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Joint Cost and Schedule Uncertainty: A How-To Primer

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■ Tom Walker

- Principal Analyst with Tecolote Research
 - 19 years in the Los Angeles Division
 - Global Positioning System Directorate, 13 years

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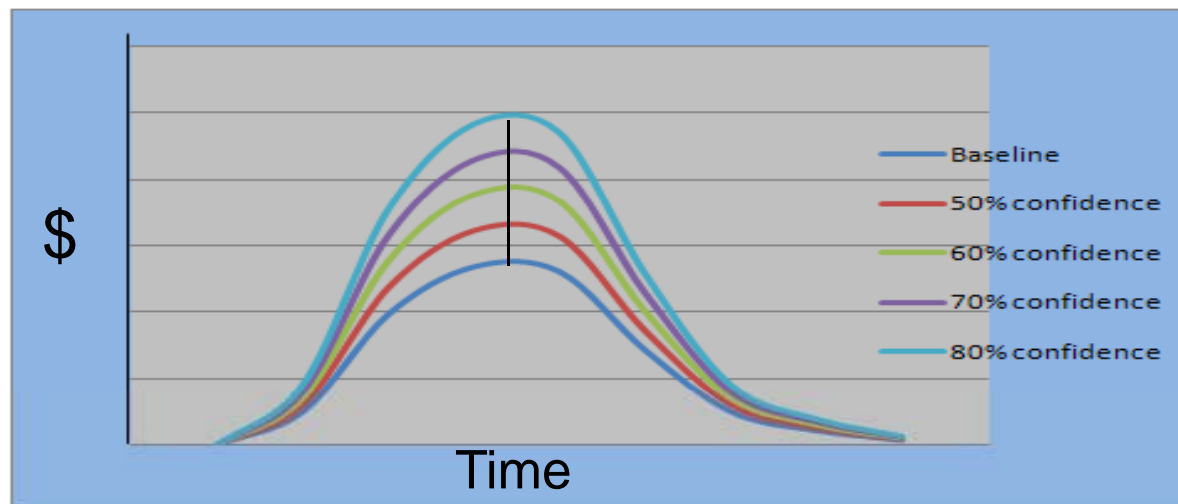
- Sr. Consultant with Galorath, Inc.
 - 6+ years supporting the Los Angeles Division of Tecolote
 - Primarily supports GPS Directorate



What is the Issue?

- **Most cost estimating models vary cost by confidence levels (CL). For example, you may have a project which is \$50M at the 50% confidence level and \$62M at the 70% level.**
- **However, most models use the program schedule within the model. This schedule is fixed and will not vary with the confidence levels or selection of different levels of risk**
- **What you end up with is additional dollars/hours packed into the same schedule**

Symmetrical
cost profiles.
Peak cost
occurs same
time for each CL.
All profiles end
at same time





What is A Solution?

