



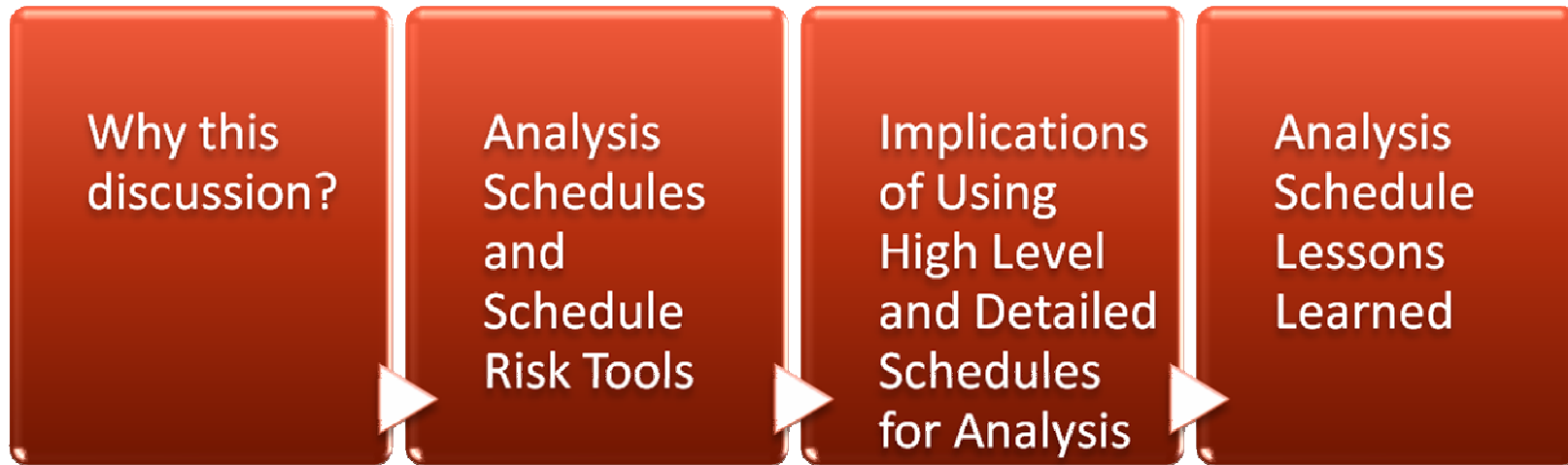
Analysis Schedules: *Danger at a High Level*

Presented at:
ICEAA 2013
Professional Development & Training
Workshop
June 18-20, 2013

Justin Hornback
Program Manager
NASA Strategic Business Unit
Reed Integration, Inc.



Topics



This is a guided discussion, comments and questions welcomed throughout.



Why this discussion?

- Background: Government organization charged with evaluating the adequacy of schedule and funding of a large project (>\$250M) using project-provided schedule and cost estimates received a large (>2000 tasks) schedule capable of risk analysis with limited modification or summation. Analysis conducted using detailed schedule revealed interesting results when compared with high level (<40 tasks) schedule used in previous evaluations of the same project at earlier points in lifecycle and was also the foundation for the cost estimation analysis.



What is Schedule Risk Analysis?

▶ Schedule Risk Analysis

- Model Activity/Task Durations as Uncertain Quantities that have Probability Distributions
- Combine Activity/Task Durations Statistically (Monte Carlo simulations) to Generate Cumulative Distributions of Project Total Duration
- Obtain confidence level dates to determine additional amount of time to complete project
- Identify best and deterministic date and probability of project completion date.

*Stephen A. Book. "Schedule Risk Analysis: Why It is Important and How to Do It. March 2002.



What is an Analysis Schedule?

- ▶ Logical network of activities/tasks required to complete the goals of a Program/project.
- ▶ Any schedule used to conduct schedule uncertainty and risk analysis.
 - Typically developed by the estimator/analyst.
 - Can be the Program/project schedule.
 - Often created in coordination with cost estimate/analysis.
 - Typically a summation of activities/tasks maintaining schedule network logic.



Why develop an Analysis Schedule?

