AUGUR

Schedule Risk at Early Acquisition

ICEAA Professional Development & Training Workshop

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Presenter Bios

Gabriella Magasic

- Augur Consulting
- 3+ Years of Industry Experience
  - Background is schedule and performance management
  - MA in Applied Economics
- Supports DOD customers

Sam Kitchin

- Augur Consulting
- 11+ Years of Industry Experience
  - Background is cost, schedule, and performance management (Incl. EVM)
  - ICEAA Certified CCEA
- Support a range of DOD and DOE customers

Outline

- Background and Purpose
- Risk Analysis Techniques
- Informed Recommendations
- Additional Considerations
- Conclusion

Background and Purpose

Intent

- Knowledge of schedule risk & uncertainty is critical for effective project management
  - GAO Scheduling Best Practices include "Conducting a Schedule Risk Analysis (SRA)"
  - Guidance is focused on Monte Carlo methods for mature schedules
- In low maturity environments, techniques for modeling risk & uncertainty must be modified

Goal: Identify strategies to assess schedule uncertainty in early acquisition

What is "Early Acquisition"?

- No singular definition for “Early Acquisition”
- In early acquisition, the "schedule" may not be an integrated master schedule (IMS)
- Level of detail driven by program needs or time/resource constraints

- No matter what the maturity of a program may be, there is a need to understand the schedule, risk, and uncertainty to support the success of the project

Two Types of Low Maturity

Low Schedule Maturity

- Schedule may exist but lack definition
- High-level WBS or IMS
- Captures major deliverables & milestones; lack detail in particular sections
- Not constructed to include task level detail
- Driven by schedule only

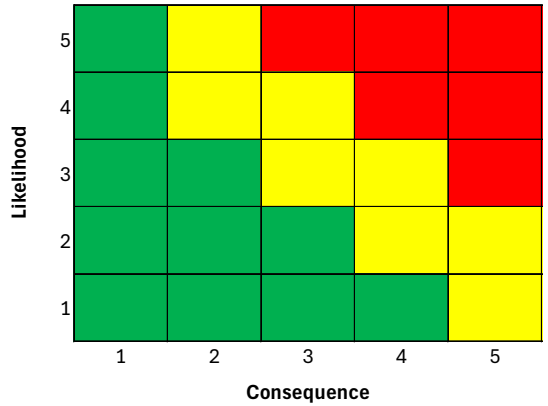
Low Technical/Acquisition Maturity

- A lack of maturity outside of the schedule
- No full understanding of the project scope
  - Impossible to construct detailed schedule without full understanding of work
  - Major milestones, performers, and deliverables unclear
- Unknown factors drive schedule

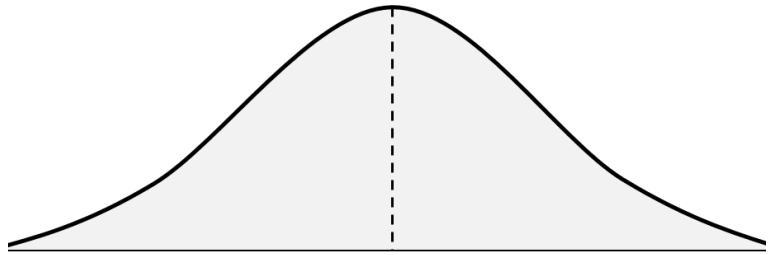
Risk vs Uncertainty

- Often used interchangeably, but distinct concepts!

- **Risk**: A discrete event with an estimated probability of occurrence and corresponding duration impact. “Threats” have negative impacts while "Opportunities” could positively impact the project



