Integrating Cost, Schedule, and Technical Performance to Increase the Probability of Program Success (PoPS)

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Projects are usually managed by measuring *cost* and *schedule* adherence to *plan*.

Success means three things
- At or below cost
- On or before schedule

We’ll show you how to integrate cost and schedule with *technical performance*.
- Now the product or service works within its performance parameters with *cost* and *schedule*.
First we always need to answer the question, *where are we going?*

To increase the Probability of Success, we have to know our destination with some level of confidence before we start, or we will be lost from day one.
- DID 81466B is coming
- It integrates EV, IMS, and mentions Technical Performance Measures
- Our presentation today will address connecting these dots.
One Important Reminder

- All project variables are *random* variables.
- All variables interact with each other, defined by the network of activities.
The first impulse is to start with Cost and Schedule, this is a problem...

When asked about project performance, we usually start on the wrong end of the problem…
We must start with what **DONE** looks like
Done always includes Technical Performance

*Done means ...* “I want a vehicle that can drive on steep mountain trails
How Steep? Real Steep!”

![Diagram of a vehicle on a steep incline]

- 2.5 feet up
- A 60% Grade
- 4.5 feet forward

Measurements based on available 33-inch tires
Let’s find some useful measures
Acquirer Defines the Needs and Capabilities in terms of Operational Scenarios
 Supplier Defines Physical Solutions that meet the needs of the Stakeholders

Mission Need
MoE
Operational measures of success related to the achievement of the mission or operational objective being evaluated.

MoP
Measures that characterize physical or functional attributes relating to the system operation.

TPM
Measures used to assess design progress, compliance to performance requirements, and technical risks.

“Coming to Grips with Measures of Effectiveness,” N. Sproles, *Systems Engineering*, Volume 3, Number 1, pp. 50–58
With our goal in mind (climb steep roads), let's consider what is needed for success.
Let's Connect Some Dots

Technical and Programmatic Risks Connected to the WBS

IMS contains all the Work, Budget, Risk mitigation plans, define in the Integrated Master Schedule to measure maturity

The Products and Processes that produce them in a “well structured” decomposition in the WBS

Budget at the Work Package

Named Deliverables defined in the WBS

Performance attached to each critical deliverables in the WBS and identified in each Work Package in the IMS
Deliverables describe the increasing maturing of a product or service through Events or Milestones, Accomplishments, Criteria, and Work Packages.

Each Event or Milestone represents the availability of one or more capabilities.

The presence of these capabilities is measured by the Accomplishments and their Criteria.

Accomplishments are the pre-conditions for the maturity assessment of the product or service at each Event or Milestone.

This hierarchy decomposes the System Capabilities into Requirements, Work Packages, and the activities the produce the deliverables. This hierarchy also describes increasing program maturity resulting from the activities contained in the Work Packages.

Performance of the work activities, Work Packages, Criteria, Accomplishments, and Events or Milestones is measured in units of “physical percent complete” by connecting Earned Value with Technical Performance Measures.

Program Events
Define the availability of a Capability at a point in time.

Accomplishments
Represent requirements that enable Capabilities.

Criteria
Represent Work Packages that deliver the Requirements.

The structure of a Deliverables Based Plan
What are steps to connect the dots?

1. Define deliverables.
2. Define work.
4. Arrange work.
5. Perform work.
6. Measure progress.
**Address each activity with a Cost, Schedule, and Technical Performance answer**

<table>
<thead>
<tr>
<th>Cost</th>
<th>Schedule</th>
<th>Technical Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Allocate budget to WBS elements down to the Control Account</td>
<td>✓ Define Intermediate and final deliverables</td>
<td>✓ Measures of Effectiveness (MoE)</td>
</tr>
<tr>
<td>✓ Better – allocate budget to the Work Package level</td>
<td>✓ Define incremental accomplishments</td>
<td>✓ Measures of Performance (MoP)</td>
</tr>
<tr>
<td></td>
<td>✓ Lay out logical flow of deliverables</td>
<td>✓ Performance upper and lower limits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓ Increasing maturity measures</td>
</tr>
</tbody>
</table>
**Address each activity with a Cost, Schedule, and Technical Performance answer**

Define the **Work** to produce the deliverables to meet the requirements

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</table>
| ✓ Define work packages with BCWS spreads | ✓ Define work packages with durations and resource requirements | ✓ Define outcomes of each work package  
✓ Define unit of measure for success of each outcome |
**Address each activity with a Cost, Schedule, and Technical Performance answer**

Define the *Performance Measures* for deliverables to assure compliance

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</tr>
</thead>
</table>
| ✓ Cost performance  
  Upper and lower variance limits for each Control Account.  
 ✓ Cost forecasting for CA, WBS, deliverables **WITH** variance. | ✓ Duration  
  performance upper and lower limits | ✓ Measures of effectiveness  
 ✓ Measures of performance  
 ✓ Technical performance measures  
 ✓ Risk measures for each performance item |

