Taking Control:
Cost and Schedule Risk Analysis Agenda

- Introductions

- Why is Cost and Schedule Risk Analysis Important

- How does DQ relate to the CSRA

- Issue: What are the inputs to a CSRA and how are they used

- Example Analysis of "Build a House"

- Incorporating Mitigation

- Conclusions and Feedback

Why is a Cost and Schedule Risk Analysis Important?

- Cost overrun is common in infrastructure, building, and technology projects.

- For IT projects, a 2004 industry study by the Standish Group found an average cost overrun of 43 percent;

- 71 percent of projects came in over budget, exceeded time estimates, and had estimated too narrow a scope;

- Total waste was estimated at $55 billion per year in the US alone. "(Wikipedia -- Cost Overruns)

Standish Group (2004). CHAOS Report (Report). West Yarmouth, Massachusetts: Standish Group

HMAS Hobart destroyer delivery delayed

HMAS Hobart destroyer was ordered in 2007 by the Royal Australian Navy, but errors and delays in construction caused extensive schedule slippage. Despite commissioning initially planned for December 2014, the ship was not laid down until September 2012, and launched in May 2015. Department of Defence accepted delivery of HMAS *Hobart* on 16 June 2017.[1] The ship was commissioned on 23 September 2017.[2]

Delivered nearly 3 years late!

ExxonMobil recent acquisition

- (June 6, 2018) ExxonMobil purchased 50% of Equinor's interest in the BM-S-8 block offshore Brazil which contains part of the 2 Billion barrels of pre-salt Carcara oil field. ....Production is expected to start in 2023 or 2024. Exploration drilling began on the Guanxuma prospect on April 25. 2018.

- (June 7, 2018) Referring to Brazil O&G, "The exploration cycle can last two governments," or eight years, said Helder Queiroz Pinto Junior, an economics professor and former oil regulator. "The companies focus on the geological conditions, and these are promising areas."
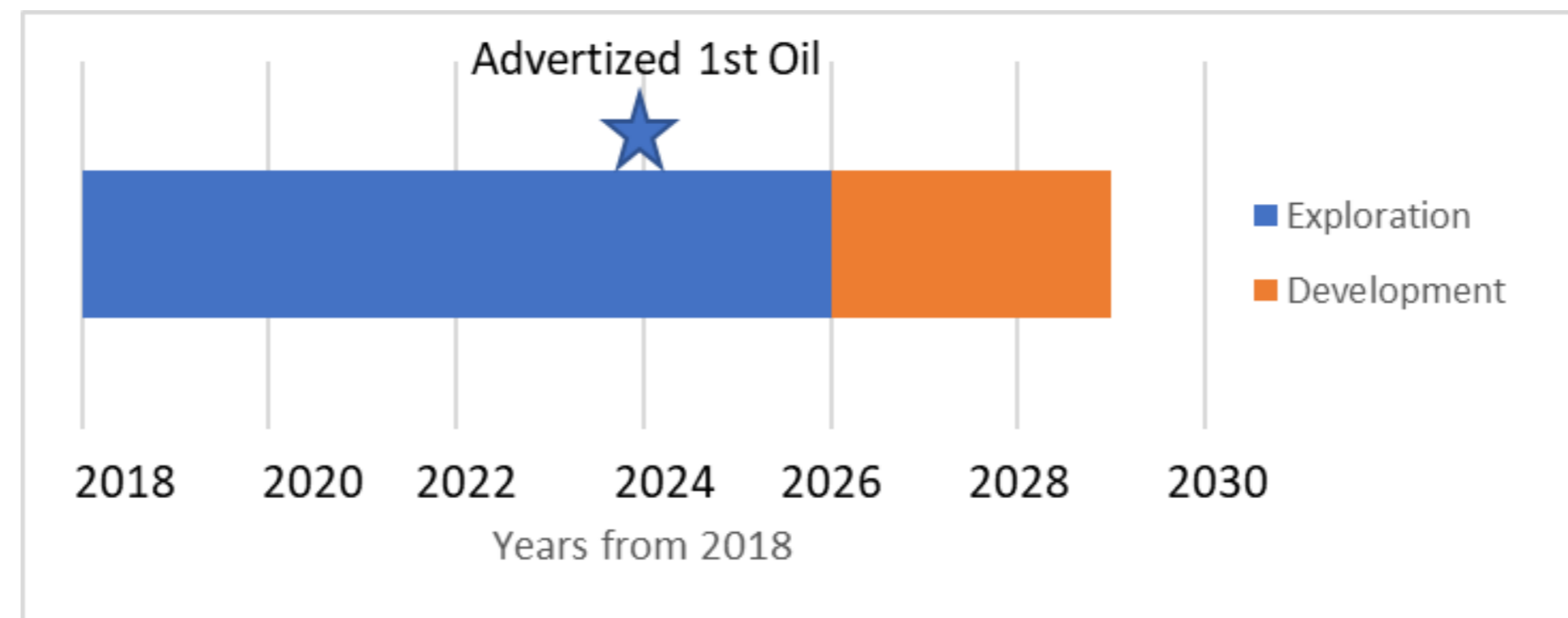
NASA Cost Over Runs (June 15, 2018)

- Cost and schedule problems with major NASA programs pointed blame at a wide variety of sources, from the tools used to track programs to the agency's mindset to Congress itself.

- Problem with such overruns might be linked to the use of an approach called joint confidence level (JCL) for cost and schedule estimates

- The biggest challenges to cost and schedule include a "culture of optimism" at the agency and underestimating technical complexity.

Why Do Projects Fail - Frame

- Poor communication

- Inadequate initial scoping

- Requirements are unclear

- Planning based on insufficient data

- Poor project management

- Expectation too high or unrealistic

- Failure to understand who is the "customer".

- Conscious and Unconscious biases

- Clear project milestones

- Ambiguous contract

- Failure to understand the total process flow across departments / organization / other companies

- Failure to consider needs of the business side

- Unaligned expectations

- Failure to get signoff from impacted organizations after framing.

