Continuous Cost-Risk Management & EVM Links to Risk Management for NASA Projects

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Topics

• Why Continuous Cost-Risk Management (CCRM) & EVM for risk management?
  • NASA Administrator/Comptroller initiatives
  • GAO and Aldridge Reports

• NPR 7120.5C: NASA Project Management

• Continuous Cost Risk Management
  • Stage 1: Preparation
  • Stage 2: Development
  • Stage 3: Application
    • Earned Value Management

• CCRM Implementation
Total Cost Growth for Two Space Programs

Development Growth Causes

Addressed by CCRM: 70%

Quantitative Framework

Why Continuous Cost-Risk Management (CCRM)?

- 2002: NASA Administrator and Comptroller charged with improving budget credibility
  - Created HQ Cost Analysis Division
- Began working on cost initiative improvements: CAIV, CADRe, Cost-Risk, LCCE, EVM, Data Collection etc.
- Developed CCRM process
- 2004 GAO recommendations
  - Develop an integrated plan including
    - Guidance for rebaselining
    - Enforced use of EVM
    - Staff and support for cost-estimating and EVM
  - Establish a standard framework for LCCEs
    - Based on a full LCC
    - Using a WBS encompassing both in-house and contractor efforts
    - Using CARDs (NASA CADRe)
    - With ICES at each milestone
    - Using cost risk assessments
  - Prohibit projects from proceeding through the review and approval process without above
Aldridge Commission Recommendations On NASA Cost Estimating

- Recommended an independent cost analysis organization similar to the OSD CAIG (Cost Analysis Improvement Group)
  - Independent cost estimating organization
  - Maintains corporate data base of historical project cost information
  - Generally uses parametric cost estimating procedures
  - Recommends final cost position to approving bodies
- NASA responding in 7120.5C with a NASA Cost Position development process
NPR 7120.5 “C”:
Program and Project Management Requirement

• Requirements cover all aspects of program and project management at NASA, including….
  • Cost, Risk and Performance Management Integration

• Context is Continuous Cost-Risk Management (CCRM)
  • A cost discipline architecture designed for maximizing the quality of cost management information for the Project Manager that:
    • Is a “system of cost systems”
    • Removes the “stove piped” nature of cost disciplines
    • Focuses on same risks with which all cost disciplines have to deal
    • Produces cost-risk feedback for successful project and risk management

• NPR 7120.5C will replace NPR 9501.3 as governing document for EVM at NASA
Continuous Cost-Risk Management (CCRM)

- A cost management architecture providing:

1. **Identification** of medium and high risk WBS elements, their assessment & translation of risk into cost-risk in LCCEs
   - Supports adequate budget for project

2. **Communication** of identified medium and high risk WBS elements to project managers (contractor or NASA)

3. **Post-cost estimate tracking** of medium and high risk WBS element cost and schedule performance using EVM system
   - Produces early warning of potential cost and schedule problems
   - Enables actionable intelligence for timely mitigation/management

4. **Updates** of technical and cost data (including annual LCCEs)

5. **History** of cost and technical data for use in updating cost models
Continuous Cost-Risk Management
A System of Cost Systems linked together in sequence by the same risks

Incorporated in NPR 7120.5C

Preparation
Cost-Risk Feedback: Steps 1-5

Application
Cost-Risk Feedback: Steps 9-12

Development
Cost-Risk Feedback: Steps 6-8
Continuous Cost - Risk Management

1. Perform Cost/Benefit Trades (CAIV)
2. Build Reqmts/Function/WBS Matrix (CADRe)
3. Develop Ref Point Cost & Schedule Estimate
4. Assess WBS Element Risk
5. Translate Risk into Cost/Schedule Impacts
6. Develop EVM, Risk & CADRe RFP DRDs
7. Review Cost Proposal During Source Selection
8. Participate In Post-Contract Award Meeting (Key Bridging Event)
9. Do EVM, schedule risk critical path analyses, etc.
10. Update LCCE (CADRe) & Cost/“S”-curve Assessment
12. Assess Data For Model & Database Updates (CADRe) & (ONCE)
Continuous Cost-Risk Management

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(Key Bridging Events)
Continuous Cost-Risk Management

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Translating Risk to Cost Impacts
e.g., Wavefront Sensor

\[
\text{Cost} = a + bX^c
\]

**Steps:**
1. **CER (Step 3):**
   \[
   \text{Cost} = a + bX^c
   \]
2. **(Step 4):**
   - Historical data point
   - Cost estimating relationship
   - Standard percent error bounds