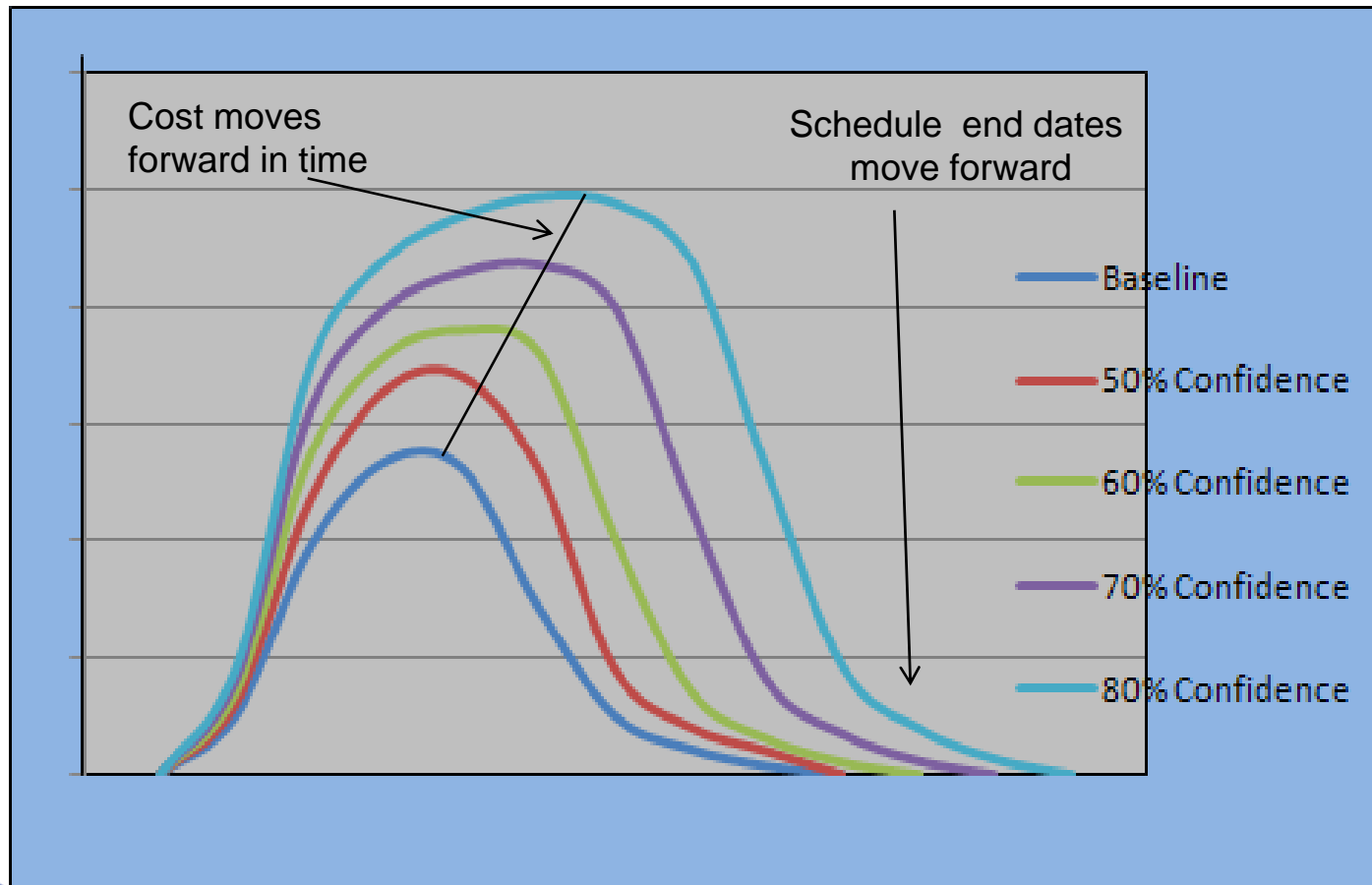
- **ACEIT cannot add risk to dates.**
- **What will ACEIT apply risk to? – Numbers**
- **What can be used to determine a schedule in ACEIT? – Numbers**
 - A schedule = A duration (years, months, days)
 - A duration = A number
- **If it is possible to create a schedule based on numbers, not dates, ACEIT may be able to create longer schedules at the higher confidence levels.**
- **Good News: IT IS POSSIBLE!**
- **Use schedule durations within ACEIT to account for schedule risk**





With Joint Cost-Schedule Risk

A few easy additions to the ACEIT model to incorporate schedule risk will allow your cost estimates to shift to the right as the schedule increases





What ACEIT Will and Will Not Do

- **ACEIT will not apply risk to a date, i.e., 01Jan2010**
 - So it will not “stretch” a schedule end-date based on risk and confidence levels
- **ACEIT will apply risk to a number**
 - Use a schedule duration value to determine the schedule end-dates, and ACEIT will increase that value based on risk and confidence levels
- **Only actual hard-coded date input needed is the program start date**
 - End dates will be determined by the start date plus the software development durations – in months – provided by SEER
 - Using DateAdd(start_date, Years, Months, Days)
 - As the duration months value is increased with risk, the schedule end-date will stretch longer and take the costs (also with risk) out with it





- We used the SEER for Software parametric model to derive the cost and the development schedule for each Build
- The output which we use from SEER is the cost distribution and the schedule duration distribution curves
- The development schedule output from SEER is given as a duration value in months
- Risk on the schedule duration is what causes the schedule to increase as the confidence levels are increased in ACEIT.
- ACEIT will distribute the costs across fiscal years based on the schedule duration calculated in ACEIT