Why Do Projects Fail - Execution

- Commencing work too early
- No time for Project Management
- Inexperienced project managers
- Lack of resource or turnover of key people
- Temporary team
- Untrained resources / quality of resources
- Poor estimates
- Supplier skills over-stretched
- Risks shared with other elements
- Contingent Risks

- Risk unidentified and/or not managed
- Lack of involvement by customer
- Scope creep
- Lack of change management or change control system
- Lack of a change control board
- Re-baseline when changes occur in the project
- Over optimism
- Measured again unrealistic time schedule and budget allowance

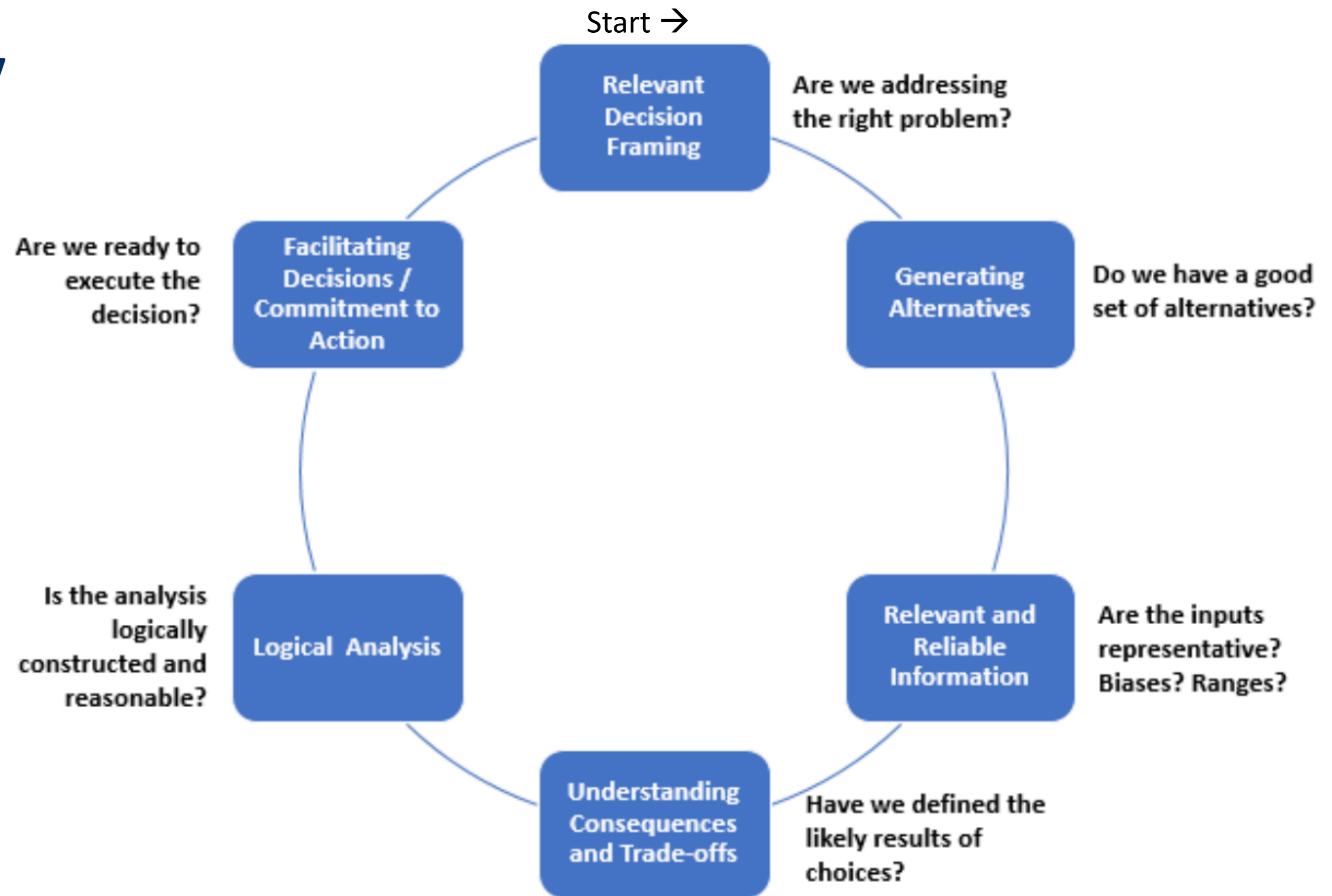# Objective is to understand the uncertainty in Cost and Schedule

For many reasons, estimates often underestimate

- Time required
- Cost required
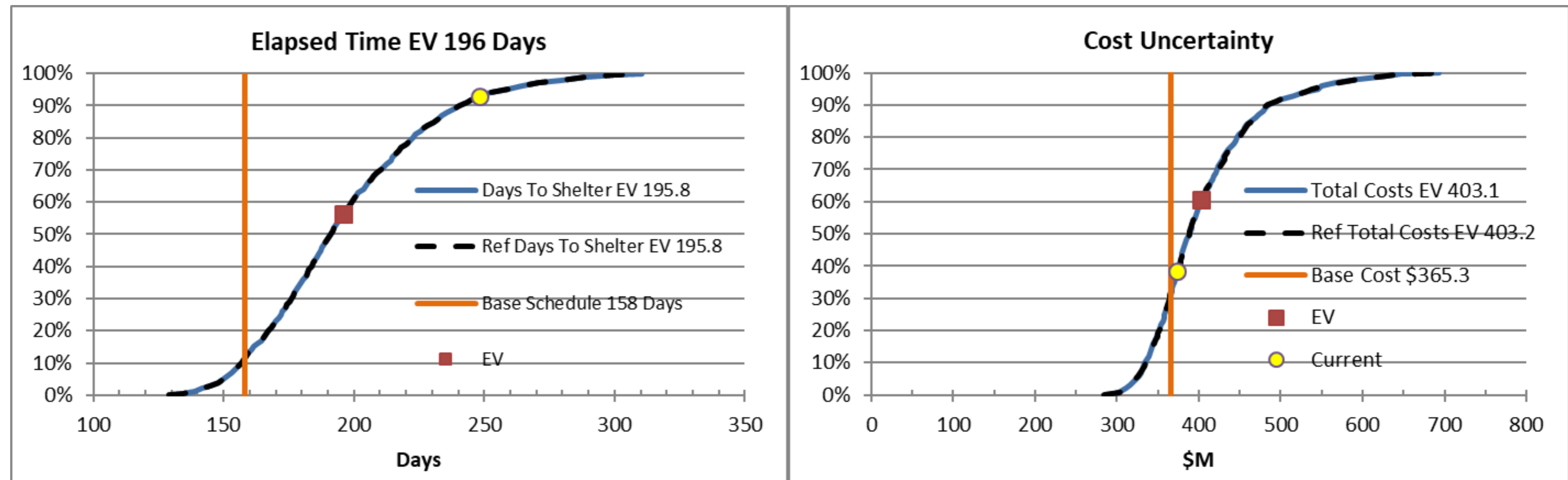
Decision Quality

- A Quality CSRA requires us to consider the elements of the DQ Spider.

- Our conclusions and decision are only as good as the weakest link in the circle.

Start →

Relevant Decision Framing

Are we addressing the right problem?

Generating Alternatives

Do we have a good set of alternatives?

Relevant and Reliable Information

Are the inputs representative? Biases? Ranges?

Understanding Consequences and Trade-offs

Have we defined the likely results of choices?

Logical Analysis

Is the analysis logically constructed and reasonable?

Facilitating Decisions / Commitment to Action

Are we ready to execute the decision?

From SPE Technical Report Guidance for Decision Quality for Multicompany Upstream Projects

When should a CSRA be conducted?