**Input variable:**
- Cost Estimate
- \$
SUM WBS COST DISTRIBUTIONS:

**CORRELATED WBS COST DISTRIBUTIONS:**

Flywheel Power Storage Subsystem

Laser Power Converter

Wavefront Sensor

SUMMARY COST DISTRIBUTION:

- **BELL CURVE**

  \[ \eta_{\text{RPE}} \]

  \[ \sum_{\text{RPE}} \]

  \[ \text{COST} \]

- **“S”-CURVE**

  \[ \eta_{\text{RPE}} \]

  \[ \sum_{\text{RPE}} \]

  \[ \text{COST} \]

**Range 1**
Continuous Cost-Risk Management

1. Perform Cost/Benefit Trades (CAIV)
2. Build Reqmts/Function/WBS Matrix (CADRe)
3. Develop Ref Point Cost & Schedule Estimate
4. Assess WBS Element Risk
5. Translate Risk into Cost/Schedule Impacts
6. Develop EVM, Risk, CADRe, etc. RFP DRDs
7. Transition from “Prepare” to “Develop” Cost-Risk Feedback
8. Participate In Post-Contract Award Meeting (Key Bridging Event)
9. Do EVM, schedule risk critical path analyses, etc.
10. Update LCCE (CADRe) & Cost/“S”-curve Assessment
12. Assess Data For Model & Database Updates (CADRe) & (ONCE)
Develop RFP Cost-Risk DRDs

( DRDs Addressed & Interrelated )

➢ EVM Report (Cost Performance Report)
  • Identify high and medium risk WBS elements for monthly reporting
  • Standardized Work Breakdown Structure (WBS)
  • Financial Management Reporting (533M&Q)
  • Risk Management Plan & Reports
  • PRA Plan and Reports
  • Project Integrated Master Schedule

➢ Cost Analysis Data Requirement (CADRe)
  • Equivalent to a combination of the Cost Analysis Requirements Description (CARD); Life Cycle Cost Estimate (LCCE); and, Cost Estimating Data Collection DRDs
1. Earned value insight (BCWS, BCWP, ACWP on Format 1 and narrative status on Format 5) for the following high risk WBS elements shall be provided every month regardless of variance percentage levels until the system program office (SPO) informs the contractor otherwise:

   (List High Risk WBS Elements here)

If WBS elements, other than those identified here, begin to experience variances exceeding 10% due to technical risk for two consecutive months, the contractor will inform the Program Manager and a consensus reached on adding them to the group of high risk WBS elements identified for monthly cost performance reporting and analysis purposes. All other WBS elements shall have earned value (BCWS, BCWP, ACWP) reported at level 3 of the WBS to satisfy observing and monitoring requirements according to acquisition reform guidelines.
What’s Contained in the CADRe?

- **Part A**
  - Includes some traditional CARD information, (streamlined due to NASA product lines)
  - *Includes identification of where risks may affect costs*
- **Part B**
  - Contains technical cost driver and programmatic data in tabular form
- **Part C**
  - Integrates the Life Cycle Cost Estimate (detachable)
  - *LCCE Includes impact of risk on cost by WBS element*

- Updated periodically through the life of the project
Continuous Cost-Risk Management

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12. Assess Data For Model & Database Updates (CADRe) & (ONCE)

Application
Cost-Risk Feedback: Steps 9-12

Feedback:
Steps 9-12
High Risk WBS Element Focus
(EVM Analysis)
Cost and schedule efficiency (Compared to plan)

Baseline: $2,079.6K (w/out fee)
Completion Estimate: $2,076.1K
% Complete: 33  % Spent: 35

Cost Schedule

Adequate Performance
Developing Problems
Significant Problems

Contract: MOH-2  Ktr: Mega Hertz (CPAF) as of June 2004
In Accordance With (IAW), NPR 9501.3 Earned Value Management Implementation on NASA Contracts, CHAPTER 4.  Earned Value Management Pre-contract Activities, Paragraph 4.6 **EVM Links to Risk Management** states the following:

“Throughout the execution of the contract, the Project Manager shall ensure that the results of all analysis based on EVM are linked to the Risk Management Plan of the Project (as applicable).  Any cost and/or schedule risks being managed by the Project Manager should rely on the results of EVM analysis to track, manage, and mitigate the risks.”
3 DIMENSIONS OF EVM

**RISK**: A measure of the potential inability to achieve overall program success within defined cost, schedule and technical constraints. Risk consists of two components: (1) The probability (or likelihood) of failing to achieve a particular outcome; and (2) The consequences (or impact) if failing to achieve that outcome.
Concepts of Earned Value Management (EVM)

- Earned Value Management is a tool that allows both government and contractor program managers to have visibility into technical, cost, and schedule progress on their contracts.