- ▶ Very large/detailed schedules can make analysis very challenging.
 - Often multiple schedules linked to Program milestone schedule for management tracking
- ▶ Schedule does pass basic health checks, will not work for analysis.
 - No critical path
 - Many parallel activities with limited logic at Program/project level
 - Limited predecessor and successor relationships
 - Limited level of detail to identify and map schedule risks



“Dream” Analysis Schedule Attributes

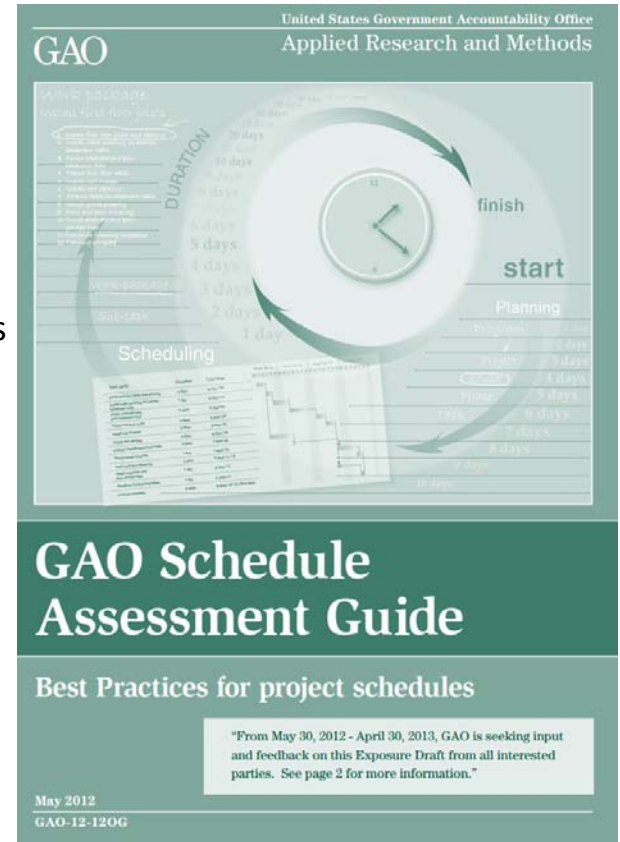
- ▶ All activities defined using Work Breakdown Structure (WBS).
 - Entire scope is accounted for in schedule.
 - ▶ Logic
 - All activities sequenced and utilize network logic.
 - ▶ Resource loaded activities included.
 - Labor, material, overhead.
 - Time dependent and independent.
 - ▶ Estimated durations included.
 - Reference to resources applied and external factors affecting duration.
 - Reference estimate foundations (ex. Expert opinion, historical).
 - ▶ Critical path defined.
 - ▶ Total slack, or float, identified.
 - Removed for risk and uncertainty analysis.
 - ▶ Evidence of continuous updates, rolling wave approach.
- ▶ History detailed in schedule or baseline schedule provided.
 - Trend analysis.
 - Schedule analysis uncertainty foundations.
 - ▶ Limited to no use of Level of Efforts (LOEs) or Hammock tasks.
 - LOE: **Latest** start dates and **earliest** finish dates.
 - Hammock: **Earliest** start dates and **latest** finish dates.
 - Not modeled in schedule analysis as activities should not fall on critical path, required capture for cost analysis.
 - ▶ No or very limited use of task constraints.
 - Example: Launch window
 - ▶ Utilizes standard working hours.
 - No schedule crashing.

*Source: NASA Independent Program Assessment Office Programmatic Assessment Group



GAO Schedule Best Practices

- ▶ Best Practice #8 Conduct and Schedule Risk Analysis
 - A Schedule Risk analysis (SRA) was conducted
 - Schedule was assessed against best practices before conducting the simulation
 - The SRA has low, most likely, and high duration data fields
 - SRA accounts for correlation in the uncertainty of activity durations
 - Risks are prioritized by probability and magnitude of impact
 - Risk register was used to identify schedule risk factors before SRA was conducted
 - SRA data and methodology are available and documented
 - SRA identifies the activities that most often ended up on the critical path in the simulation
 - Risk inputs have been validated, are reasonable and show no evidence of bias
 - Schedule contingency is included in baseline schedule
 - Schedule contingency is held by the project manager
 - Contingency is allocated according to prioritized risk list
 - Project documents the derivation and amount of contingency set aside by management for risk mitigation
 - An SRA is performed periodically as the schedule is updated

