(RISK-2890) Journey-Map to a More Mature Schedule Risk Analysis (SRA) Process

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David T. Hulett

- My consulting firm, Hulett & Associates, LLC of Los Angeles, was established in 1990
- I have written two books on Schedule Risk Analysis and Integrated Cost-Schedule Risk Analysis (ICSRA)
- I have authored two Recommended Practices for AACE International, on ICSRA and Decision Trees
- Something You Don't Know About Me – I enjoy international consulting and training, even with the long airplane rides to Asia, Europe and South America

Introduction to the Journeymap

Advancing Risk Analysis Maturity provides benefits but requires more expertise and effort

Context

- Not all organizations need to achieve the highest level of risk analysis maturity
- Although those with the lowest maturity levels will not be able to use risk analysis to determine the probability of schedule failure, identify, prioritize and mitigate project risks and calculate the impact of schedule on labor-type costs
- Higher maturity levels follow recognized principles, use modern tools and provide management with actionable information on project risk that will contribute to decision making

Journeymap - Unaware to Advanced

Level 0: Unaware of Cost and Schedule Risk

- Individuals rely entirely on the results from project scheduling software, specifically the milestone and project finish dates. They promise and defend those dates.
- Individuals are not alert to any threat to achieving the finish date produced by the schedule.
- When faced with contrary results from others, they claim “this project is different” or “it won’t happen on my project.”

Level 0: Weaknesses

- The organization may rely on the schedule software's result long after it becomes obvious the project is not performing to those dates
- Risks are not addressed so they may happen when they could be avoided or their impact on the schedule may be larger than necessary.
- Surprises and "firefighting" responses after the risk occurs are common at this level of maturity.

Level 1: Basic Risk Awareness

- This level indicates awareness of project risk as something to consider when reviewing on or reporting the project scheduling software's calculated finish date
- Risk may be discussed frequently and decisions may take account of the risk
- Characterized by the lack of a systematic way to think about risks

Level 1: Benefits / Strengths

- Assess whether the project schedule adopted may be biased (usually for shorter schedule) and review whether to replan deterministically
- Adopt a probabilistic attitude towards the project plan, project teams and management as well
  - This may take some practice

Level 1: Weaknesses

- Since the risks are not addressed in an organized way, some important risks may be overlooked
- The risks that have been identified may not be the root causes of schedule variability
- This level lacks an organized way of calculating how individual risks affect the schedule including the complex logical relationships that cause the risk to affect the risk-critical paths
- At Level 1 addressing risks is *ad hoc* and therefore may be quite inefficient

Level 2: Qualitative Risk Analysis

- This level of maturity represents examining project risk to schedule using qualitative methods that lead to developing a Project Risk Register.
- This method recognizes the need to identify risks and prioritize them by probability and impact
- Often used for smaller projects

Level 2: Characteristics

- Examining project risk to schedule (and to other objectives such as cost, quality and scope) using qualitative methods that lead to developing a Project Risk Register
- Often viewed as a low-cost and easily-understood but organized method of addressing project risks
- Maturity at Level 2 may be sufficient for some projects or some organizations.

Level 2: Capabilities Needed

- Ability to identify and name project risks by the risk sentence structure
- Ability to understand the probability that a risk will happen affecting the project finish date - “uncertainty that matters”
- Ability to estimate, within a range, the probability and effects of a risk’s occurring projected on the project finish date
- Participate in or lead a risk workshop

Level 2: Impact Definitions

Defined Conditions for Impact Scales of a Risk on Major Project Objectives Examples for Negative Impacts Only					
Project Objective	Very Low 1	Low 2	Moderate 4	High 8	Very High 16
Cost	Insignificant Cost Increase	<$.5 million Increase	$.5 – $5 million Increase	$5 - $20 million Increase	>$20 million Increase
Time	Insignificant Time Increase	<2 weeks Increase	2 – 5 weeks Increase	6 to 10 weeks Increase	> 10 weeks Increase
Scope	Scope Decreases Are barely Noticeable	Minor Areas of Scope Affected	Major Areas of Scope Affected	Scope Reduction Unacceptable to Sponsor	Project End Item is Effectively Useless
Quality	Quality Degradation Barely Noticeable	Only Very Demanding Applications are Affected	Quality Reduction Requires Sponsor Approval	Quality Reduction Unacceptable to Sponsor	Project End Item is Effectively Useless