- Multiple Phases of the Project
  - Vision of the project, scoping economics
  - Project selection
  - Front End Engineering & Design (FEED)
  - FID and project execution
- Pharmaceutical
  - Pre-clinical
  - Clinical
    - Phase I Trials
    - Phase II Trials (initial reading of efficacy and explore safety)
    - Phase III Trials (large trials possibly lasting years)

Metrics of a Distribution

- Typical Asymmetric distribution
- Mean or Expected Value or Average is a common metric but it is not necessarily the P50 or median
- Mode is the Most Likely with the highest density value
- Percentiles reflect the probability of being that number or less (Shown P5, P10, P50, P90, P95)
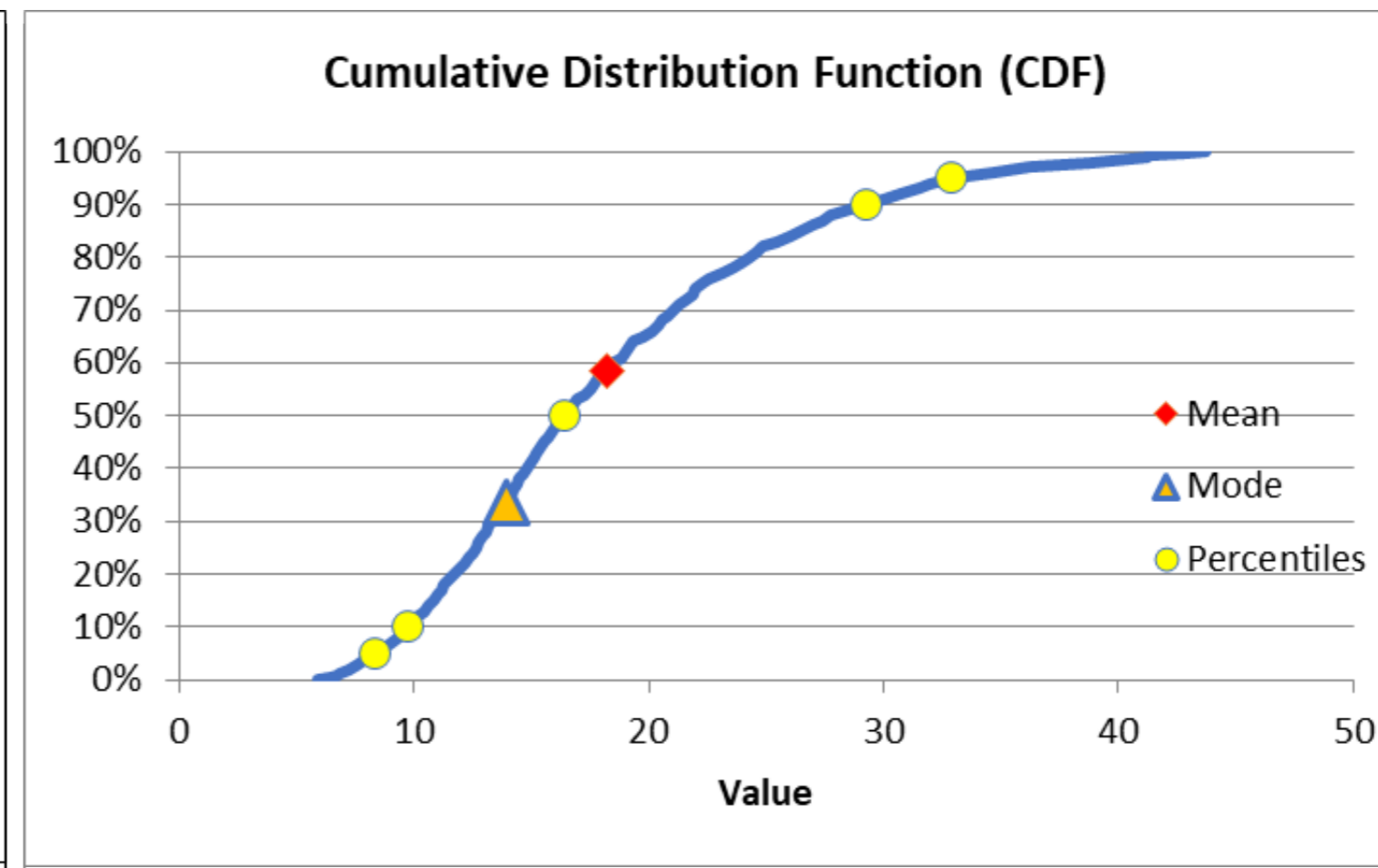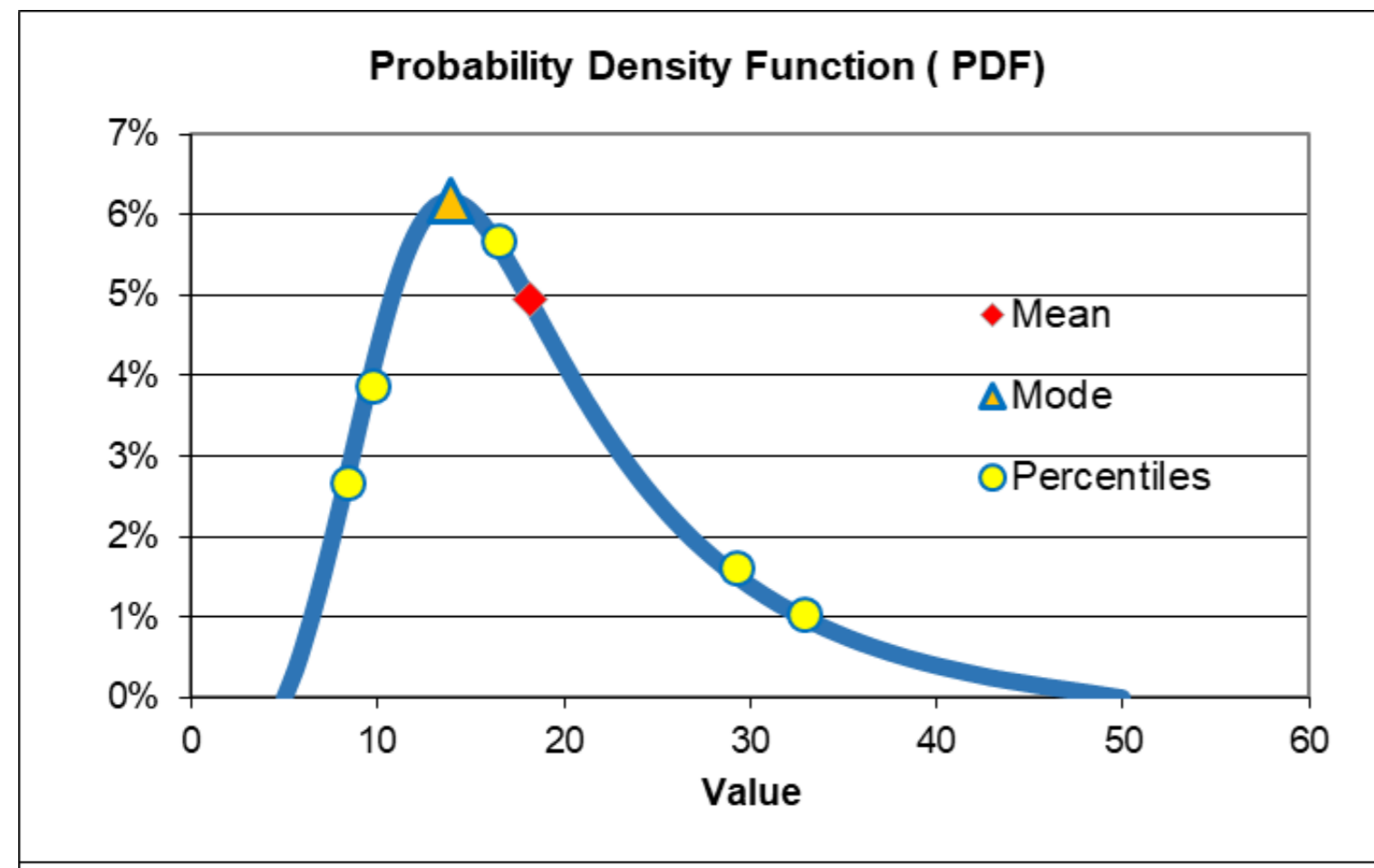
What inputs should be assessed by the Subject Matter Experts (SMEs)?