- We used SEER for Software to develop an example for this presentation. The example consists of three programs (CSCI's) developed over three builds. The WBS and sizing selected were:

	Least	Likely	Most
Build 1			
CSCI 1	5,000	10,000	20,000
CSCI 2	4,000	8,000	16,000
CSCI 3	2,000	4,000	6,000
Build 2			
CSCI 1	10,000	13,000	15,000
CSCI 2	4,000	7,000	40,000
CSCI 3	3,000	6,000	10,000
Build 3			
CSCI 1	2,000	5,000	10,000
CSCI 2	3,000	6,000	12,000
CSCI 3	4,000	6,000	9,000





SEER Schedule Durations

- The example was selected to illustrate that the critical path items can change by build and by confidence level.
- ACEIT has the ability to account for these changes.

	Schedule Duration		
	50%	60%	70%
Build 1			
CSCI 1	18.2	21.8	26.5
CSCI 2	16.7	20.0	24.3
CSCI 3	12.2	14.3	17.0
Build 2			
CSCI 1	19.5	22.3	25.8
CSCI 2	19.0	24.3	31.7
CSCI 3	14.5	17.2	20.7
Build 3			
CSCI 1	13.7	16.5	20.1
CSCI 2	14.9	17.9	21.8
CSCI 3	14.5	17.0	20.1





ACEIT Functions for Joint Cost-Schedule Risk

- **Two basic ACEIT functions are used to create a Joint Cost-Schedule Risk estimate**
 - DateAdd
 - RiskCost
- **DateAdd(Date, Year, Month, Day)**
 - DateAdd(Start_date_bld2, 0, **build2_duration** ,0) [chart 9]
 - Adds the schedule duration of Build 2, in months, to the start date
 - i.e., If the start date is 01Jan2011 and the duration is 25 months -> the end date will be 01Feb2013
- **RiskCost(@variable, confidence level)**
 - RiskCost(@Build2_end, 60) [chart 10]
 - Determines the end date for Build 2 at the 60% confidence level based on the duration distribution





ACEIT Sections Used in Joint Cost-Schedule Risk Application

ACEIT Section	Description
1 - Cost Input	Software development cost from SEER with risk
2 - Schedule Input	SW development schedule from SEER with risk
3 - Software <u>Build</u> Durations	Sets durations (schedule) for each <u>Build</u> based on the CSCI with the longest duration in that Build
4 - Schedule Dates	Determines the calendar start and end dates for each Build using DateAdd , offset variable, and Build durations
5 - Offset	Used to set the start date of the next Build based on a calculated offset number– in months– using the duration of the previous Build
6 - Cost Roll-up, sets up Start and Finish dates to react to the risk	Uses RiskCost to “stretch” the schedule duration values based on the SEER schedule risk (from section 2) and changing confidence levels in ACEIT reports. Affects the duration variables used in section 4 that sets the start and end dates for each Build

These six sections created in ACEIT are used in the Joint Cost-Schedule risk process to supply input data (from SEER), label and manipulate the data, and perform the calculations with risk that will affect both the cost and the schedule. Sections 3, 4, and 6 are the functions that make the schedule stretch out in time. Each section will be noted in the briefing where used.





Schedule (Duration) Input Section

Schedule duration data – in months – with risk from SEER. ACEIT section 2

WBS/CES Description	Unique ID	Equation / Throughput	Distribution Form	High (% of PE)	High Percentile	PE Position in Distribution
Build 1 Duration		Data from SEER output				
CSCI 1	dur_1	7.57	LogNormal	211	90	Median
CSCI 2	dur_2	10.8	LogNormal	245	90	Median
CSCI 3	dur_3	20.2	LogNormal	280	90	Median

Schedule duration for Build 1 is 20 months

ACEIT section 3 determines the schedule (duration) for each Build based on the highest CSCI value from the schedule input section

WBS/CES Description	Unique ID	Equation / Throughput	BASELINE
Build 1 Duration	bld1_dur	RND(MAX(dur_1, dur_2, dur_3))	20
Build 2 Duration	bld2_dur	RND(MAX(2dur_1, 2dur_2, 2dur_3))	18
Build 3 Duration	bld3_dur	RND(MAX(3dur_1, 3dur_2, 3dur_3))	15