Definitions are necessary to put all risks on the same scale. Some qualitative risk analyses do not create / use these definitions and are useless

Level 2: Risk Prioritization Scheme

Probability and Impact Risk Scores: Time Objective											
Risk = P x I											
Probability	Threats					Opportunities					Probability
Very High											Very High
High											High
Moderate											Moderate
Low											Low
Very Low											Very Low
	VL	L	M	H	VH	VH	H	M	L	VL	
	Threat Impact					Opportunity Impact					

Level 2: Strengths

- Handling risk at maturity level 2 may be enough for many projects
- The smaller, shorter-duration, lower-cost projects that do not affect the commitments or reputation of the organization might be handled with the development and maintenance of a risk register
- Record the mitigation of risks and their assessed improvement in lowering the probability, reducing the impact, or both

Level 2: Weaknesses

- Can not provide an estimate of the probability that the scheduled finish date will be overrun or the amount of contingency needed to provide a desired level of certainty
- Gauging the impact of a risk on the finish date is difficult without a schedule
- Risk workshops, often used to collect these data, can ignore risks that are difficult to discuss in a group

Level 3: Basic Quantitative Analysis

- Recognizes that project schedule success is affected by uncertainty of the estimated durations of the activities in the project schedule
- Can be analyzed statistically by applying Monte Carlo simulation (MCS) with specialized but available software

Level 3: Characteristics

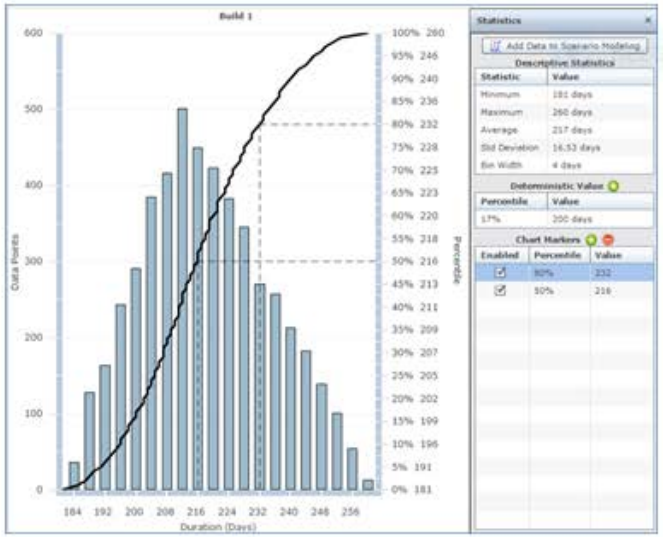
- Variability of activity durations is represented by applying probability distributions, typically 3-point estimate of Low, Most Likely and High days of impact *directly to the activity durations*
- Monte Carlo simulation produces histograms and cumulative distributions giving probability of finishing on time and estimates a contingency of schedule and cost

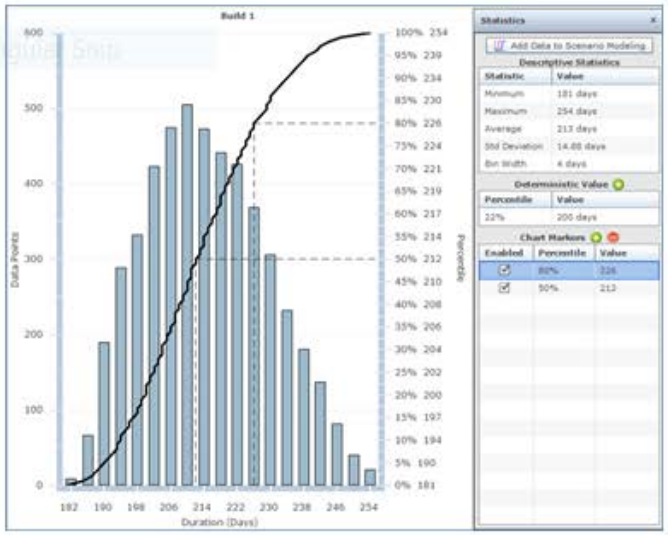
Level 3: Capabilities Needed

- An ability to understand and assess a schedule against schedule best practices (e.g., GAO Schedule Assessment Guide)
- Using Monte Carlo simulation (MCS) software that simulates schedules using 3-point estimates on durations

