The presentation gives an overview of the National Aeronautics and Space Administration (NASA) Earned Value Management (EVM) structure. We briefly talk about the current EVM high-level policies within NASA and the EVM governing structure. It touches on the roles and responsibilities of EVM Focal Points within the Agency.

We will also discuss the approach that MSFC followed in implementing EVM and better data analysis within the Habitat Holding Racks (HHR) Project. We will address the approach used at the Marshall Space Flight Center (MSFC) to effectively equip and support MSFC projects in applying a sound EVM and data analysis process. In addition, we will show metrics associated with the HHR project before and after the implementation of EVM on the project. We will discuss the monthly report, using sample data, that the project manager used each month to assess the performance of the project. The data received from EVM helped create a solid method for assessing the project’s performance. The use of EVM data analysis can be an effective and efficient tool in today’s environment with increasing workloads and downsizing workforces. EVM provides project managers with information that can be used in the decision making process.
NASA EVM Overview
and Case Study

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Outline

- NASA Organizations
- Current Policies
- EVM Governing Structure
- Focal Point Goals, Roles and Responsibilities
- NASA - Overall Implementation Approach
- Case Study – Habitat Holding Racks (HHR)
- HHR Project Overview
- Implementation Approach
- Performance Data
- Benefits to Project
- Sample HHR Monthly EVM Report
Current NASA Policy

- Apply EVM principles to all projects (contractor and civil service) exceeding $20M, but less than $50M total project cost
  - Plan all work scope
  - Breakdown scope for control of technical schedule and cost objectives
  - Integrate scope, schedule and cost into a performance measurement baseline
  - Use actual costs incurred in accomplishing work performed
  - Objectively assess accomplishments
  - Analyze variances and prepare estimate at completion
  - Incorporate EVM into decision making and review processes
- Full EIA-748-A guideline compliance shall be applied to all projects (contractor and civil service) exceeding $50M total project costs
- Use of EVM is not required on contracts with research institutes and in grants of any type.
- Project Manager can require the use of EVM on any contract regardless of value of type.
EVM Governing Structure

Office of Chief Engineer

NASA HQ Focal Points
- Office of CFO
- Procurement
- Space Operations Mission
- Safety & Mission Assurance
- Aeronautics Research
- Science Mission
- Exploration Systems

Center Focal Points
- ARC
- DFRC
- GRC
- GSFC
- JPL
- JSC
- KSC
- LaRC
- MSFC
- SSC

FPC Chair: OCE/Mike Blythe/Sandra Smalley
Deputy Chair: MSFC / J. Kerby

Key Members – Focal Points
FP Goals

- To set priorities and direction for Agency EVM activities.

- To guide the implementation of EVM in a consistent, practical, and value-added manner, in order for it to be utilized as a key integrated management process for NASA projects.
Roles and Responsibilities of FP Members

- Serve as the EVM consultant and expert advisor to their respective organization.
- Support the Project Manager to help ensure that:
  - Contracts include applicable EVM requirements and that an EVM compliant system is utilized in accordance with policy requirements and thresholds.
  - EVM data are analyzed and assessments are developed and utilized in management reviews.
  - EVM analysis results are integrated into risk management mitigation processes.
  - Initiatives are implemented – Integrated Baseline Reviews (IBRs), in-house EVM, implementation assessment, EVM metric data development, consistent processes for analyses and utilization of automated analysis tools.
EVM IMPLEMENTATION APPROACH

- NPG 7120.5
- EVM Handbooks
- Scheduling Handbook
- Standardized WBS, etc.

POLICY, HANDBOOKS, GUIDANCE

MISSION PROGRAM/PROJECT REQUEST

Mission Directorate & Center
EVM Focal Point

RESOURCES, SYSTEMS, TOOLS
- Principal Center
- Automated Tools
  - EVM Engine
  - wInsight/Data Analysis
- APPEL Training
- DCMA - Surveillance
- EVM Focal Points

PRODUCTS & SERVICES
Guidance & Consultation for:
- EVM Policy & Procedures
- Training
- RFP Development
- SEB EVM Evaluation
- IBR Support
- Data Analysis / Tools
- Surveillance
- In-house EVM
- Metrics
Components for Implementation

Key Components

EVM

Policies & Guidance
Management Reporting & Utilization of EVM in NASA Culture
Training
Data Analysis Tools
In-House EVM
External Communication
Special Initiatives (Ad Hoc)

Integration & Planning
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

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May 23, 2006
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
## Overall 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
EVM Implementation Process for HHR

- Mini-IBR (Integrated Baseline Review)
  - Review across project functions
  - Resources
  - Schedule

- Re-established schedule for current environment

- Adjusted EAC according to new schedule

- Monthly meetings with Contractor to review EVM data
## Habitat Holding Rack Performance Data

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
<th>Percentage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 1996</td>
<td>Program Operating Plan (POP) Submit</td>
<td>$X</td>
</tr>
<tr>
<td>April 1998 POP Submit</td>
<td></td>
<td>8% increase</td>
</tr>
<tr>
<td>November 2000</td>
<td></td>
<td>78% increase</td>
</tr>
<tr>
<td>September 2001 (reduced scope)</td>
<td></td>
<td>17% decrease</td>
</tr>
<tr>
<td>January 2002</td>
<td></td>
<td>9.6% increase</td>
</tr>
<tr>
<td>March 2002</td>
<td>New Project Manager – EVM Implemented</td>
<td>11% increase</td>
</tr>
<tr>
<td>Final</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage Increase before utilization of EVM</th>
<th>Percentage Increase after utilization of EVM</th>
</tr>
</thead>
<tbody>
<tr>
<td>87.6% excluding de-scope</td>
<td>1.4%</td>
</tr>
</tbody>
</table>