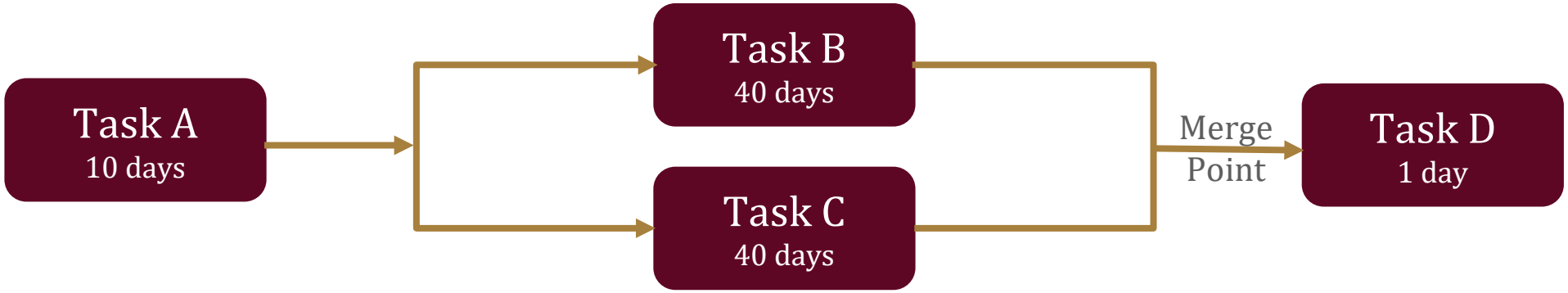
- **Uncertainty**: The total range of durations a schedule task or program may take based on unknowable factors



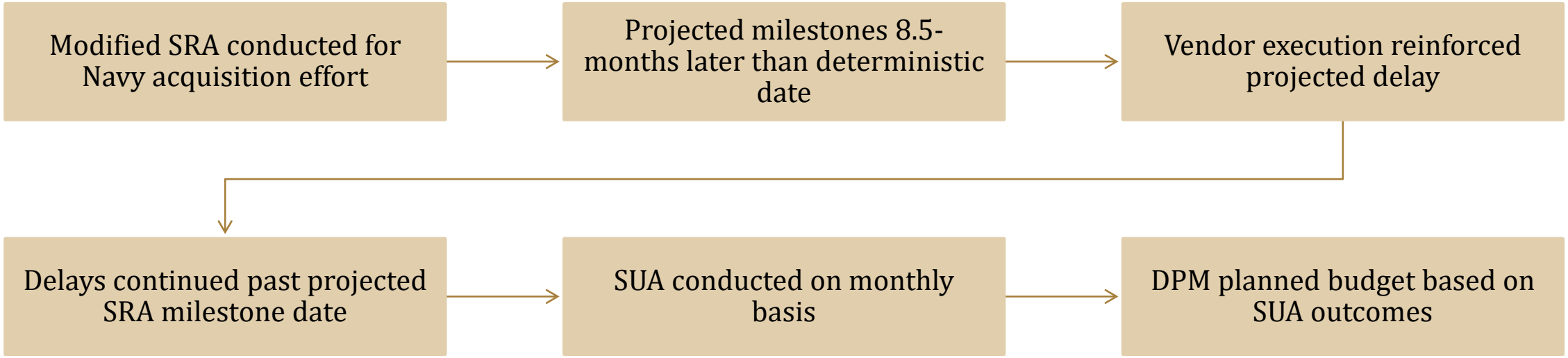
- Deterministic Schedule: A schedule that has not been adjusted for risk or uncertainty

Risk & Uncertainty in Schedules

- Some nuances to schedule risk and uncertainty
- Uncertainty typically applied to task durations
  - Often based on expert inputs (best case/worst case/most likely)
  - Tasks are detailed and change quickly
  - Often difficult to gather historical data to inform risk models
- Merge bias is result of schedule network logic



Realistic Applications of Risk and Uncertainty Analysis



- Benefits of risk and uncertainty analysis:
  - Support cost planning
  - Inform external dependencies
  - Notify PMs on frictional areas within their program

*Note: Schedule Uncertainty Analysis (SUA) – term used by Augur to describe a schedule with uncertainty distributions applied to tasks but without risks integrated into the schedule