- Minimum, Most Likely , Maximum

- P10, Most Likely, P90

- Low, Most Likely, High

- P10, P50, P90

- Historical data only

And what is included in those ranges?

Main Products of A Range Analysis

Three main outputs;

1. Cost Contingency

2. Cost Risk Reserve

3. Schedule Contingency

What is Cost Contingency?

AACE International has defined contingency as "An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result in additional costs.
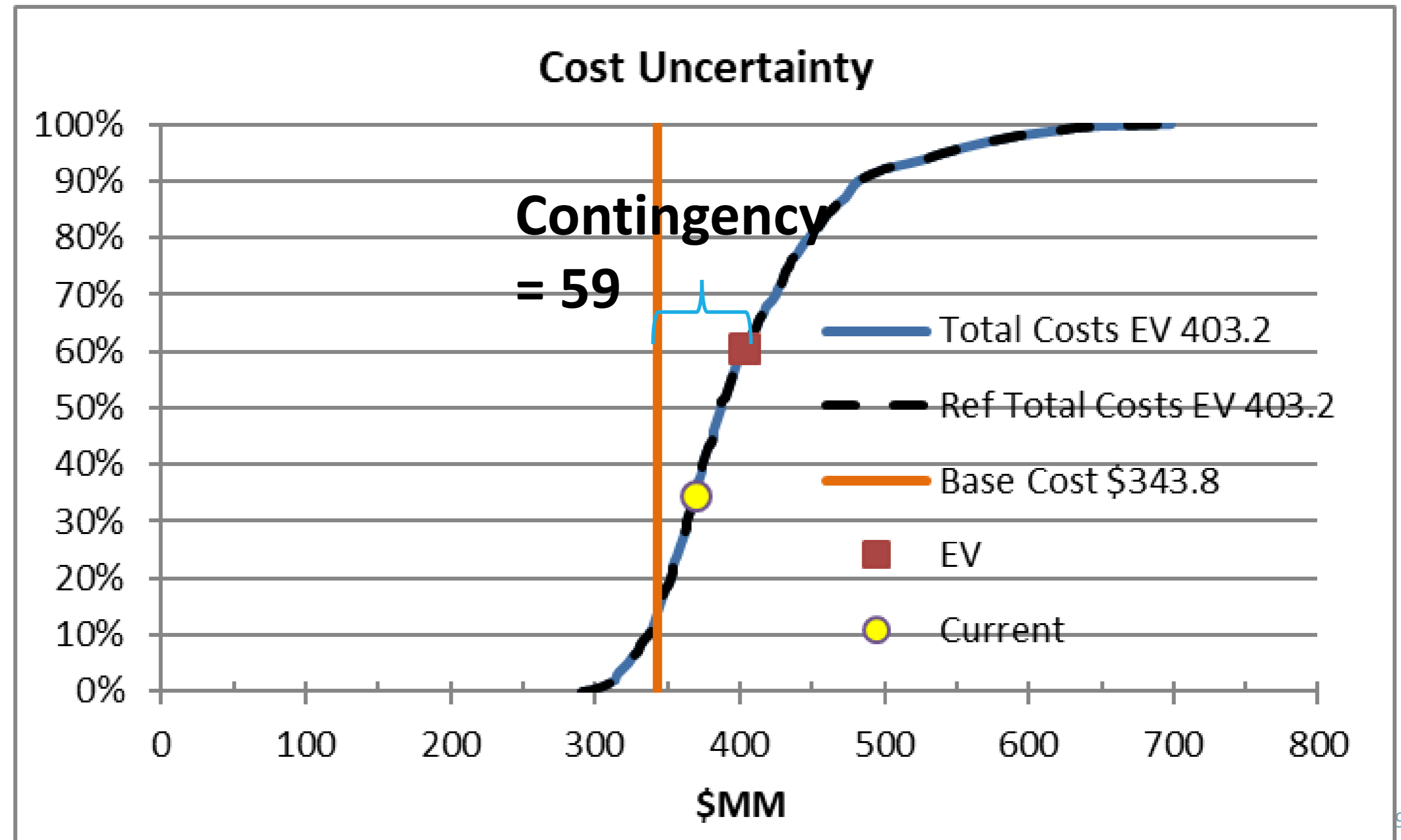
Contingency usually excludes:

- Major scope changes
- Extraordinary events
- Management reserves
- Escalation and currency effects

Contingency **is Expected** to be spent on a project

Cost Contingency is generally the difference between the Baseline Value and the CSRA EV result

- Issue is whether cost contingency is already included in the individual cost estimates
- Should strikes, natural disasters, or other rare events be included in analysis

Cost Uncertainty

Contingency = 59

Total Costs EV 403.2

Ref Total Costs EV 403.2

Base Cost $343.8

■ EV

● Current

$MM

What is Risk Reserve?

Risk reserve is sometimes referred to as management reserve or owners reserve and **is a portion of the capital budget used to cover <u>reasonable</u> unforeseen events**.

This budget includes costs for events that should they occur it would be expected that the budget be able to cover these costs. Examples include weather risk, equipment damage during construction, etc.

Risk reserve does not include

- Extreme risk events like tornados, acts of war, or any other event that would not be reasonable to budget for.

- Scope change
- Escalation and currency effects

If all goes well risk reserve does not need to be spent

What is Schedule Contingency?

This is an extra allowance of time on a project schedule to ensure that you have a reasonable chance of completing the project on time.

Not only should you have contingency on the total project duration, it should also be added to any key milestone on the project. **This includes reasonable risks that should be expected and budgeted for**.

Schedule contingency usually excludes;

- Extreme risks

- Scope changes

If all goes well **you may not need to use** all or even a part of your schedule contingency.