↑
These variables are used to set the schedule dates for the build start and end dates - chart 11

↑
The risk from the input section will follow these values as they are used in setting the start and end dates in the schedule section - ACEIT section 4

The output from SEER (in blue) can be configured in Excel so it fits right into the pre-formatted ACEIT “Risk Basic” work screen with a quick cut-and-paste



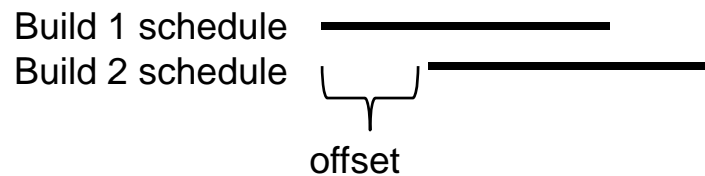
Start-End Dates Section

Schedule dates for the start and end dates for each Build - ACEIT section 4			
WBS/CES Description	Unique ID	BASELINE	Equation / Throughput
ATP Block 1	ATP_1	01MAR2010	1-Mar-10
Build 1			
Build 1 start	Build1_start	01MAR2010	ATP_1
Build 1 end	Build1_end	30OCT2011	DateAdd(Build1_start, 0, bld1_dur, 0)
Build 2			
Build 2 start	Build2_start	30SEP2010	DateAdd(Build1_start, 0, offset [7], 0)
Build 2 end	Build2_end	30MAR2012	DateAdd(Build2_start, 0, bld2_dur, 0)

These variable will be used in the "Start Date" and "Finish Date" columns where RiskCost is applied to them (next chart)

'bld1_dur' = 20 months
'bld2_dur' = 18 months

- 1) The "offset" is a pre-calculated value (ACEIT section 5) based on the duration of Build 1 times .35 (20 x .35 = 7). This sets the start date of Build 2 to be 7 months after the start of Build 1



- 2) The value for "bld..x_dur" (schedule duration) will increase based on the risk for that value from the software duration inputs section (SEER output – ACEIT section 2). Offset will also increase.



Where it All Comes Together

The cost input section contains a flexible start and finish date based on the risk in the duration values

WBS/CES Description	Unique ID	BASELINE	Equation / Throughput	Phasing Method	Start Date	Finish Date
		13.7				
Build 1	Build1_cost	8.4	bld1 hrs * Labor Rate		Build1_start	RiskCost(@Build1_end,CL)
Build 2	Build2_cost	5.3	bld2 hrs * Labor Rate	BE	RiskCost(@Build2_start,CL)	RiskCost(@Build2_end,CL)
Confidence Level	CL	60	60	C		

Use a variable for the confidence level input, so it can be changed easily to go with each ACEIT CL report run

All start and finish date changes are based on the schedule durations and risk from SEER (see ACEIT section 3)

- Build 1 start date is set by ATP variable (contract start date)
- Build 1 end date is based on its duration value (from SEER) and will increase as risk confidence levels increase
- Build 2 start date is based on the duration of Build 1, and will move as Build 1 duration increases with risk
- Build 2 end date is based on its duration value (from SEER) and will increase as risk confidence levels increase
- Repeat sequence for every build



Results

- **After you've run a phased report at higher risk confidence levels, the calendar dates for the build's start/finish dates (ACEIT section 4) will change to the new stretched out dates so the amount of schedule extension can easily be determined**
- **The amount of costs moving forward with the schedule can be determined by comparing the annual costs at the various confidence level reports**





Recap

- Create a cost and schedule input section for the estimated values from SEER output (ACEIT section 1 and 2)
- Configure ACE so that the duration for each software build is a variable representing a value – in months (ACEIT section 3)
 - The schedule (or duration) for each build is determined by the longest duration among all the CSCIs in that build
 - Make the schedule duration a variable e.g., “build1_duration”
- Create a schedule date section for start and end dates for each build (ACEIT section 4 and 5)
 - Use DateAdd with the duration variable to derive the dates
- In the cost calculation section use the variables created in ACEIT section 4 in conjunction with the RiskCost function in the Start Date and Finish Date columns





- **Questions?**

- **Please feel free to contact us:**
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 - Steve Sultzer sdsultzer@galorath.com

- **Thank you for your attention!**