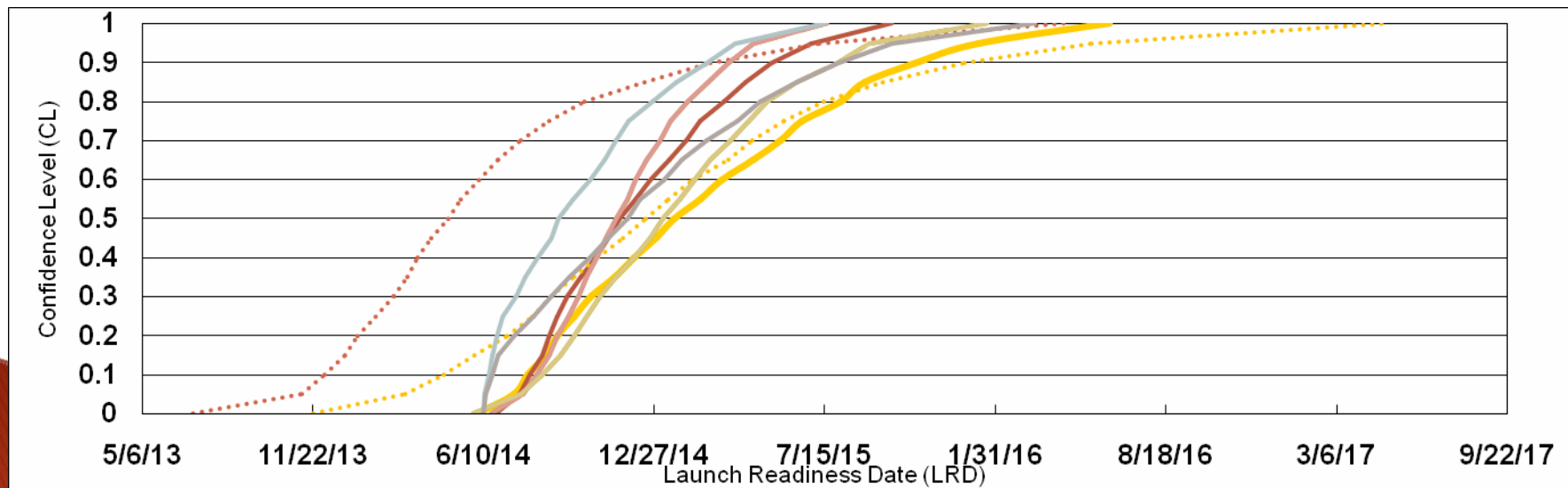


*Source: GAO Best Schedule Practice and Criteria



Pitfalls of Analysis Schedules

- ▶ Model creation over summarizes task durations and logic.
 - Loss of details of individual tasks and logic
 - Critical Path sensitivity
- ▶ Utilization of Program/project schedule makes working with schedule within analysis tools cumbersome.
 - Units (Hours/Days)
 - Mapping Risks and Uncertainty to unique tasks
- ▶ Linkage to cost estimate/budget basis for analysis schedule.
 - Gaming the analysis.
- ▶ Scenario lottery
 - Running large number of scenarios to achieve desired result.
 - Uncertainty and Risk Distributions.





Schedule Estimating/Analysis Tools*

- ▶ Oracle Primavera Risk Analysis (PRA)
- ▶ Acumen Fuse
- ▶ Tecolote Joint Analysis of Cost and Schedule (JACS)
- ▶ Booz Allen Hamilton Polaris™
- ▶ Palisade @Risk
- ▶ Deltek Active Risk Manager (ARM)
- ▶ Barbecana Full Monte
- ▶ Structured Data, LLC RiskAMP

*Not an exhaustive list and list does not imply ranking or endorsement.

The estimator/analyst must understand how each tool models and reports results.



Program/project schedules for Analysis

- ▶ Program/project (P/p) schedule quality improvement
 - Increased understanding of schedule and cost relationship/dependency
 - Increase in schedule development standards
 - Improving likelihood of P/p schedule capable of risk and uncertainty analysis.
- ▶ Fewer errors than analysis schedule creation
- ▶ Captures Working Plan
- ▶ How are they used for analysis:
 - All float/slack is removed to identify critical path for risk and uncertainty analysis.
 - Constraints removed from tasks for risk and uncertainty analysis.
 - Constraints override impact