Risk Analysis Techniques

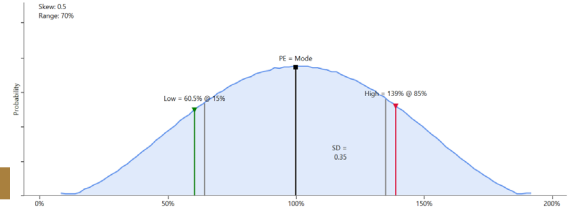
Techniques Introduction

- The following slides identify techniques for addressing schedule risk and uncertainty in early acquisition
- Many factors will impact the choice of technique
  - Project size and duration
  - Level of detail in the schedule
  - Leadership use cases, needs, and priorities
- There is no single solution that will work for any project
- In most cases, techniques will need to be tailored or combined

Techniques

1. Traditional Schedule Risk Analysis
2. Modified Schedule Risk Analysis
3. What-If Analysis
4. Risk Register
5. Added Risk Factor
6. Schedule Estimating Relationships
7. Subjective Assessment

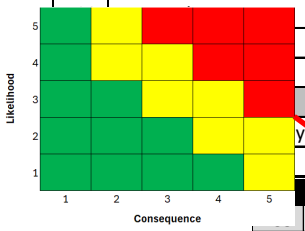
1. Traditional Schedule Risk Analysis



Overview

- Model with Monte Carlo simulations
- Uncertainty applied at lowest level task
- Risks integrated through logic
- Built out IMS and Risk Register needed

ID	Task Name	Duration	Start	Finish	Duration Uncertainty
121	Full SRA	100 days	Tue 2/6/24	Mon 6/24/24	
122	Software Development	100 days	Tue 2/6/24	Mon 6/24/24	
123	Phase 1	40 days	Tue 2/6/24	Mon 4/1/24	
124	Task A	10 days	Tue 2/6/24	Mon 2/19/24	PERT*(72.6,100,127.4,4,15,85)
125	Task B	15 days	Tue 2/20/24	Mon 3/11/24	PERT*(60.5,100,139.5,4,15,85)
126	Task C	15 days	Tue 3/12/24	Mon 4/1/24	PERT*(81.6,120.2,160.6,4,15,85)
127	Phase 2	60 days	Tue 4/2/24	Mon 6/24/24	
		20 days	Tue 4/2/24	Mon 4/29/24	PERT*(72.6,100,127.4,4,15,85)
		20 days	Tue 4/30/24	Mon 5/27/24	PERT*(72.6,100,127.4,4,15,85)
		20 days	Tue 5/28/24	Mon 6/24/24	PERT*(84.8,111.7,139.6,4,15,85)
		60 days	Mon 4/1/24	Mon 6/24/24	
	y	0 days	Mon 4/1/24	Mon 4/1/24	30
		0 days	Mon 6/24/24	Mon 6/24/24	100



Risk		Risk Description	Likelihood (%)	Duration Impact	Activities Impacted
		Risk Event Register			
136	RE1	Procurement Delay	75	30	126
137	RE2	Major SW Failure	10	100	130

Pros

- Apply uncertainty and view results at lowest level
- Well-informed forecasted dates
- Insight into impact to critical path or alternative critical paths

Cons

- Needs substantial data/risk knowledge
- Uncertainty input requires SME buy-in
- Time consuming
- Requires specialized software
- Difficult to apply in early acquisition

2. Modified Schedule Risk Analysis

Overview

- Schedule "flattened"
- Uncertainty applied more generally
- Understanding of critical events & driving paths required
- Good middle-ground solution

ID	Task Name	Duration	Start	Finish	Duration Uncertainty
138	**Modified SRA**	**100 days**	**Tue 2/6/24**	**Mon 6/24/24**	
139	**Software Development**	**100 days**	**Tue 2/6/24**	**Mon 6/24/24**	
140	Phase 1	40 days	Tue 2/6/24	Mon 4/1/24	PERT*(60.5,120.2,160.6,4,15,85)
141	Phase 2	60 days	Tue 4/2/24	Mon 6/24/24	PERT*(72.6,111.7,139.6,4,15,85)
142	**Risk Event Register**	**60 days**	**Mon 4/1/24**	**Mon 6/24/24**	
143	Procurement Delay	0 days	Mon 4/1/24	Mon 4/1/24	30
144	Major SW Failure	0 days	Mon 6/24/24	Mon 6/24/24	100