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Address each activity with a Cost, Schedule, and Technical Performance answer

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<thead>
<tr>
<th>Cost</th>
<th>Schedule</th>
<th>Technical Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ BCWS profile</td>
<td>✓ Vertical integration FIRST</td>
<td>✓ Work Packages produce 100/0 compliance</td>
</tr>
<tr>
<td>✓ Cost demand curves</td>
<td>✓ Horizontal integration SECOND</td>
<td>with performance measures</td>
</tr>
<tr>
<td>✓ CFSR profiles</td>
<td>✓ Focus on value flow of the</td>
<td>✓ Tasks in WP 0/100 completion criteria</td>
</tr>
<tr>
<td></td>
<td>deliverables</td>
<td></td>
</tr>
</tbody>
</table>

All measurement in units meaningful to the decision makers
It’s all about delivering value to the customer not the reporting process
Address each activity with a Cost, Schedule, and Technical Performance answer

<table>
<thead>
<tr>
<th>Perform the Work in the planned sequence</th>
<th>Cost</th>
<th>Schedule</th>
<th>Technical Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Work authorization through charge numbers</td>
<td>✓ Work authorization through Work Package start / end</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answering the question

*How long am I willing to wait before I find out I’m late*

Means

*Tangible evidence of physical percent complete at periods at least ½ the distance of the period of performance*

You can’t take corrective action is you wait too long
Address each activity with a Cost, Schedule, and Technical Performance answer

<table>
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<th>Measure Progress as Physical Percent Complete</th>
</tr>
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<tbody>
<tr>
<td>Cost</td>
</tr>
<tr>
<td>✓ Earned Value</td>
</tr>
<tr>
<td>✓ Probabilistic cost forecasting</td>
</tr>
<tr>
<td>✓ Risk adjusted ETC and EAC in monetary units</td>
</tr>
</tbody>
</table>
All The World Is A Stochastic Process

Cost drivers are random variables

Cost = $a + bX^c$

Combined Cost Modeling and Technical Uncertainty

Cost Modeling Uncertainty

Technical Uncertainty

Cost estimating relationship

Historical data point

Cost Driver (Weight)

Standard percent error bounds

Schedule drivers are random variables

stochastic/stəˈkastik/ processes are time varying random process found in every aspect of a project.
TPM Trends & Responses require cost and schedule changes

Design Model
ROM in Proposal

Detailed Design Model
Bench Scale Model Measurement
Prototype Measurement
Flight 1st Article

Technical Performance Measure
Vehicle Weight

28kg
26kg
25kg
23kg

CA  SFR  SRR  PDR  CDR  TRR

EV Taken, planned values met, tolerances maintained, etc.

Dr. Falk Chart – modified  21/27
If we don’t include these stochastic processes in the assessment of performance we’re just lying to ourselves.

- Understand the probability distributions.
- Connect each work activity into a network of probability distributions.
- Develop method to evaluate the effect of all this probabilistic behavior on the deliverables.
Raison d'etre to connect the dots is to ...

... reduce Programmatic and Technical RISK
Connecting the Dots increases success

Integrating Cost, Schedule, and Technical Performance
Assures Program Management has the needed performance information to deliver on-time, on-budget, and on-specified.

Technical Performance Measures

Cost Baseline
- Master Schedule is used to derive Basis of Estimate (BOE) not the other way around.
- Probabilistic cost estimating uses past performance and cost risk modeling.
- Labor, Materiel, and other direct costs accounted for in Work Packages.
- Risk adjustments for all elements of cost.

Technical Performance
- Earned Value is diluted by missing technical performance.
- Earned Value is diluted by postponed features.
- Earned Value is diluted by non-compliant quality.
- All these dilutions require adjustments to the Estimate at Complete (EAC) and the To Complete Performance Index (TCPI).

Schedule Baseline
- Requirements are decomposed into physical deliverables.
- Deliverables are produced through Work Packages.
- Work Packages are assigned to accountable manager.
- Work Packages are sequenced to form the highest value stream with the lowest technical and programmatic risk.

Conventional Earned Value
our direction

a. All formats shall be submitted electronically. Formats 1–4, and 6 shall be submitted in accordance with the UN/CEFACT (United Nations Centre for Trade Facilitation and Electronic Business) XML schemas, further defined for DoD use by standard guidelines. Format 5 shall be submitted in contractor format.

1. Formats 1–4 are submitted using the UN/CEFACT CPR XML template. Format 6 is submitted via the UN/CEFACT IMS XML template.

2. The CPR UN/CEFACT XML format is required at the control account level or lower.