Implications of Using Detailed versus High Level Schedule for Analysis



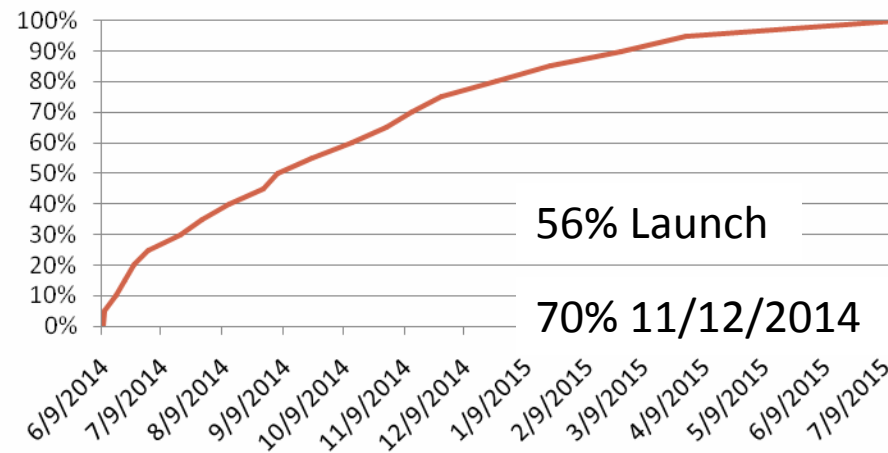
- ▶ High Level Schedule <40 Tasks
 - Serialized all tasks
 - Increasing the sensitivity of the critical path
 - Removed risk mapping to discrete tasks
 - Limited traceability of risk impact
 - Increased the impact of uncertainty on tasks
- ▶ Detailed Schedule >2000 Tasks (many 1 and ½ day tasks)
 - Increased time to modify schedule to conduct analysis
 - Individually map risks to multiple tasks elements (approx. 25)
 - Remove float
 - Remove constraints while maintaining logic
 - Correct import errors into analysis tool.
 - Impacted by analysis tool unit rounding
 - Required modification of default tool setting to hours from days
 - Large number of short durations simulated multiple hierarchy effect and uncertainty applied to these tasks was reduced due to central limit theorem, overcome through correlation.



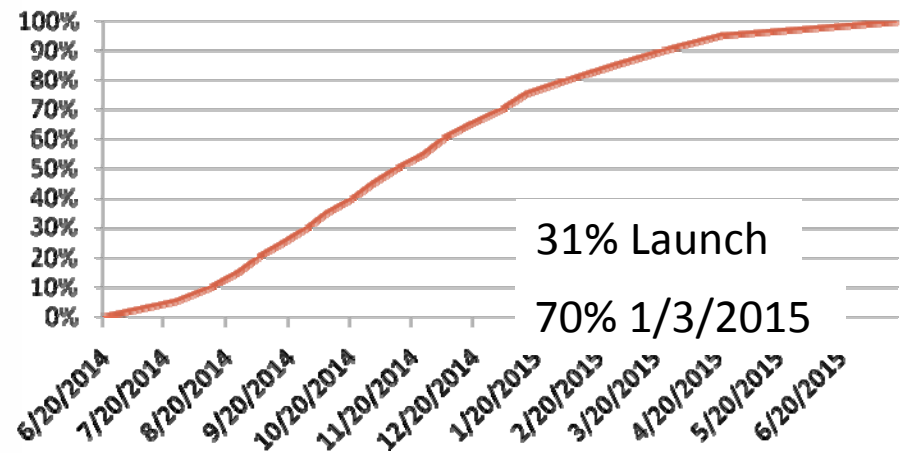
Implications cont.

- ▶ High Level/Summary Schedule Analysis was more pessimistic using identical model assumptions.
 - Total Duration
 - Risks
 - Uncertainty
- ▶ S-Curve of Detailed Analysis, no optimistic tail