RISK AWARENESS WEEK 2019
Join The Global Initiative To Promote Risk Based Decision Making

What distribution
should be use in the analysis

- Triangular distribution   (Min, Most Likely, Max)

- Pert Distribution   (Min, Most Likely, Max)

- Trigen   (P10, Most Likely, P90)

- Myerson   (P10, P50, P90)

- Metalog distribution   (flexibility)

- No distribution ??

- Adjustments to the SME assessments base on historical data

Comparison of some distributions

- Triangular – Min, Most Likely, Max
- PERT   -- Min, Most Likely, Max
- Trigen   -- P10, Most Likely, P90
- Beta   – Min, Max → match
- Myerson   -- P10, P50, P90

All the EV's are similar to the PERT distribution
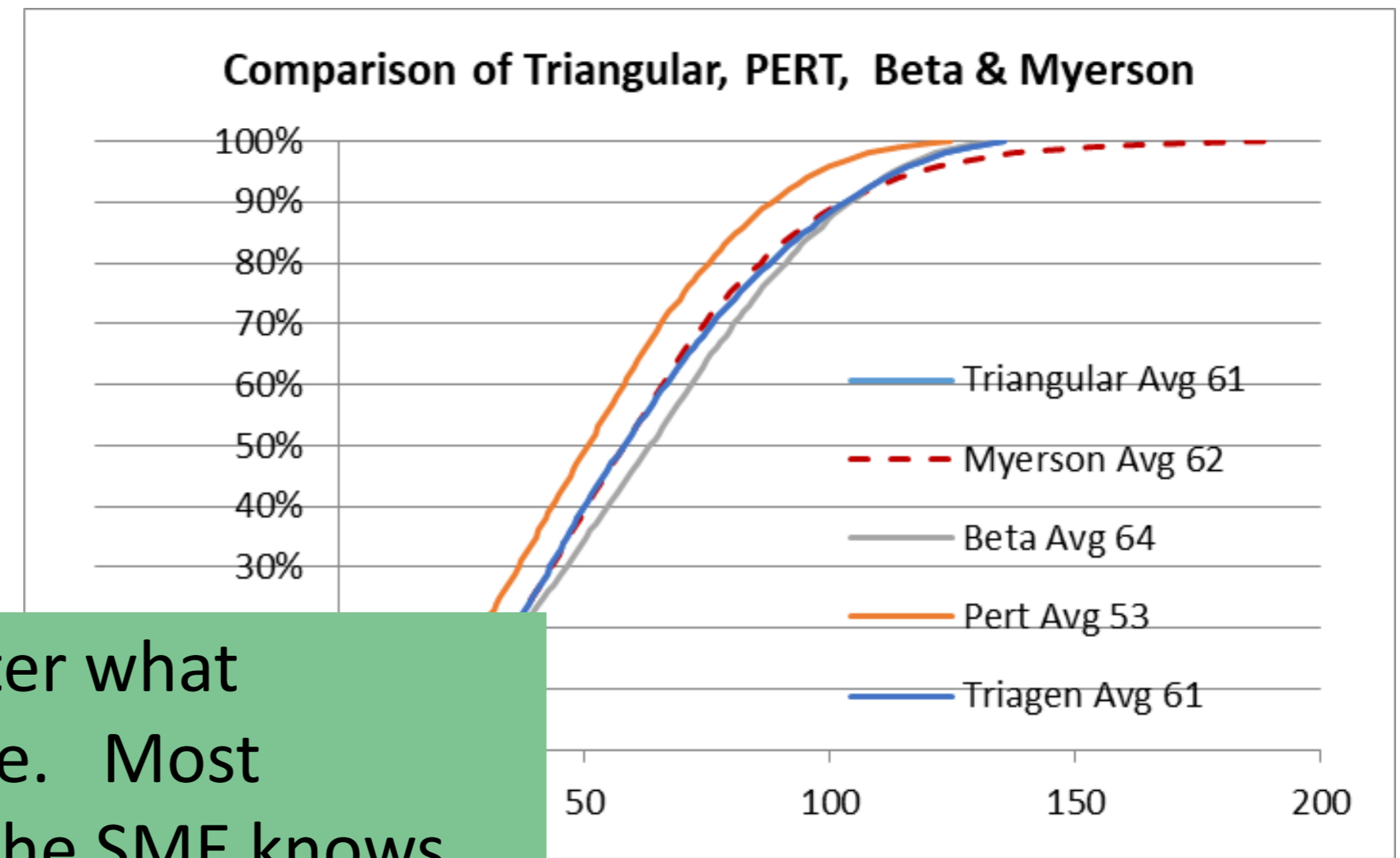
Does it really matter what distribution we use.   Most important is that the SME knows what parameters they are assessing and what is to be included.

me Random numbers
Trigen have the same result

- Beta is a function of the shape parameters
- PERT is a transformation of the Beta Distribution
- Myerson has a long tail

Comparison of Triangular, PERT, Beta & Myerson

- Triangular Avg 61
- Myerson Avg 62
- Beta Avg 64
- Pert Avg 53
- Triagen Avg 61

Min	P10	ML	P90	Max	P50
0.5	25	44	103	139.7	58.1

Flexibility CSRA Model using Excel and SIPmath Tool

- CSRA Model Requires no macros to run

- Uses a DataTable to calculated trials.