- The implementation of an Earned Value Management System (EVMS) is a recognized function of program management.

- EVM ensures that cost, schedule and technical aspects of the contract are truly integrated.

- EVM facilitates the Continuous Risk Management (CRM) Process.

- EVM can be implemented on in-house projects as well as prime contractor projects.
A fundamental requirement of the acquisition and/or modifications of major systems is **insight** into the program/project’s progress for program management purposes.

The implementation of an Earned Value Management System (EVMS) on selected contracts within applicable government programs ensures the program manager is provided with program/project cost and schedule performance data which:

1. Relate time-phased budgets to specific contract tasks and/or statements of work (SOW)
2. Indicate work progress
3. Properly relate cost, schedule and technical accomplishment
4. Are valid, timely, and auditable
5. Supply managers with information at a practical level of summarization
6. Are derived from the same internal earned value management systems used by the government/contractor to manage the contract.
Contract Management Overview

Can We Meet Program Requirements With Existing Resources?

Precontract Activities
“Acquisition Phase”
- Government Activities
  - Civilian
  - Military

Postcontract Award Activities
“Execution Phase”
- R & D
- PROD
- O & M

Direction:
NPD 9501.3A Earned Value Management
R&D: ≥ $70M  Production: ≥ $300M

EVMS Objective:
Manage, Monitor, & Control Contractor Performance

Where Are the Risks?

Type of Data Required to Answer Fundamental Questions?
- Gov’t Statement of Work (RFP)
- Contractor’s Proposal
- Organization Breakdown Structure (OBS)
- Contract Work Breakdown Structure (CWBS)
- Work Packages/Planning Packages (WPDs)
  - Scope of Work (Technical Content)
  - Budget (Cost) CAM’s Estimate Methodology
  - Time Phased (Resources Scheduled Over Time)
- Control Account Plans (EVM Milestones)
- Schedules (Logic Network/Gantt Charts)
- Other Program Documents (WBS Dictionary, Milestone Dictionary, etc.)
WBS 3.0 TEST & EVALUATION

Can We Meet Program Requirements With Existing Resources?

WBS 3.1 Tests

WBS 3.1.1 Design Verification Test

WBS 3.1.2 Contractor Developmental Test

WP1: DVT #1
WP2: DVT #2
WP3: DVT #3
WP4: DVT #4
WP5: DVT #5
WP6: DVT #6
WP7: DVT #7
WP8: DVT #8
WP9: DVT #9
WP10: DVT #10

Where Are the Risks?
Integrated Program Management/Earned Value Management
Roles & Responsibilities

**IPM/EVM**

- EVM Implementation
- EVM Training
- EVM Tools (i.e., Winsight)
- EVM Metrics (CPR Metric)
- Performance Monitoring & Oversight Reporting
- CPR & C/SSR Trend Analysis
- CAM Roles & Responsibilities
- CAM Training – Fundamentals of EVM
- Work Packages & Planning Packages (WP/PP)
- Work Package Documentation (WPDs)
- Control Account Plans (CAP Sheets)
- Earned Value Milestones (EV)
- “What If’s”
- Coordination with Schedule & Risk Management
- Other

**Cost Mgmt (OPR)**

- OSP Risk Management Plan Implementation
- OSP Risk Interrelationship Documentation
- CST Risk Management Tools (i.e., IRMA)
- IRMA Metrics (5x5 & Risk Stepdown/Waterfall)
- Performance Monitoring & Oversight Reporting
- CST Risk Trend Analysis
- Integrated Baseline Review (IBR) Focal Point
- IRMA & CRM Training
- Coordinate (WP/PP)
- Coordinate Work Package Documentation
- Coordinate Control Account Plans (CAP Sheets)
- Coordinate Earned Value Milestones (EV)
- “What If’s”
- Coordination with Cost & Schedule Management
- CST Integration
- Other

**Schedule Mgmt (OPR)**

- Logic Networks/Scheduling Implementation
- Scheduling PMTs Training
- Scheduling Tools (i.e., MS Project or Open Plan)
- Schedule Metrics
- Performance Monitoring & Oversight Reporting
- Logic Networks/Schedules Status (Monthly)
- Critical Path Method (CPM) Analysis
- Work Around Plans
- Coordinate (WP/PP)
- Coordinate Work Package Documentation
- Coordinate Control Account Plans (CAP Sheets)
- Coordinate Earned Value Milestones (EV)
- “What If’s”
- Coordination with Cost & Risk Management
- Other

**CST Risk Mgmt (OPR)**

- OSP Risk Management Plan Implementation
- OSP Risk Interrelationship Documentation
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- Coordinate (WP/PP)
- Coordinate Work Package Documentation
- Coordinate Control Account Plans (CAP Sheets)
- Coordinate Earned Value Milestones (EV)
- Coordination with Cost & Schedule Management
- CST Integration
- Other
Risk Management Metrics

