**: 22,480
- **VAC**: 35

### EAC Forecast

- **Min.**: 22,022
- **Max.**: 23,385

### Variance Status Indicator Key

- **Worse than -10%**
- **Better than -5%**
- **Between -10% and -5%**
- **Change Threshold = 5%**

### SPI

- **Current**: 0.92
- **Cumulative**: 0.94

### CPI

- **Current**: 0.88
- **Cumulative**: 0.93

### Percent Scheduled

- 35.0%

### Percent Complete

- 32.9%

### Percent Spent

- 35.3%

### 3 Mo. Avg Spend Rate

- 1,441 (7%)
- To Compl Perf Index (TCPI) BAC: 1.04

### 6 Mo. Avg Spend Rate

- 1,067 (5%)
- To Compl Perf Index (TCPI) LRE: 1.04
## Top Issues Summary

### Top Schedule Variances

<table>
<thead>
<tr>
<th>WBS</th>
<th>Description</th>
<th>SV</th>
<th>CV</th>
<th>VAC</th>
<th>CPI</th>
<th>TCPI-LRE</th>
<th>CPI to LRE</th>
<th>SV</th>
<th>CV</th>
<th>BAC</th>
<th>LRE</th>
<th>% Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3200 COMMUNICATIONS</td>
<td></td>
<td></td>
<td></td>
<td>0.84</td>
<td>1.03</td>
<td>-0.19</td>
<td>(203)</td>
<td>(131)</td>
<td>2,043</td>
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<td>9.8%</td>
</tr>
<tr>
<td>1</td>
<td>3700 DATA DISPLAY</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>(113)</td>
<td>0</td>
<td>388</td>
<td>388</td>
<td>1.9%</td>
</tr>
<tr>
<td>1</td>
<td>3300 AUX EQUIP</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>1.13</td>
<td>0.96</td>
<td>0.17</td>
<td>(93 )</td>
<td>78</td>
<td>2,418</td>
<td>2,410</td>
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<tr>
<td>1</td>
<td>3100 SENSORS</td>
<td>Y↑</td>
<td>G</td>
<td>G</td>
<td>0.97</td>
<td>0.99</td>
<td>-0.02</td>
<td>(37 )</td>
<td>(11)</td>
<td>1,728</td>
<td>1,750</td>
<td>8.3%</td>
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<tr>
<td>1</td>
<td>2100 PROJ MANAGEMENT</td>
<td>G</td>
<td>G</td>
<td>Y←</td>
<td>0.94</td>
<td>1.04</td>
<td>-0.10</td>
<td>(12 )</td>
<td>(17)</td>
<td>618</td>
<td>622</td>
<td>3.0%</td>
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</table>

### Top Cost Variances

<table>
<thead>
<tr>
<th>WBS</th>
<th>Description</th>
<th>SV</th>
<th>CV</th>
<th>VAC</th>
<th>CPI</th>
<th>TCPI-LRE</th>
<th>CPI to LRE</th>
<th>SV</th>
<th>CV</th>
<th>BAC</th>
<th>LRE</th>
<th>% Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3600 PCC</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>0.85</td>
<td>1.03</td>
<td>-0.18</td>
<td>(11 )</td>
<td>(296)</td>
<td>5,801</td>
<td>5,988</td>
<td>27.9%</td>
</tr>
<tr>
<td>2</td>
<td>3200 COMMUNICATIONS</td>
<td></td>
<td></td>
<td></td>
<td>0.84</td>
<td>1.03</td>
<td>-0.19</td>
<td>(203)</td>
<td>(131)</td>
<td>2,043</td>
<td>2,130</td>
<td>9.8%</td>
</tr>
<tr>
<td>3</td>
<td>2200 SYS ENGINEERING</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>0.90</td>
<td>2.65</td>
<td>-1.75</td>
<td>6</td>
<td>(26)</td>
<td>283</td>
<td>283</td>
<td>1.4%</td>
</tr>
<tr>
<td>4</td>
<td>3600 I &amp; A</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>0.96</td>
<td>1.00</td>
<td>-0.05</td>
<td>83</td>
<td>(24)</td>
<td>1,440</td>
<td>1,465</td>
<td>6.9%</td>
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<td>5</td>
<td>2100 PROJ MANAGEMENT</td>
<td>G</td>
<td>G</td>
<td>Y←</td>
<td>0.94</td>
<td>1.04</td>
<td>-0.10</td>
<td>(12 )</td>
<td>(17)</td>
<td>618</td>
<td>622</td>
<td>3.0%</td>
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### Top LRE Issues