ID	Risk	Risk Description	Likelihood (%)	Duration Impact	Activities Impacted
142		**Risk Event Register**			
143	RE1	Procurement Delay	75	30	140
144	RE2	Major SW Failure	10	100	141

Pros

- Similar outputs to traditional SRA
- Benefits large program schedules
- Can assess two schedules on same level
- Faster implementation of uncertainty
- More apt for early acquisition programs

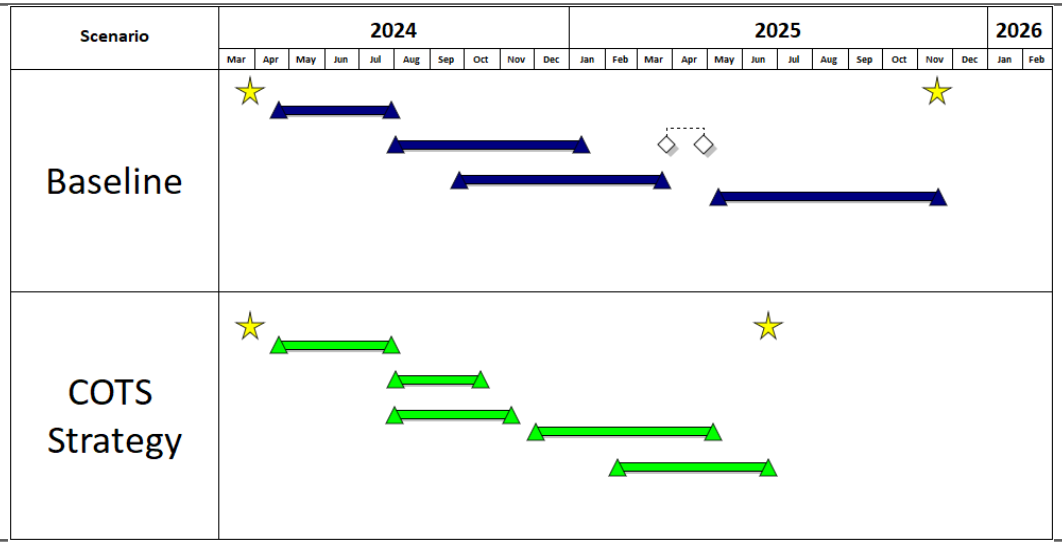
Cons

- More difficult to apply risk events w/ logic
- Less informed critical path
- Significant data requirements
- Extra effort required to flatten schedule
- Specialized software likely required

3. What-If Analysis

Overview

- Model discrete scenarios
- Ex: compare two courses of action (COAs)
- Useful when many unknowns
- Solicit input on relevant scenarios
- Documentation is key



Pros

- Targets areas of high interest
- Can model major changes to strategy
- Easy to communicate
- Works well w/ immature strategies
- May highlight risk/uncertainty

Cons

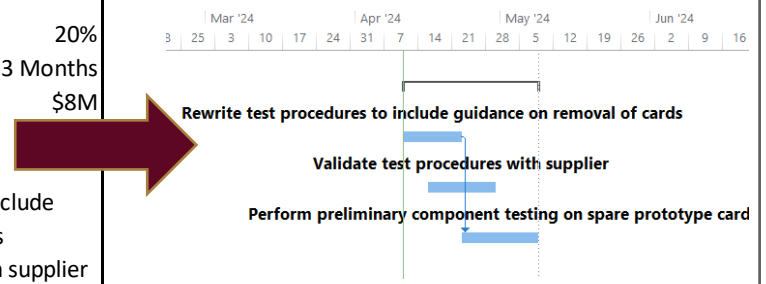
- Does not address risk or uncertainty beyond the COA definition
- No probabilities for each outcome

Risk Register

Overview

- Use Risk Register to model risk
  - Impact with probability of occurrence
- Incorporate mitigation strategies into IMS
  - Detailed tracking aids implementation
- Track opportunities as well as risks

