Integrated Cost Risk and Cluster Analyses

SBIRS SPO Visit
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Introduction

- Incorporate cluster analysis information to quantify total cost risk.
  - Identification of closest analogy should be based on proposal values or similarity to current vintage of estimate.
  - Quantitative analysis is focused on history of actual values for analogy mission.

\[ \text{JPL Historic Mission Database} \rightarrow \text{Cluster Analysis} \rightarrow \text{Closest Analogy} \rightarrow \text{Proposed Mission} \]

Identification of Cluster for a Proposed Mission and Closest Analogy

Cluster Analysis

Parameter Name

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Cost</th>
<th>Mass</th>
<th>Workforce</th>
</tr>
</thead>
</table>

Systemic and Total Cost-Risk Comparison Using External Cost Fraction

Quantitative Analysis

Highlighting Proposed Mission & Closest Analogy
Cluster Analysis

- Identify Cluster for a Proposed Mission and Closest Analogy
- Currently Based Upon 4 Categories of 16 Descriptive Parameters
  - Schedule
  - Mass
  - Cost
  - Workforce
- Can Expand Parameters to Add Technical Data as Data Become Available. Maintain vintage dates of estimates.
Quantiative Analysis

- Cluster Quantitative Analysis Focused on Analogy Mission
  - Displays Ratios of Current Actual Values to Estimates of Values at Commitment (or at Step 2 Proposal Selection).

Cluster Analysis

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Schedule</th>
<th>Cost</th>
<th>Mass</th>
<th>Workforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A Duration (Months)</td>
<td></td>
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<td></td>
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<tr>
<td>Phase B Duration (Months)</td>
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<tr>
<td>Phase C/D Duration (Months)</td>
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<tr>
<td>Cruise Duration (Years)</td>
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<tr>
<td>Phase A/B Cost (M-FY01)</td>
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<tr>
<td>Phase C/D Cost (M-FY01)</td>
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<tr>
<td>Phase E Cost (M-FY01)</td>
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<tr>
<td>Total Cost and Launch (M-FY01)</td>
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<tr>
<td>Dry Mass (kg)</td>
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<tr>
<td>Total Launched Mass (kg)</td>
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</tr>
<tr>
<td>Phase A/B I&amp;T Labor (w-years)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Phase C/D I&amp;T Labor (w-years)</td>
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<tr>
<td>Phase E I&amp;T Labor (w-years)</td>
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<tr>
<td>Total I&amp;T Labor (w-years)</td>
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</tr>
</tbody>
</table>

Legend:
- QuikScat
- Mars Climate Orbiter
- Jason 1
- Cloudsat
- Grace
- Mars Polar Lander
- Example
Cost-Risk Using External Cost Fraction

- **Cost Risk**
  - Establish Systemic Cost-Risk Using 99th Percentile Elicitation and Monte Carlo Simulation
  - Augment Cost Risk Analysis Using Project Data Illustrating Cost Growth and Reserves Expenditure

- Decompose Cost Growth Into 2 Components
  - Systemic: Under Control of the Project(Contractor)
  - External: Outside the Control of the Project(Contractor), e.g., HQ Directed Change of Launch Date

- Systemic Cost Risk Adjusted by External Cost Risk Fractions for Each WBS Element Significantly Impacted By External Factors and Also Ranked As an Important WBS Element Cost Risk Driver
  - Adjustment = (Total Growth / Systemic Growth)
  - Adjustment Factors Estimated from Analogy Mission Experience
## Example

### Mission #1 Cost Risk Ranking

<table>
<thead>
<tr>
<th>WBS Element</th>
<th>Budget (FY'02$M)</th>
<th>Pessimistic Cost</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Project Management</td>
<td>$4.050</td>
<td>$4.455</td>
<td>7</td>
</tr>
<tr>
<td>2.0 Project Systems Engineering</td>
<td>$5.250</td>
<td>$6.038</td>
<td>14</td>
</tr>
<tr>
<td>3.0 Mission Assurance</td>
<td>$3.630</td>
<td>$4.719</td>
<td>18</td>
</tr>
<tr>
<td>4.0 Science</td>
<td>$11.160</td>
<td>$15.066</td>
<td>61</td>
</tr>
<tr>
<td>5.0 Payload System</td>
<td>$47.100</td>
<td>$59.000</td>
<td>192</td>
</tr>
<tr>
<td>6.0 Observatory</td>
<td>$32.800</td>
<td>$39.300</td>
<td>110</td>
</tr>
<tr>
<td>7.0 Mission Operations System</td>
<td>$11.570</td>
<td>$15.620</td>
<td>64</td>
</tr>
</tbody>
</table>
Mission #1: Adjustment = 1 + (6.0/3.9)

- (HQ + JPL Changes on Ball) / (Ball Rate Changes + Ball Overruns)
- Estimated from Cloudsat changes to Ball contract
- Applied to WBS Element 6.0
Example

- **Mission #2 Cost Risk Ranking**

<table>
<thead>
<tr>
<th>WBS Element</th>
<th>Budget (FY'02$M)</th>
<th>Pessimistic Cost</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Project Management</td>
<td>$4.099</td>
<td>$6.149</td>
<td>31</td>
</tr>
<tr>
<td>2.0 Project Systems Engineering</td>
<td>$2.378</td>
<td>$4.042</td>
<td>25</td>
</tr>
<tr>
<td>3.0 Mission Assurance</td>
<td>$4.533</td>
<td>$4.986</td>
<td>8</td>
</tr>
<tr>
<td>4.0 Science &amp; EPO</td>
<td>$6.853</td>
<td>$7.538</td>
<td>12</td>
</tr>
<tr>
<td>5.0 Payload System</td>
<td>$41.121</td>
<td>$53.457</td>
<td>198</td>
</tr>
<tr>
<td>6.0 Flight System</td>
<td>$35.584</td>
<td>$46.260</td>
<td>170</td>
</tr>
<tr>
<td>7.0 Mission Operations System</td>
<td>$18.102</td>
<td>$20.817</td>
<td>46</td>
</tr>
</tbody>
</table>
Example

- Mission #2: Adjustment = 1+(6.0/3.9)
  - (HQ + JPL Changes on Ball) / (Ball Rate Changes + Ball Overruns)
  - Estimated from Cloudsat changes to Ball contract
  - Applied to WBS Element 6.0
Mission #2 Cost Risk
(System Engineer)

- Systemic Cost Risk
- Budget w/o Reserves
- Budget w/Reserves
- Total Cost Risk

Cost (FY02$M)
Example

Mission #2  Cost Risk
(Cost Integrator)

- Systemic Cost Risk
- Budget w/o Reserves
- Budget w/Reserves
- Total Cost Risk

Cost (FY02$M):

- $100
- $120
- $140
- $160
- $180
- $200
- $220

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