<table>
<thead>
<tr>
<th>WBS</th>
<th>Description</th>
<th>SV</th>
<th>CV</th>
<th>VAC</th>
<th>CPI</th>
<th>TCPI-LRE</th>
<th>CPI to LRE</th>
<th>SV</th>
<th>CV</th>
<th>BAC</th>
<th>LRE</th>
<th>% Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3600 PCC</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>0.85</td>
<td>1.03</td>
<td>-0.18</td>
<td>(11 )</td>
<td>(296)</td>
<td>5,801</td>
<td>5,988</td>
<td>27.9%</td>
</tr>
<tr>
<td>2</td>
<td>3200 COMMUNICATIONS</td>
<td></td>
<td></td>
<td></td>
<td>0.84</td>
<td>1.03</td>
<td>-0.19</td>
<td>(203)</td>
<td>(131)</td>
<td>2,043</td>
<td>2,130</td>
<td>9.8%</td>
</tr>
<tr>
<td>3</td>
<td>4000 SPARES</td>
<td>G</td>
<td>G</td>
<td>Y↑</td>
<td>0.95</td>
<td>1.00</td>
<td>-0.06</td>
<td>1</td>
<td>(8 )</td>
<td>756</td>
<td>762</td>
<td>3.6%</td>
</tr>
<tr>
<td>4</td>
<td>2100 PROJ MANAGEMENT</td>
<td>G</td>
<td>G</td>
<td>Y←</td>
<td>0.94</td>
<td>1.04</td>
<td>-0.10</td>
<td>(12 )</td>
<td>(17)</td>
<td>618</td>
<td>622</td>
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</tr>
<tr>
<td>5</td>
<td>2200 SYS ENGINEERING</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>0.90</td>
<td>2.65</td>
<td>-1.75</td>
<td>6</td>
<td>(26)</td>
<td>283</td>
<td>283</td>
<td>1.4%</td>
</tr>
</tbody>
</table>
The Bulls-Eye Chart provides overall status at a glance. The point labeled '0' represents the status for the current month. The point labeled '1' represents the status one month ago.

- The project is currently behind schedule.
- The project is currently over cost.
- Normally, a negative schedule variance will have a negative impact on cost by program completion. Special attention should be paid to cost for behind-schedule elements as the contract approaches completion.

The Cost/Schedule Variance Chart graphically depicts the cost and schedule variances in percentages, and provides the associated values in dollars (in thousands).

- Currently, the contractor has an unfavorable schedule variance of -428 (-6%) and an unfavorable cost variance of -499 (-7%).
- The Budget at Completion (BAC) is 20,796 and the effort is 33% complete.
- The contractor's Latest Revised Estimate (LRE), which depicts their Estimate at Completion (EAC), is 20,761, which is 35 less than the BAC.
- The LRE Validity Chart compares the contractor's Latest Re-Estimate (LRE) to several statistically derived values for the Estimate at Completion (EAC). The LRE and EAC are terms that are often used interchangeably, representing the estimate of the total direct charges against the contract. The LRE should be somewhere within the range of the calculated values.
- Currently, MEGA HERZ ELEC & VEN LRE of 20,761 is 35 less than the BAC.
- The LRE appears to be below the range of the statistically derived values.
- "Since the LRE falls outside the range of calculated values, the contractor should re-evaluate the LRE as soon as possible."