RISK ID	1709-R
Risk Description	**If** circuit card assemblies fail during component testing **then** new cards will need to be fabricated
Probability	20%
Impact (Time)	3 Months
Impact ($s)	$8M
Mitigation Steps	
1	Rewrite test procedures to include guidance on removal of cards
2	Validate test procedures with supplier
3	Perform preliminary component testing on spare prototype card



Pros

- Models risks identified by stakeholders and documented in project artifacts
- Leverages analysis and rigor applied by risk management team
- Mitigation strategies tracked in schedule

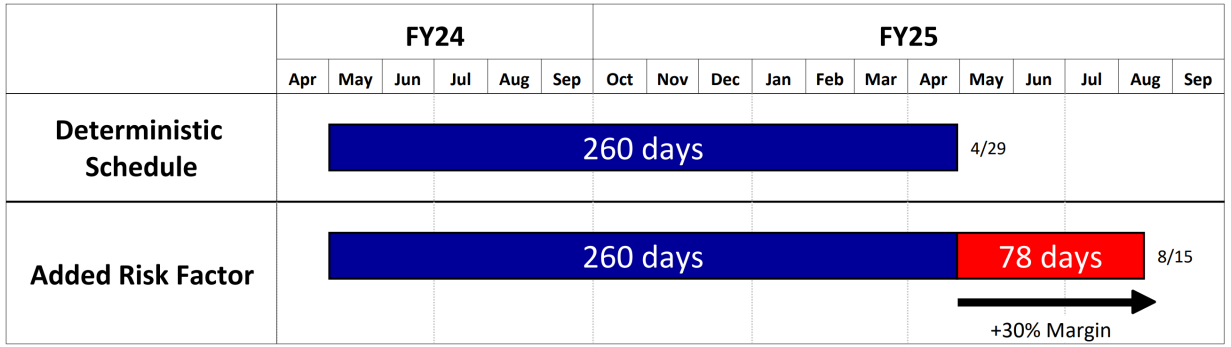
Cons

- Need mature risk management process
  - Projects in early acq. may not have register
- Risks can be difficult to model
- Does not capture duration uncertainty

Added Risk Factor

Overview

- Flat % of total duration or sub-element
- Based on data/rules of thumb/fixed rates
- Applies to major project elements or project in their entirety
- Repetitive/standardized timelines



Pros

- Applicable in most scheduling settings
- Based on historical project data
- Easily combined with other techniques
- Models repetitive processes well
- Not time consuming

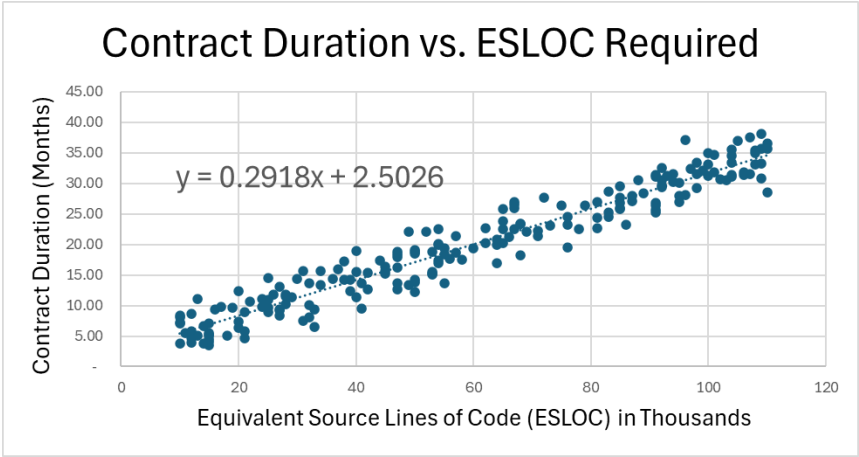
Cons

- No insight into Critical Path (CP) or schedule friction points
- No identification of task level uncertainty or impact of risk events
- Less meaningful without historical data

Schedule Estimating Relationships (SERs)