- Uses standard Excel graphics editable by user

- SIPmath Tool Developed by Probability Management and Dr. Sam Savage

  ✓An Add-In to Excel available FREE from www.ProbabilityManagement.org

  ✓Enterprise version available with correlation and data libraries
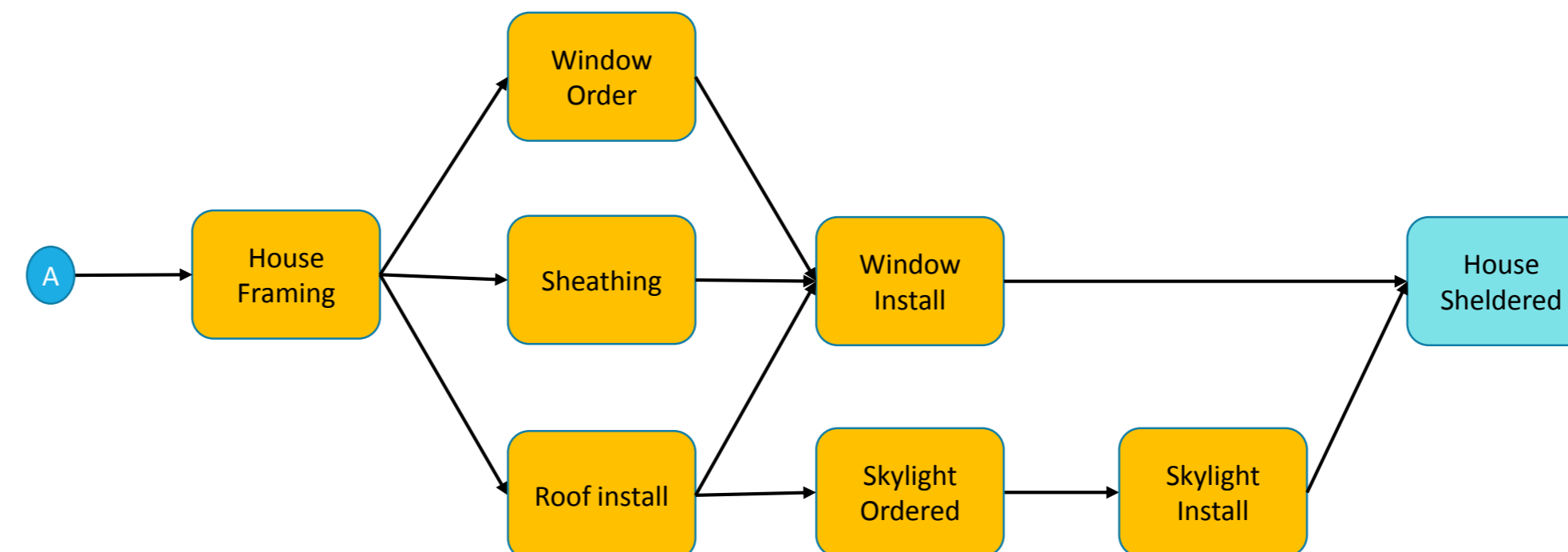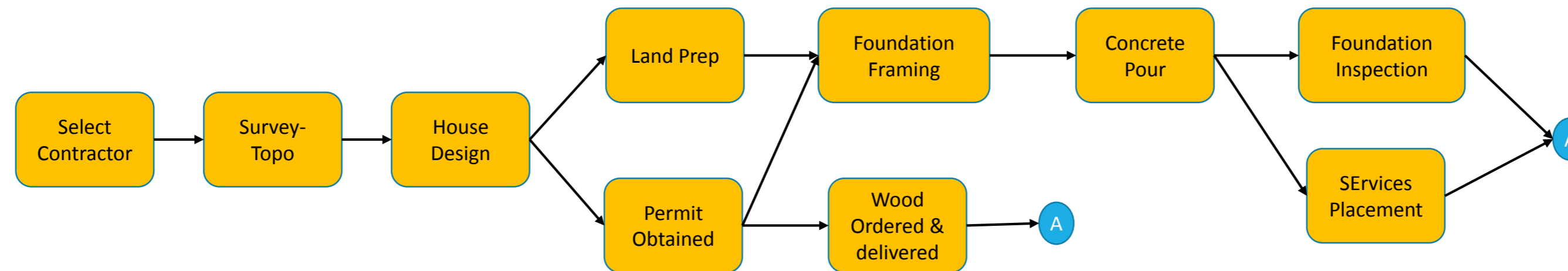
Features of the SIPmath CSRA Model

- Complete flexibility to reflect task relationships
- Flexibility to use inputs other than P10-P50-P90 such as PERT or Triangular
- Automatic updates of results with changes of inputs
- Results consolidated on Dashboard that can be modified to user requirements.
- Graphics easily copied to PowerPoint, Word or other application.
- Manual sensitivity to any of the uncertainties – schedule or cost
- Option to show the schedule and cost using the P50 Inputs.
- Can trim tails of any distribution by controlling the random number.
- Add explicit mitigation with probability of success
- Free SIPmath can add distributions of activities or cost.
- Correlation among activities or costs can be added with Enterprise version of SIPmath.

Case Study

- Build a House

- Evaluate from selecting the contractor to where house is sheltered.

Select Contractor → Survey-Topo → House Design → Land Prep → Foundation Framing → Concrete Pour → Foundation Inspection → A

House Design → Permit Obtained → Wood Ordered & delivered → A

Concrete Pour → SErvices Placement → A

A → House Framing → Window Order → Window Install → House Sheldered

House Framing → Sheathing → Window Install

House Framing → Roof install → Skylight Ordered → Skylight Install → House Sheldered

Data is table input by User

Task #	Schedule Activities	Schedule Comments / (leads) or Lags	Schedule Days				Variable Cost Per Day		
			P10	P50	P90		Min	ML	Max
1	Contractor Contract		0	0	0				
2	Survey - Topo		6	10	24				
3	Design		20	30	60				
4	Land Prep		6	9	21		1.200	1.300	1.600
5	Permit		7	10	28				
6	Wood Order / Delivery		14	20	36		0.000	0.000	0.000
7	Foundation Framing		8	12	20		2.000	3.000	3.600
8	Concrete Pour and Fill		4	7	15				
9	Services Placement		3	4	10		1.200	1.300	1.600
10	Foundation inspection		4	5	10				
11	Framing		24	32	60		2.000	3.000	4.000
12	Roof Install		5	8	20		0.500	0.600	0.750
13	Sheathing		6	10	20		0.800	1.000	1.200
14	Window order	0	35	45	75				
15	Window install		4	6	7		0.200	0.300	0.400
16	Skylight order		14	20	35				
17	Skylight Install		2	2.5	10		0.200	0.300	0.400
18	Sheltered Work		1	1	1				

RISK AWARENESS WEEK 2019
Join The Global Initiative To Promote Risk Based Decision Making