- The To Complete Performance Index (TCPI) chart illustrates the efficiency rate that the contractor must accomplish to meet the BAC or LRE, based on the contractor's performance to date.
- To date, the cost performance efficiency has been 0.932. In other words, for each dollar spent, the contractor has accomplished $0.93 worth of the work budgeted.
- To meet the BAC, the contractor must accomplish $1.04 of work for each dollar spent.
- Given the performance to date, it does not seem likely that the contractor will be able to meet the BAC.
- To meet the LRE, the contractor must accomplish $1.04 of work for each dollar spent.
- Given the performance to date, it does not seem likely that the contractor will be able to meet the LRE.
EVM Definitions

**TERMINOLOGY**

- ACWP: ACTUAL COST OF WORK PERFORMED (ACTUAL COST)
- BAC: BUDGET AT COMPLETION (ALLOCATED BUDGETS)
- BCWP: BUDGETED COST OF WORK PERFORMED (EARNED VALUE)
- BCWS: BUDGETED COST OF WORK SCHEDULED (PLANNED VALUE)
- CBB: CONTRACT BUDGET BASELINE (TOTAL AUTHORIZED WORK)
- CPI: COST PERFORMANCE INDEX
- CV: COST VARIANCE (BCWP-ACWP)
- EAC: ESTIMATE AT COMPLETION (GOVERNMENT'S EAC)
- ETC: ESTIMATE TO COMPLETE
- LRE: LATEST REVISED ESTIMATE (CONTRACTOR'S EAC)
- MR: MANAGEMENT RESERVE
- PMB: PERFORMANCE MEASUREMENT BASELINE
- SPI: SCHEDULE PERFORMANCE INDEX
- SV: SCHEDULE VARIANCE (BCWP-BCWS)
- UB: UNDISTRIBUTED BUDGET

**COMMON CAUSES FOR VARIANCE**

**FAVORABLE**

- POOR INITIAL PLANNING OR ESTIMATING
- TECHNICAL BREAK THROUGH
- COST OF LABOR AND MATERIAL LOWER THAN PLAN
- FRONT END LOADING
- METHOD OF EARNING BCWP

**UNFAVORABLE**

- POOR INITIAL PLANNING OR ESTIMATING
- TECHNICAL PROBLEM
- COST OF LABOR OR MATERIAL HIGHER THAN PLAN
- INFLATION
- NEW LABOR CONTRACTS
- WORK STOPPAGE

**USE OF CONTRACTOR PERFORMANCE MEASUREMENT DATA**

- CONTRACTOR BUDGET BASELINE
- LRE
- MR
- BAC
- ACWP
- BCWS
- SCHEDULE VARIANCE

**PURPOSE:**

- CPR: COST PERFORMANCE REPORT
- C/SSR: COST/SCHEDULE STATUS REPORT

TO OBTAIN CONTRACT COST AND SCHEDULE STATUS INFORMATION ON WHICH TO BASE PROGRAM MANAGEMENT DECISIONS
Benefits of EVM Data Analysis

- **NO-SURPRISES!**
- EVM provides a more realistic approach to cost planning based on statistical data
- EVM provides a tool for Project Managers to utilize in reviewing Contractor data
  - Direct comparisons between contractor data and wInsight data is very beneficial
- Provides a solid means to forecast future cost requirements based on previous contractor performance
- Shows Valid History
  - Looks at both total contract and new baseline performance
- Provides estimate of required contractor performance to maintain budget within project schedule
  - Provides projections/justifications for future budgets
  - Provides good Estimates at Completion (EAC)
- Provides trends analysis to reflect whether contractor performance is decreasing or increasing
- Identifies Cost/Schedule drivers
- Helps determine risks to project
- Information to support hunches