Detailed



Summary

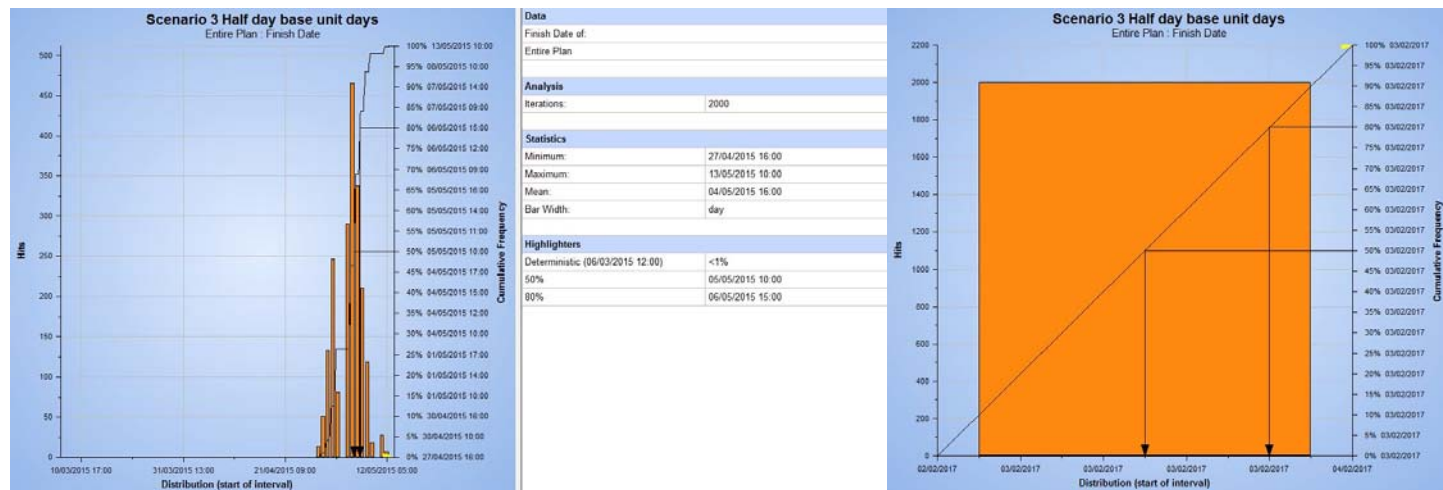




Implications cont.

► Units

- Using detailed schedules for analysis, pay attention to units and impact on risk and uncertainty distributions.
- Many tools round to the whole unit.
 - Example: A one day task duration will have no distribution if modeled with three point estimate of Min - 95% ML - 100% Max - 125% if using a base day unit within analysis tools.



Hour Unit

Day Unit



Implications cont.

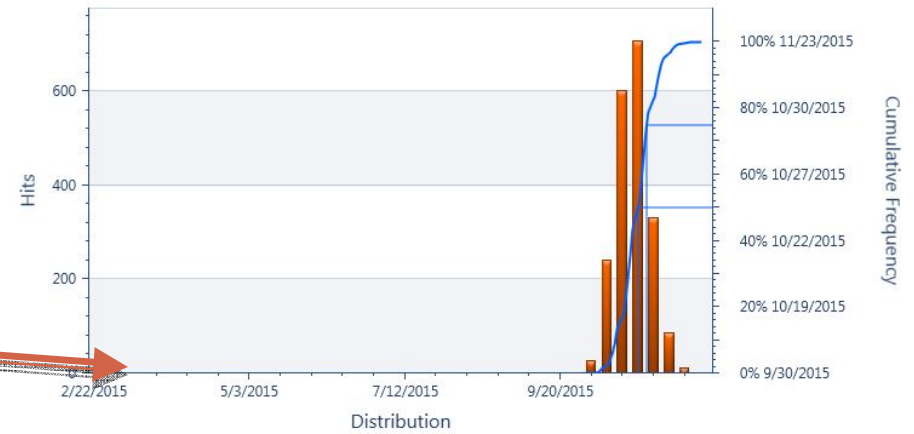
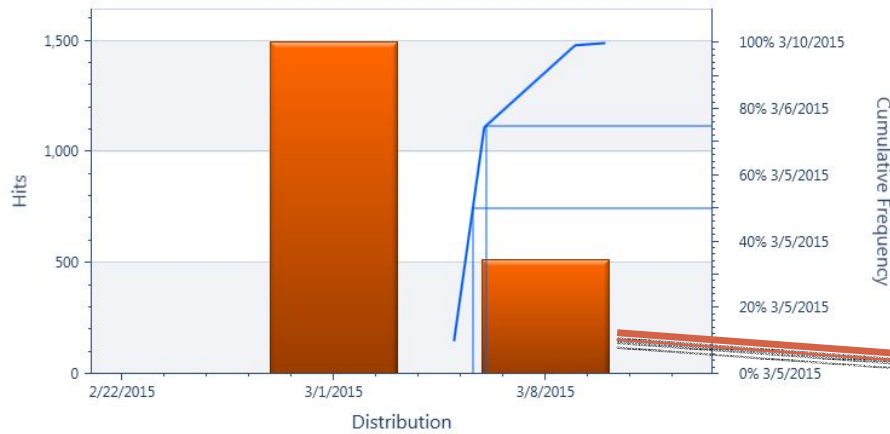
► Impact of rounding units