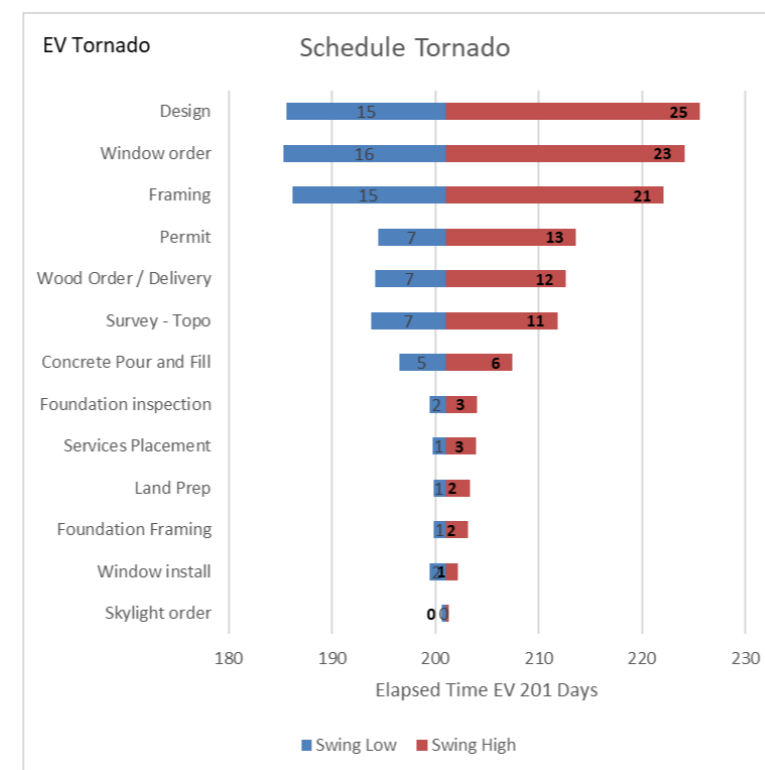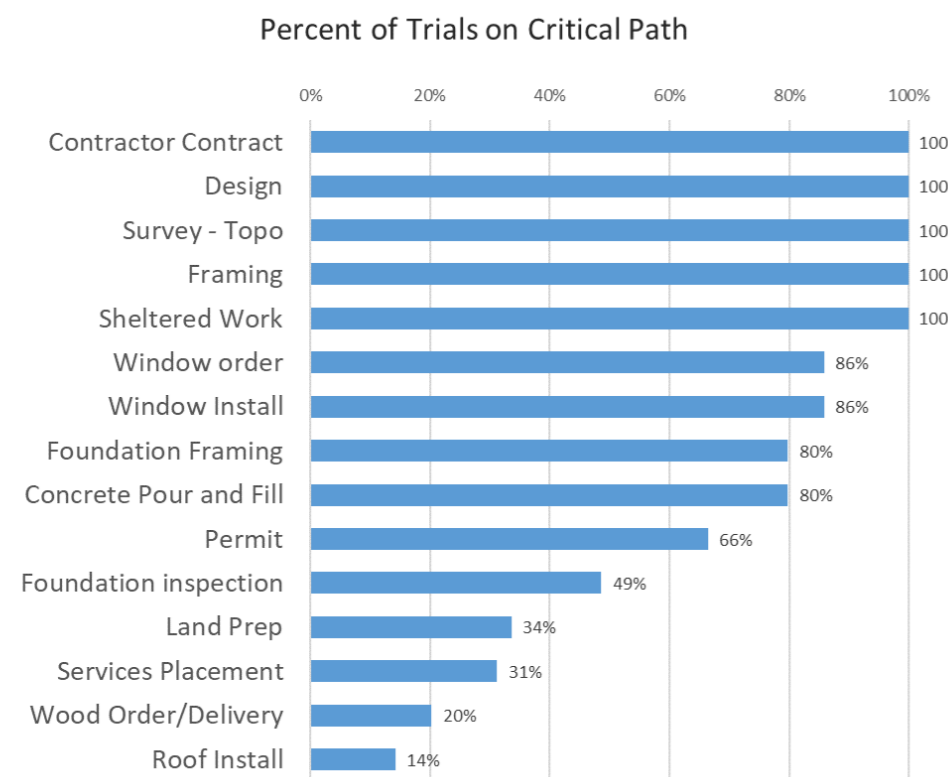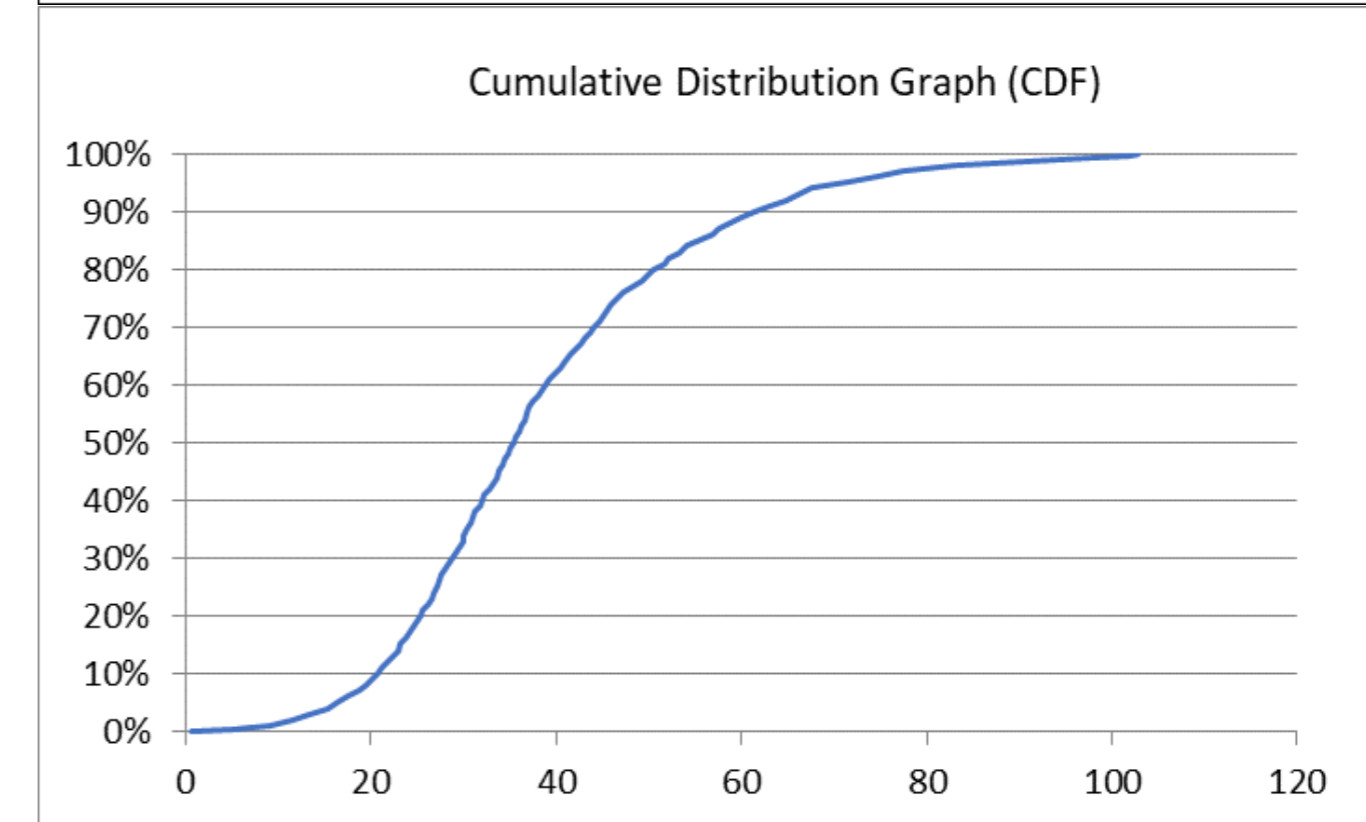# Built in graphics provide reference and helps identify the source of uncertainty
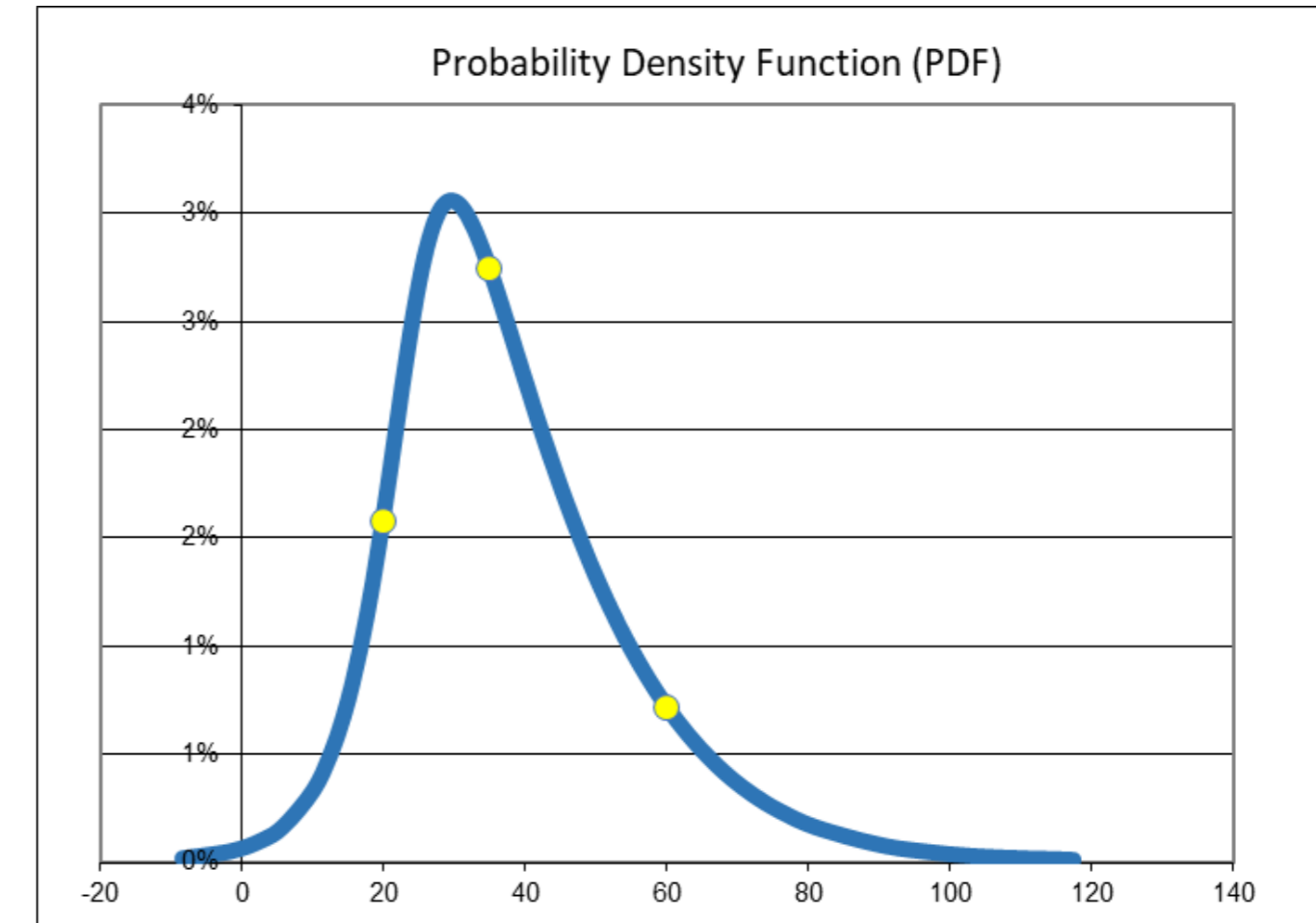
- Baseline schedule about the P15