Contract End/Flight Hardware delivery on October 31, 2004
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
Sample HHR Monthly Report
SAMPLE DATA

SCHEDULE PERFORMANCE

COST PERFORMANCE

TO MEET BUDGET AT COMPLETION (BAC)

TO MEET CONTRACTOR'S LATEST REVISED ESTIMATE (LRE)

<table>
<thead>
<tr>
<th>Performance Indicator Key</th>
<th>At Completion Indicator Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worse than -10%</td>
<td>TCPI &gt; CPI by more than 5%</td>
</tr>
<tr>
<td>Between -10% and -5%</td>
<td>TCPI &gt; CPI by less than 5%</td>
</tr>
<tr>
<td>Better than -5%</td>
<td>TCPI &lt; CPI</td>
</tr>
<tr>
<td>Change Threshold = 5%</td>
<td></td>
</tr>
</tbody>
</table>
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>
</tr>
</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>

<table>
<thead>
<tr>
<th></th>
<th>NASA</th>
<th>Ktr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAC</td>
<td>20,796</td>
<td>↑</td>
</tr>
<tr>
<td>EAC</td>
<td>22,480</td>
<td>↑</td>
</tr>
<tr>
<td>VAC</td>
<td>35</td>
<td>↓</td>
</tr>
</tbody>
</table>

EAC Forecast

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22,022</td>
<td>23,385</td>
</tr>
</tbody>
</table>

Variance Status Indicator Key:
- 🟡 Worse than -10%
- 🟢 Better than -5%
- 🟠 Between -10% and -5%
- 🟡 Change Threshold = 5%

<table>
<thead>
<tr>
<th></th>
<th>SPI</th>
<th>CPI</th>
<th>3 Mo. Avg CPI</th>
<th>6 Mo. Avg CPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>0.92</td>
<td>0.88</td>
<td>0.95</td>
<td>0.92</td>
</tr>
<tr>
<td>Cumulative</td>
<td>0.94</td>
<td>0.93</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percent Scheduled: 35.0%
Percent Complete: 32.9%
Percent Spent: 35.3%

3 Mo. Avg Spend Rate: 1,441 (7%)
6 Mo. Avg Spend Rate: 1,067 (5%)

To Compl Perf Index (TCPI) BAC: 1.04 (↑)
To Compl Perf Index (TCPI) LRE: 1.04 (↓)

Funding Status

<table>
<thead>
<tr>
<th>$ in Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.4</td>
</tr>
<tr>
<td>22.0</td>
</tr>
<tr>
<td>20.8</td>
</tr>
<tr>
<td>20.8</td>
</tr>
<tr>
<td>23.0</td>
</tr>
</tbody>
</table>
# 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>G+</td>
<td>G+</td>
<td>G+</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>1</td>
<td>3700 DATA DISPLAY</td>
<td>G-</td>
<td>G-</td>
<td>G-</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>
<td>11.6%</td>
</tr>
<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>
</tr>
<tr>
<td>1</td>
<td>2100 PROJ MANAGEMENT</td>
<td>G↑</td>
<td>Y ↔</td>
<td>G-</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>
</tr>
</tbody>
</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>298</td>
<td>5,801</td>
<td>5,988</td>
<td>27.9%</td>
</tr>
<tr>
<td>2</td>
<td>3200 COMMUNICATIONS</td>
<td>G+</td>
<td>G+</td>
<td>G+</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>2.85</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>3800 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>
</tr>
<tr>
<td>5</td>
<td>2100 PROJ MANAGEMENT</td>
<td>G+</td>
<td>Y ↔</td>
<td>G+</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>
</tr>
</tbody>
</table>

## 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>G+</td>
<td>G+</td>
<td>G+</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>Y↑</td>
<td>G+</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>Y ↔</td>
<td>G+</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>
</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 Revised 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
BCWP: BUDGETED COST OF WORK PERFORMED
BCWS: BUDGETED COST OF WORK SCHEDULED
CPI: COST PERFORMANCE INDEX
CPI = BCWP / ACWP
CPI < 1: COST OVER PERFORMANCE
CPI > 1: COST UNDER PERFORMANCE
CPI = 1: NO COST VARIANCE

Schedule Performance Index
SPI = BCWP / BCWS
SPI < 1: SCHEDULE OVER PERFORMANCE
SPI > 1: SCHEDULE UNDER PERFORMANCE
SPI = 1: NO SCHEDULE VARIANCE

COMMON CAUSES FOR VARIANCE

Cost

- Inflation
- Material cost increases
- Labor rates
- Unforeseen difficulties
- Design changes

Schedule

- Changes in workscope
- Changes in work process
- Resource constraints
- Weather conditions
- Vendor performance

USES OF CONTRACTOR PERFORMANCE MEASUREMENT DATA

- CPI and SPI to monitor progress
- Identify areas requiring corrective action
- Adjust project plans and budget

CPR: COST PERFORMANCE REPORT
CSSR: COST SCHEDULE STATUS REPORT

PURPOSE: TO OBTAIN CONTRACT COST AND SCHEDULE STATUS INFORMATION ON WHICH TO BASE PROGRAM MANAGEMENT DECISIONS