Overview

- Mathematical models of duration as function of technical & program factors
  - Modify assumptions and quantify impact
  - Regression provides prediction interval
  - Generate optimistic & pessimistic results



Regression Statistics	
Multiple R	0.9655
R Square	0.9323
Adjusted R Square	0.9319
Standard Error	2.4620
Observations	200

Pros

- Analysis is backed by actual data
- SERs can be reused
- Easy to see impact of changing inputs
- Works well as a secondary methodology

Cons

- Difficult to gather data
- Data must be reliable and relevant
- Unlikely to be useful for task level analysis

Subjective Assessment

Overview

- Input from subject matter expert (SME)
- Quantifies program unknowns
- Looks at major program elements; SME estimates rational range of outcomes
- Built upon as the program matures

What does the time frame look like to complete this project?

Pros

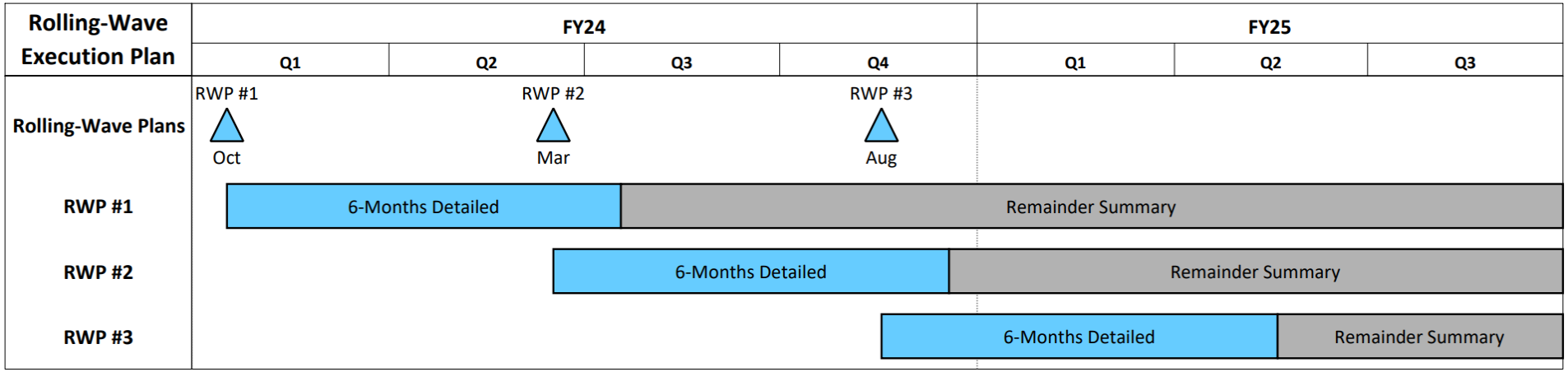
- Can be done quickly w/ minimal effort
- Mature schedule products not required
- Applicable to early acquisition programs
- No IMS or risk information required

Cons

- Limited justifications in forecasted dates
- Bare-bones estimate
- Requires SME familiarity with project to provide realistic project duration ranges
- No reasoning behind the variance of dates

Informed Recommendations

- Recommend “Hybrid” technique
  - One method may not be a perfect fit; two or more will better meet program needs
- Schedules in early acquisition are not fully mature and will continue to develop
  - A schedule risk analysis is not a ‘one and done’ effort.
  - Assessment of risk should mature alongside the schedule development
- Rolling wave planning



Application of Techniques

WBS Description	WBS Lvl	Risk & Uncertainty Application	Scenario
Sample Program Name	**1**		
Development	**2**		
Government Design	3		
Warfare Center	4	Traditional SRA	A detailed IMS exists with historical and SME information to inform applicable uncertainty distributions and risks
Contractor Support	4	Modified SRA	A detailed IMS exists but common groupings of tasks can be identified. Tasks are bucketed and assigned an uncertainty distribution. Risks are still captured within the SRA
Vendor Development Contract	3		
Systems Engineering	4	Applied Risk Factor	Analysis of analogous contracting efforts shows an average delay of X% of the baseline duration
Prototype HW Fabrication	4	Risk Register	Parts procurement risk identified, and mitigation steps built into schedule if part delayed
Integration	4	Subjective Assessment	A SME identifies the low/most-likely/high duration estimates for integration
Vendor Test	4	Schedule Estimating Relationship	A regression analysis considering multiple factors that affect duration to generate a worst case and best case for the duration of the test event
Government Test	3	What-If Analysis	Two scenarios modeled; one where the system passes and one where it does not