Level 3: Distributions Used

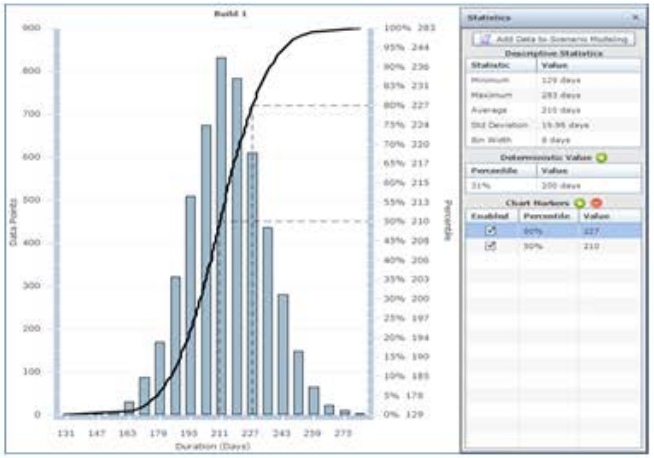
Triangular

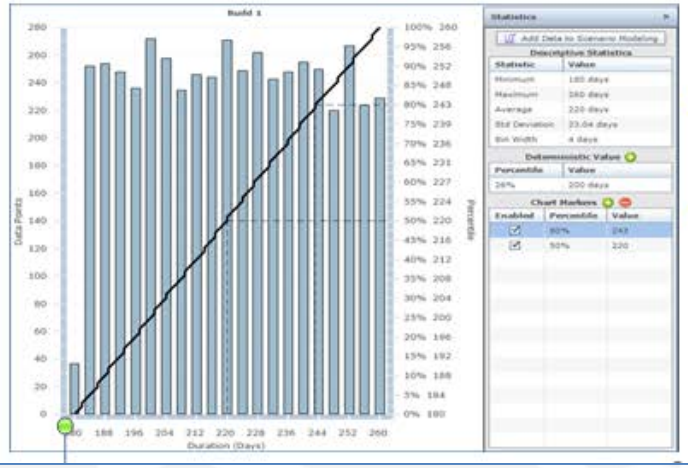




Beta PERT

Normal





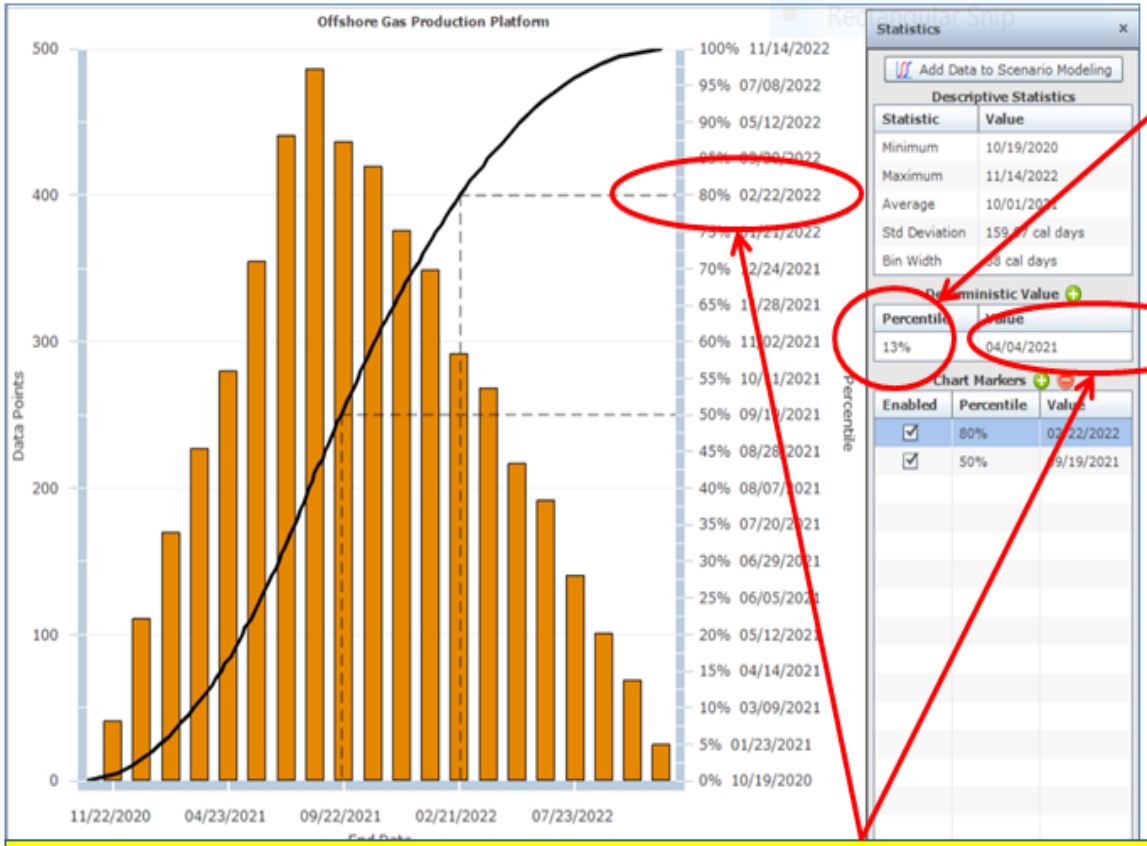
Uni-form

These reflect the "image" of, perhaps, several risks on activity durations – not the risks themselves

Level 3: Benefits

- The use of the schedule avoids having to guess at the impact on the finish date
  - Uses schedule logic and Monte Carlo simulation software for complex calculations
- Provides results such as total project contingency estimates that are not available from the qualitative Risk Register methods

Level 3: Benefits - Example



Question # 1: Probability of finishing on schedule= 13%

Question #2: Contingency for an 80% likelihood of finishing on time or earlier
Subtract scheduled finish of 4-4-21 from the P-80 date of 2-22-22 for 10.5 months

Simulation software shown here is Polaris® from Booz Allen Hamilton

Level 3: Weaknesses

- Since does not use the individual risk, does not identify which risks caused the fluctuations in the MCS
- Does not handle the probability that the risk will / will not occur
- Range estimating cannot capture the effect of individual risks if:
  - An activity if affected by several risks
  - A risk affects multiple activities – chained together
- Require specifying correlation coefficients, about which we are particularly imprecise

Level 4: Modern Quantitative Risk Analysis

- Builds up risk to the model to simulate the schedule.
- Distinguishes between:
  - *Uncertainty* – background variability, estimating error and bias, if present
  - *Identifiable project-specific risks*, starting from the Level 2 risk register, augmenting it by:
- Collecting quantitative data in confidential risk interviews, identifies "Known-Unknowns" and gets better quality data