CONSEQUENCE

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<th>MAJOR</th>
<th>SERIOUS</th>
<th>CRITICAL</th>
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PROBABILITY

1 5

2a

3

4

6 10

7a

8

9

10

Risk Management Process

- Identify
- Plan
- Control
- Communicate
- Document

Technical Performance

- Cost
- Resources
- Schedule
- Time

Risk @ 2010

Risk Id: 2000 has 11 risky items to be identified and charted

Risk @ 2010

Risk Id: 2000 has 11 risky items to be identified and charted
Risk Management Metrics

Can We Meet Program Requirements

WBS X.2 Systems Engineering
(EVM/CST Risk Manager Metric: High Threat)

Analysis: The budget for this task will be consumed before the end of Nov 03. This leaves a shortfall to complete the work in Dec 03 and Jan 04.

Where Are the Risks?
Identifying & Managing Program Level CST Risk Drivers

STEP 2: Rate Top 10 Program Level Risk Drivers Threat Level

The Top 10 CST Risk Drivers illustrate that Project X has 5 Low CST Risks, 3 Medium CST Risks, and 2 High CST Risks. These are the areas the RMT would focus their attention and in preparation of an IBR, the PM/RM should request in advance, program documentation for these elements.

Schedule Variances tend to pose a greater degree of risk because their impact is typically horizontal across multiple WBS elements. Cost Variances are more vertical and impact primarily the same leg of the WBS for which it belongs.
WHY IMPLEMENT EVM?

- EVM instills a disciplined approach to cost, schedule, and technical development via the Work Breakdown Structure (WBS).

- EVM ensures that cost, schedule and technical aspects of the contract are truly integrated.

- Data derived from EVMS provides **insight and visibility** into contractor’s progress for program management purposes (trend analysis, forecasting, early warning signs, trigger mechanism, etc.).

- EVM is a Risk Mitigation Step at the Program Level designed to reduce risk on complex programs.

- EVM is a sound business practice.
Continuous Cost-Risk Management

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11. Assess Data For Model & Database Updates (CADRe) & (ONCE)
12. Assess Data Benefit Trades (CAIV)

Application
Cost-Risk Feedback: Steps 9-12
Measuring Range Change
Update Contract “S”-Curve Over Time

Confidence Level

Cost

Govt’s Initial Cost-Risk Distribution

Near-End of Contract Cost-Risk Distribution

Mid-Contract Cost-Risk Distribution

Range 1
Range 2
Range 3

Contract Target Cost
Project Budget
Continuous Cost-Risk Management
A System of Cost Systems linked together in sequence by the same risks

Incorporated in NPR 7120.5C

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9. Update LCCE (CADRe) & Cost / “S”-curve Assessment
11. Assess Data For Model & Database Updates (CADRe) & One NASA Cost Engineering (ONCE) Data Base
12. Review Cost Proposal During Source Selection
CCRM Repeats in Each Project Phase

<table>
<thead>
<tr>
<th>Pre-Phase A</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C/D</th>
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<tbody>
<tr>
<td>Conceptual Definition</td>
<td>Conceptual Design</td>
<td>Preliminary Design</td>
<td>Design, Development, Test &amp; Evaluation</td>
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- Initial CADRe
- Updated CADRe
- CADRe Updates as Necessary

ATP
IOC

Continuously Cost-Risk Management

Pre-NAR
NAR
Preliminary Design Review
Critical Design Review
How Do We Implement the CCRM and the CADRe?
Implementing CCRM and the CADRe

- Brief the NASA Mission Directorates and Agency PMC
- Institutionalize CCRM into the draft NPR 7120.5C
- Expand on “how to’s” in the Cost Estimating Handbook
  - www.ceh.nasa.gov
- Brief to NASA Center leadership, S&MA project managers and cost analysts
- Establish “Center CCRM/CADRe Champions”
  - Recommend/provide tools (e.g., NAFCOM; ACEIT; Crystal Ball; @RISK)
- Put CADRe, EVM, PRA, Risk Management, Technical Performance Measurement, Schedule Risk DRDs in RFPs and assist in drafting them
- Directly assist project offices in implementing each step of the CCRM
- Hire a SETA/FFRDC to augment NASA personnel for training, DRD writing and implementing on projects
- Benchmark project management teams in their CCRM capability
  - Rate against CCRM criteria
  - NAR teams could implement
- Contact at HQ: David R. Graham (202) 358-1002; david.graham-1@nasa.gov