Additional Considerations

- Paper addresses several other benefits, weaknesses and considerations for schedule risk and uncertainty analysis
  - Improved schedule management
  - Benefits to improving cost outcomes
    - Better fidelity in cost estimates
    - Align funding to execution
  - Ability to identify resource constraints
- Early project buy-in can lead to better future outcomes

Conclusion

- Schedules are models
  - Output is the result of assumptions, inputs, and calculations
  - Goal is to align to reality, but result will never be perfect
- Analysis of risk & uncertainty can be used to quantify and predict variability in schedule results
- In early acquisition, projects will need to be creative
  - Presentation identified techniques, but tailoring will be necessary
  - Often a hybrid solution will be most relevant
- Schedule risk & uncertainty is critical at any stage of a project

Questions?

Backup

References

[1] U.S. Government Accountability Office, "Schedule Assessment Guide: Best Practices for Project Schedules," pp. 99-120, 2015.

[2] AACE International, "(PUBLIC REVIEW DRAFT) AACE® International Recommended Practice No. 132R-23: SCHEDULE RISK ANALYSIS MATURITY MODEL," *AACEI RP,* p. 26, 2023.

[3] NASA, "Appendix K: Schedule Estimating Relationship (SER) Development and Model Inputs," *NASA Cost Estimating Handbook Version 4.0,* pp. K-1 - K-11, 2015.

[4] ICEAA, "Cost and Schedule Risk Analysis," CEBoKWikiDev, 9 July 2021. [Online]. Available: https://wikidev.iceaaonline.com/w/index.php?title=Cost_and_Schedule_Risk_Analysis&oldid=7436. [Accessed 29 January 2024].

[5] The Naval Center for Cost Analysis, "Joint Cost Schedule Risk and Uncertainty Handbook," pp. 1-80, 2014.

[6] National Defense Industrial Association: Integrated Program Management Division, "Planning & Scheduling Excellence Guide (PASEG)," pp. 145-160, 2019.

Acronyms

Acronym/Abbreviation	Meaning
AS	Acquisition Strategy
COA	Course of Action
CP	Critical Path
FY	Fiscal Year
GAO	Government Accountability Office
IMS	Integrated Master Schedule
PM	Program Manager
PRS	Program Roadmap Schedule
SER	Schedule Estimating Relationship
SME	Subject Matter Expert
SRA	Schedule Risk Analysis
SUA	Schedule Uncertainty Analysis
WBS	Work Breakdown Structure

Abstract

It can be difficult to construct a realistic schedule early in the acquisition lifecycle due to the limited certainty of requirements, design decisions, and other key elements of program planning. Understanding risk and uncertainty in a schedule is essential, and the GAO Scheduling Guide includes “Conducting a Schedule Risk Analysis” as one of the 10 Best Practices. A schedule risk analysis (SRA) can provide quantitative insight into potential areas of delay along with associated cost impacts. However, a well-formed SRA requires clear input and structured analysis of risk events and uncertainty. This paper discusses how to address schedule risk in low maturity projects by identifying the unique challenges in early acquisition environments, investigating different risk modeling techniques, and analyzing how uncertainty must be interpreted and applied early in the project lifecycle.

Technique Summary

Technique	Models Uncertainty	Models Risk Events	Monte Carlo	Requires Detailed IMS	Data Driven	Time to Implement
Traditional Schedule Risk Analysis				Yes		Long
Modified Schedule Risk Analysis				Yes		Med
What-If Analysis				Possibly		Med
Risk Register				Possibly		Short
Added Risk Factor				No		Short
Schedule Estimating Relationships				No		Long
Subjective Assessment				No		Short