- Apply risks to activities they affect
- The risk analyst will often decide to develop a summary schedule for the risk analysis
- Best to compare MCS results to history of schedule overruns of similar projects for "outside view"

Level 4: Applying Uncertainty

Templated Uncertainty Editor

Templates Add Remove

Priority	Filter	Schedule Uncertainty
1	Approval	Triangular - Min:0.9 Likely:1.05 Max:1.2
2	Engineering	Triangular - Min:0.9 Likely:1.05 Max:1.25
3	Procurement	Triangular - Min:0.9 Likely:1.05 Max:1.15
4	Fabrication	Triangular - Min:0.85 Likely:1.1 Max:1.4
5	Installation	Triangular - Min:0.9 Likely:1.1 Max:1.4
6	Drilling	Triangular - Min:0.85 Likely:1.05 Max:1.4
7	HUC	Triangular - Min:0.8 Likely:1 Max:1.4

Uncertainty of Schedule Durations can be put on categories of activities as reference ranges

Level 4: Applying Risk Drivers

Risk Drivers represent root causes of schedule variability

Risk Driver Names and Probability

Discrete | Driver

Risk Driver Editor

Risk Drivers

Enabled	UID	Risk Driver Name	Probability	Notes
☑	1	Bids may be Abusive leading to delayed approval	60%	
☑	2	Engineering may be complicated by using offshore design firm	40%	
☑	3	Suppliers of installed equipment may be busy	30%	
☑	4	Fabrication yards may experience different Productivity than planned	55%	
☑	5	The subsea geological conditions may be different than expected	45%	
☑	6	Installation is complex and may be challenging to the shipyard	55%	
☑	7	Fabrication and installation problems may be revealed during HUC	40%	
☑	8	The organization has other priority projects so personnel and funding may be unavailable	35%	

Risk Driver Impact Editor

Tasks Add Remove

Task	Parallel
G1030 - Install CPP Topsides	☐
G1000 - Install Drilling Platform Jacket	☐
G1010 - Install Drilling Topsides	☐
G1020 - Install CPP Jacket	☐