Scenario 5 1 full day tasks with few shorter hour duratons Uncertainty and Risk Events (No Mitigation)

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| Metric | Value |
|---------------------|-----------|
| Deterministic - 0 % | 2/24/2015 |
| Mean | 3/6/2015 |
| P0 - Best Case | 3/5/2015 |
| P50 | 3/5/2015 |
| P75 | 3/6/2015 |
| P100 - Worst Case | 3/10/2015 |
| Range | 5 days |

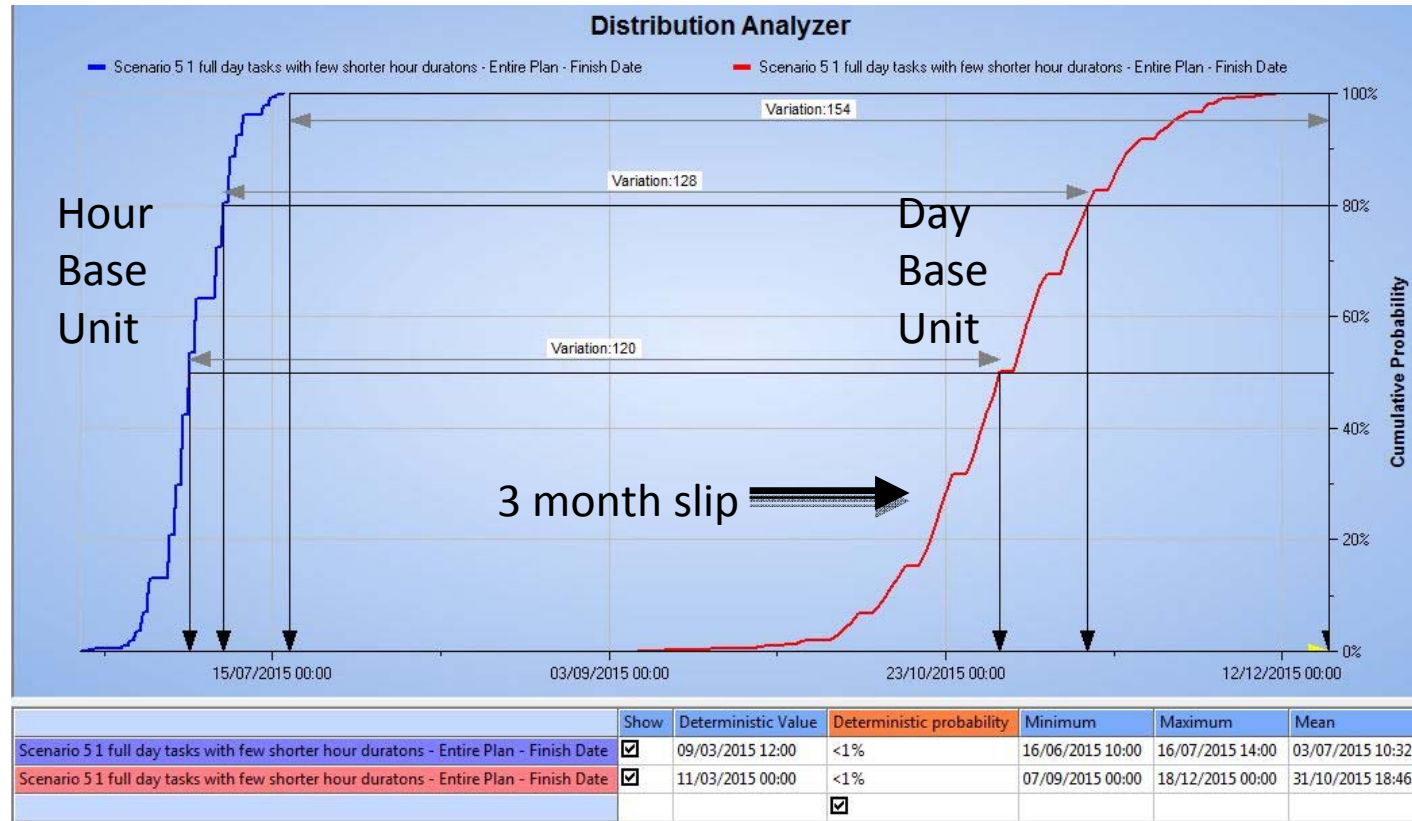
| Metric | Value |
|---------------------|------------|
| Deterministic - 0 % | 2/24/2015 |
| Mean | 10/25/2015 |
| P0 - Best Case | 9/30/2015 |
| P50 | 10/25/2015 |
| P75 | 10/29/2015 |
| P100 - Worst Case | 11/23/2015 |
| Range | 54 days |

Min 100% Most Likely 100% Max 149%

Min 100% Most Likely 100% Max 150%



Implications cont.