Duration Factor

Triangular - Min:0.9 Likely:1.15 Max:1.45

Cost Factor

Triangular - Min:0.8 Likely:1.1 Max:1.5

Risk Driver 6, Installation is complex and is assigned to four Installation activities

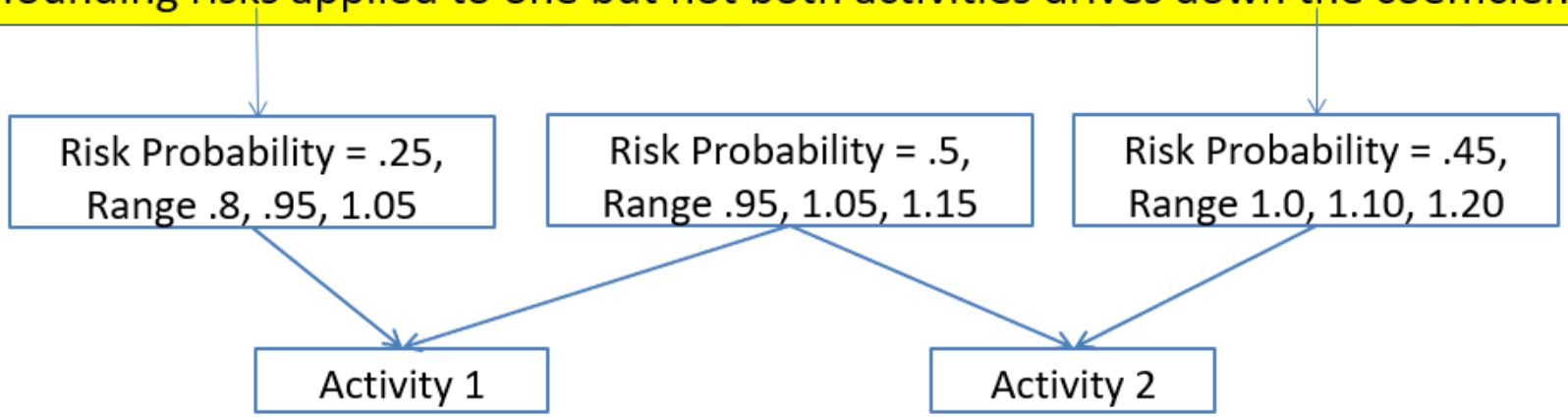
Risk Driver impact parameters distributions (multiplicative factors) on duration and cost

Level 4: Strengths

- Applying Risk Drivers *to activities' durations* is easier than estimating the impact on the *project finish date* – Let MCS of the schedule do that part
- Using identified risks to drive the MCS allows us to <u>prioritize individual risks for mitigation</u>
- Collecting risk data using confidential interviews always uncovers risks not in the standard Risk Register at Level 2
- Risk Drivers <u>model how correlation occurs</u>, developing correlation coefficients during MCS

Level 4:Risk Drivers Model Correlation

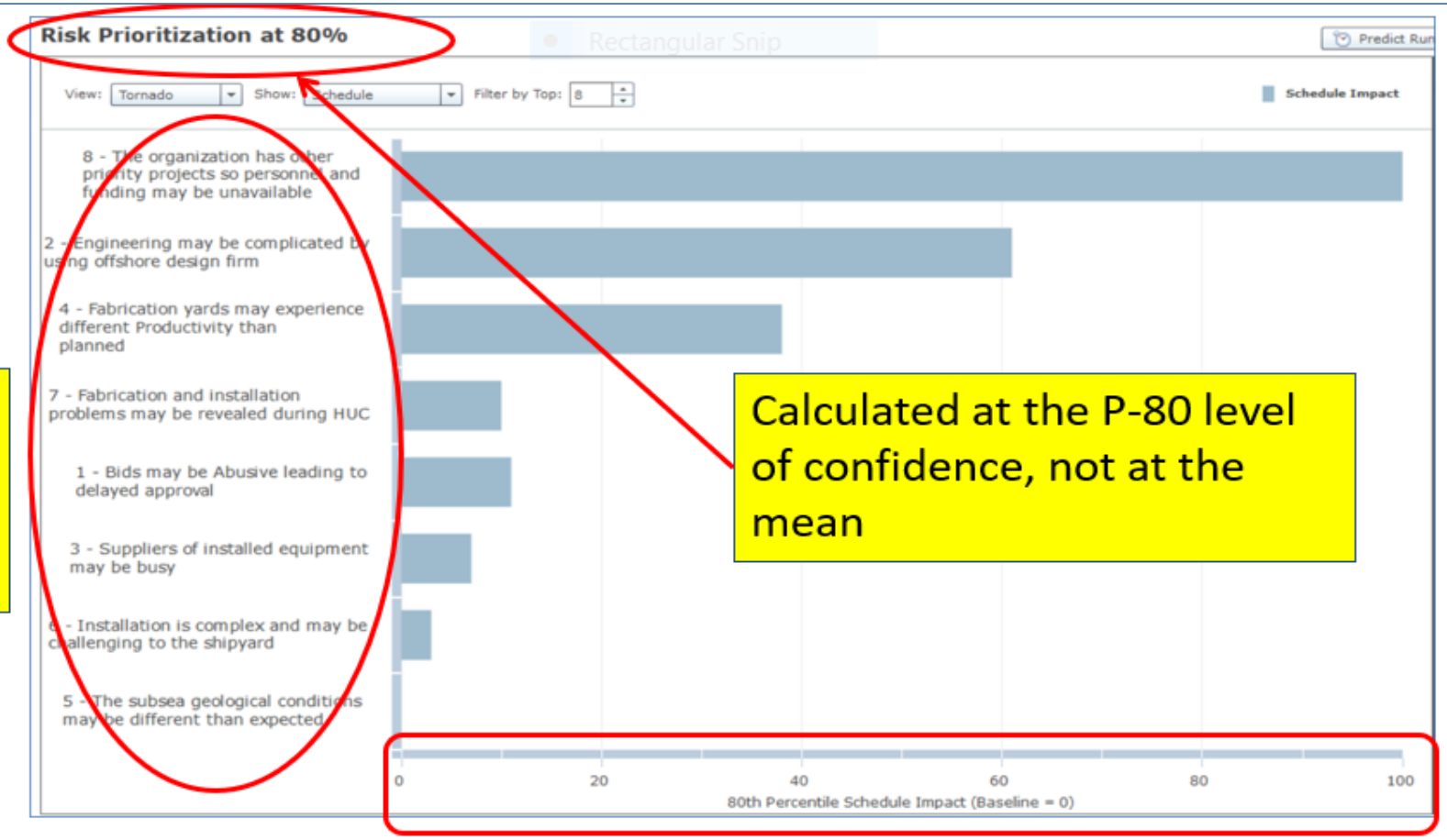
Confounding risks applied to one but not both activities drives down the coefficient



Correlation = 37%

- Correlation is modeled as it is caused in the project
- Correlation coefficients are generated, not guessed
- Correlation drives the results correctly
- By modeling correlation we never get an inconsistent correlation coefficient matrix (Steve Book)

Level 4: Prioritizing Risks Tornado



Risks, not Activities or paths

Calculated at the P-80 level of confidence, not at the mean

Days saved if mitigated, not correlation coefficients

Level 4: Weaknesses

- Individuals may incorporate their biases when discussing uncertainty concepts about possible future events
- MCS build-up data is developed based on SME's expert judgment
  - We need to check the results from Monte Carlo simulation against historical experience
  - Some suggest that using risk / uncertainty build-up from experts is not able to handle Systemic Risks – a debate.
- Best to compare MCS results to history of schedule overruns of similar projects for "outside view"

Level 5: Integrated Cost-Schedule Risk Analysis

- Recognizes the important fact that activity durations and costs are related when labor-type resources are applied
- Starts with resources costed without contingency being applied to activities
- The resources are distinguished by being time-dependent and time-dependent – handled differently in integrated cost-schedule risk analysis (ICSRA)