- ▶ Impact of Change from Hour to Day Base Unit
 - Unchanged duration, uncertainty three point estimates



Analysis Schedule Lessons Learned

- ▶ Understand how tasks elements will be handled by analysis software.
 - Recommendation:
 - Use the lowest possible unit to ensure modeling of all tasks.
 - The tools may apply distributions at the lowest unit level, hours, and only report at a higher unit, days, and the desired analysis may be absent from reporting.
 - Avoid mixing and matching long and short duration tasks in analysis schedules.
 - Traceability
 - Analysis review
 - Understand the rounding of risk and uncertainty distributions on tasks.
 - This may require educating the subject matter experts providing three point duration estimates what the tools are doing to the tasks.



Analysis Schedule Modeling

- ▶ Understand how tasks elements will be handled by analysis software.
 - Recommendations cont.:
 - Some tools are automatically cancelling out Central Limit Theorem (CLT) impact through the use of correlation. Analyst must understand what the tools is doing.
 - Test scenarios to examine how tools are handling data.
 - Examine unique tasks within the schedules.
 - Work with developers to understand how the tools are manipulating the data.
 - Identify user error.
 - Examine how schedules are imported into analysis tools, if applicable.
 - Calendar settings.

The estimator/analyst must understand how each tool models and reports results.

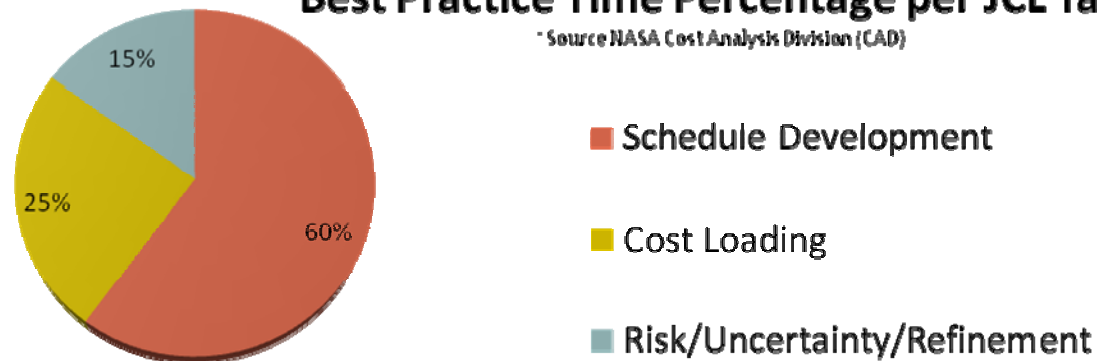
Importance to Joint Cost/Schedule Confidence Level Development



- ▶ **Best Practices highlight the importance of putting in the required effort for schedule development and analysis.**
 - ▶ JCL development procedure steps:
 1. Develop the Schedule (60%)
 2. Cost Load the Schedule (25%)
 3. Incorporate Risks (Cost/Schedule)
 4. Conduct Uncertainty Risk Analysis
 5. Obtain Results and Plot outputs
 6. Analyze Results and Refine
- } (15%)

Best Practice Time Percentage per JCL Task

* Source NASA Cost Analysis Division (CAD)





Questions?

▶ Group Discussion

- What is the largest schedule, number of tasks, you have analyzed?
- Have you ever felt that you are trusting the model without complete understanding of results.
- Many use CV for cost estimating/analysis health? Do you think that is a appropriate assessment for schedule estimating/analysis health? If not, what is an appropriate assessment?



Point of Contact

Justin Hornback, PMP, CCEA

Program Manager – NASA Strategic Business Unit

Reed Integration, Inc.

jhornback@reedintegration.com

757-541-8035 (o)

757-435-0050 (m)

www.reedintegration.com