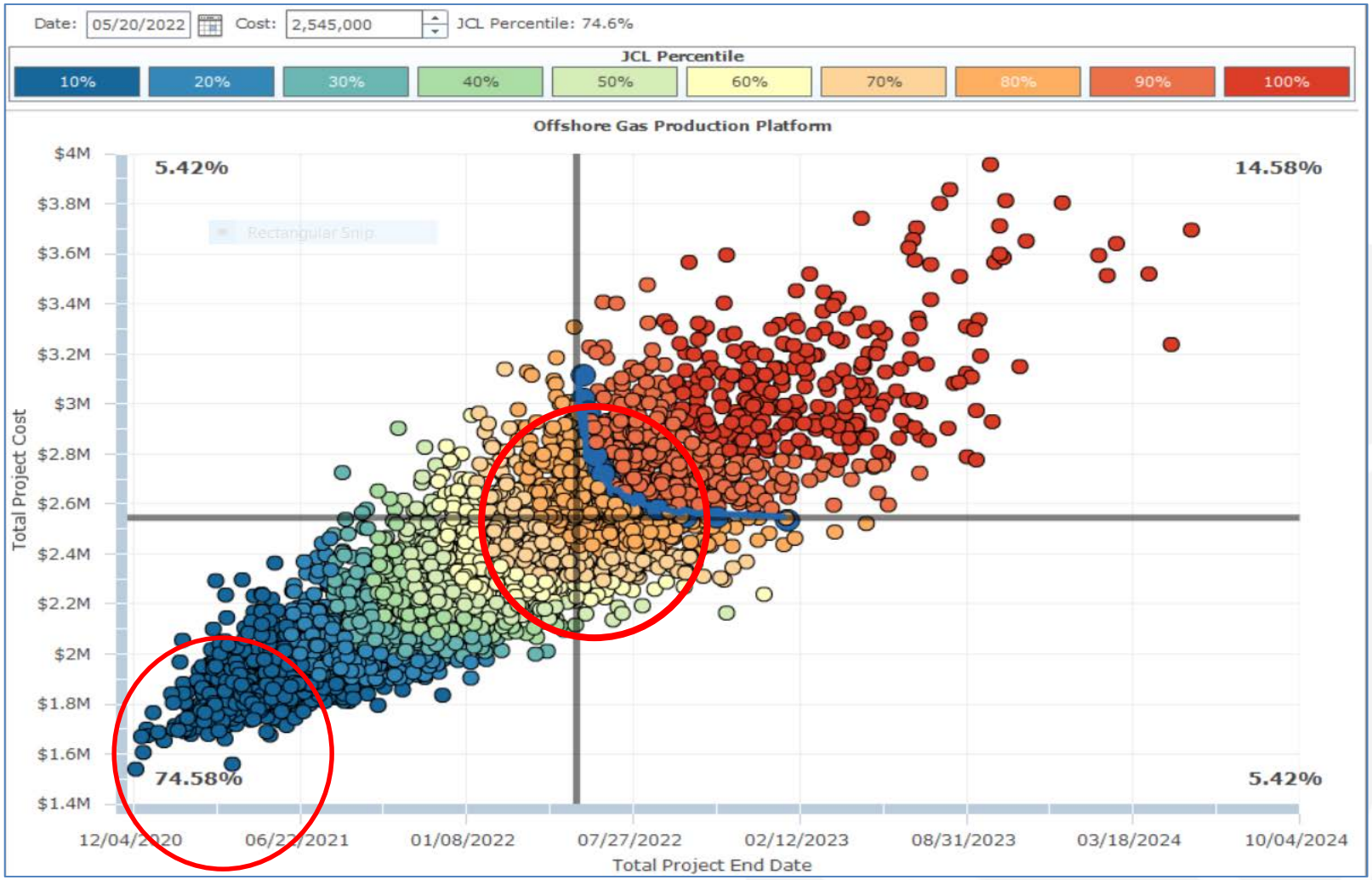
Level 5: Capabilities Needed

- Estimators and schedulers need to communicate activities' costs in a WBS that both can understand and apply
- Be alert to traditional cost risks that could increase or decrease (a) the daily expenditure rate on labor and (b) total cost of time-independent materials, even if schedule is perfect

Level 5: Strengths

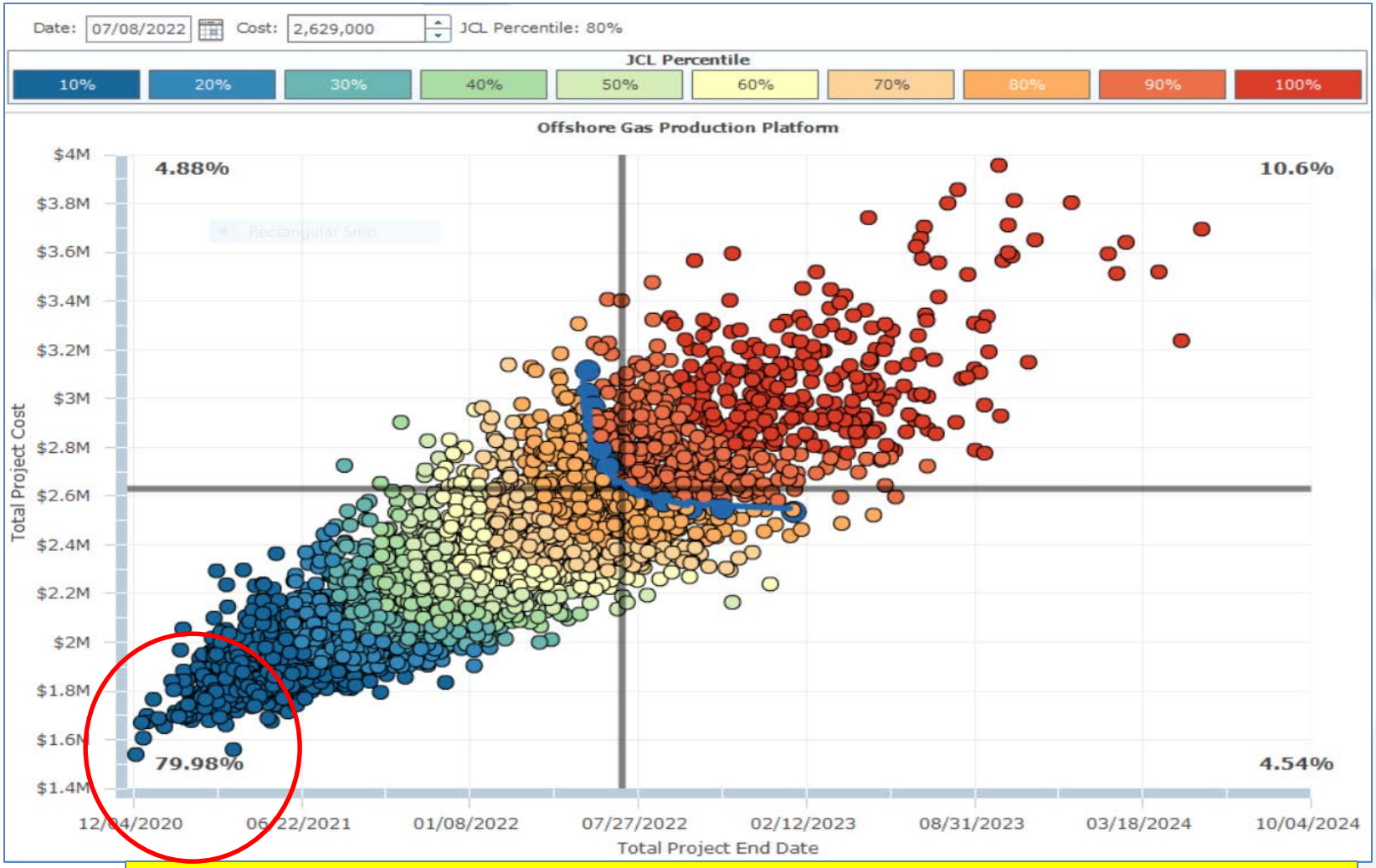
- Histograms, risk prioritization are the same as at Level 4. Risk Drivers can be used in both
- Histograms for cost reflect both:
  - Indirect effect of activity durations on costs
  - Cost-risks applied to labor's burn rate and total time-independent resource's costs
- New concept available, the *Joint Confidence Level* of estimating a finish date and cost that are both likely to be met with some target probability

Level 5: Joint Confidence Level (JCL)



The P-80 for time and cost individually produces only a 74.6% probability of both being met. Influenced by time-cost correlation

Level 5: Joint Confidence Level (JCL)



Adding 6+ weeks to the finish date and $84 million brings the probability of meeting both up to 80%

Level 5: Weaknesses

- The weaknesses at Level 4 are present at Level 5, namely that the MCS build-up rests on the expert judgment of project team members and should be bolstered by reviewing historical data.
  - Best to compare MCS results to history of schedule overruns of similar projects for "outside view"
- There is no good way implemented yet to identify *the most likely JCL-80 combination of cost and schedule*
  - Try to approximate the most likely (top of the 3-D probability "ridge") from the scatter diagram that is also JCL-80

QUESTIONS/COMMENTS?

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