- Baseline cost about P25

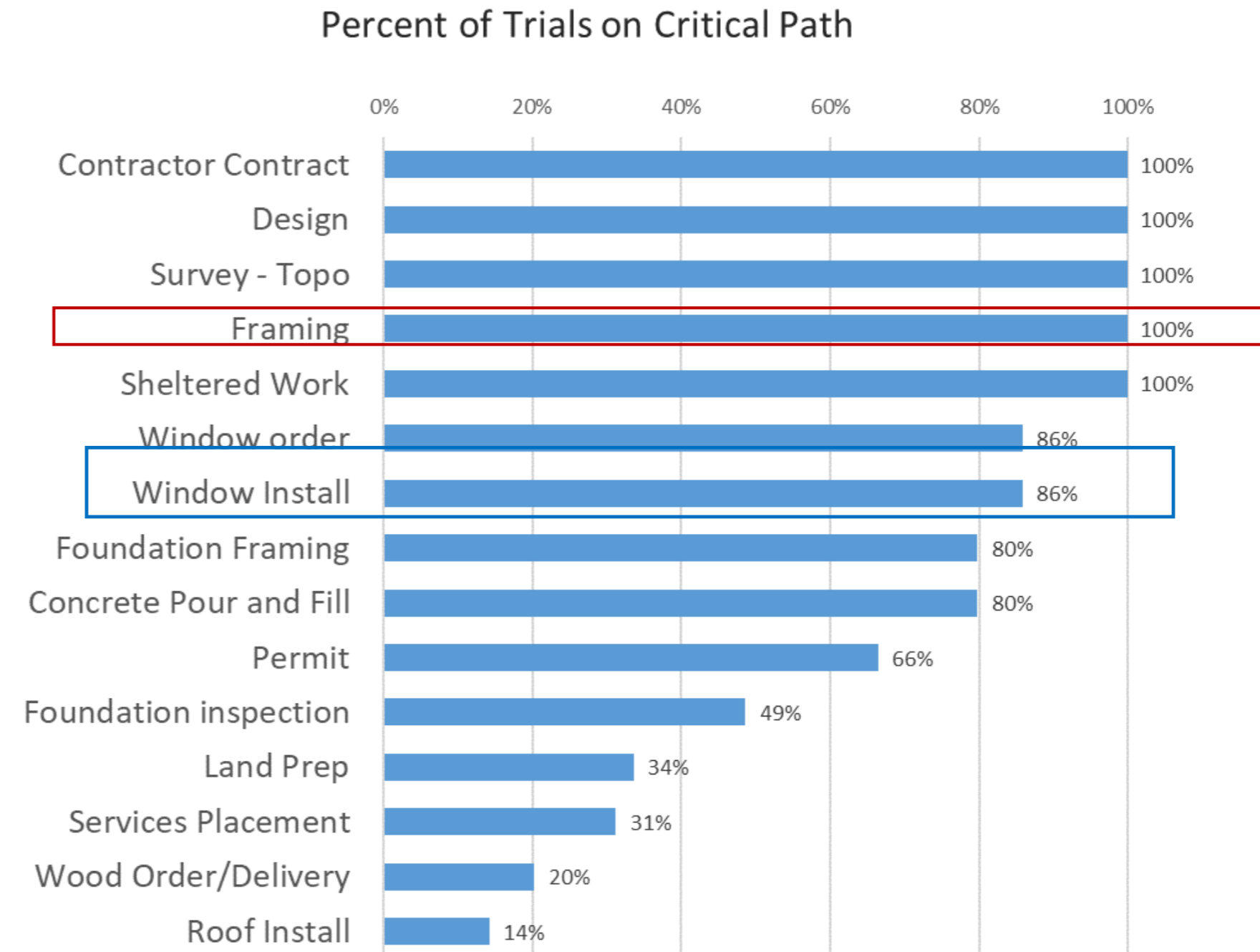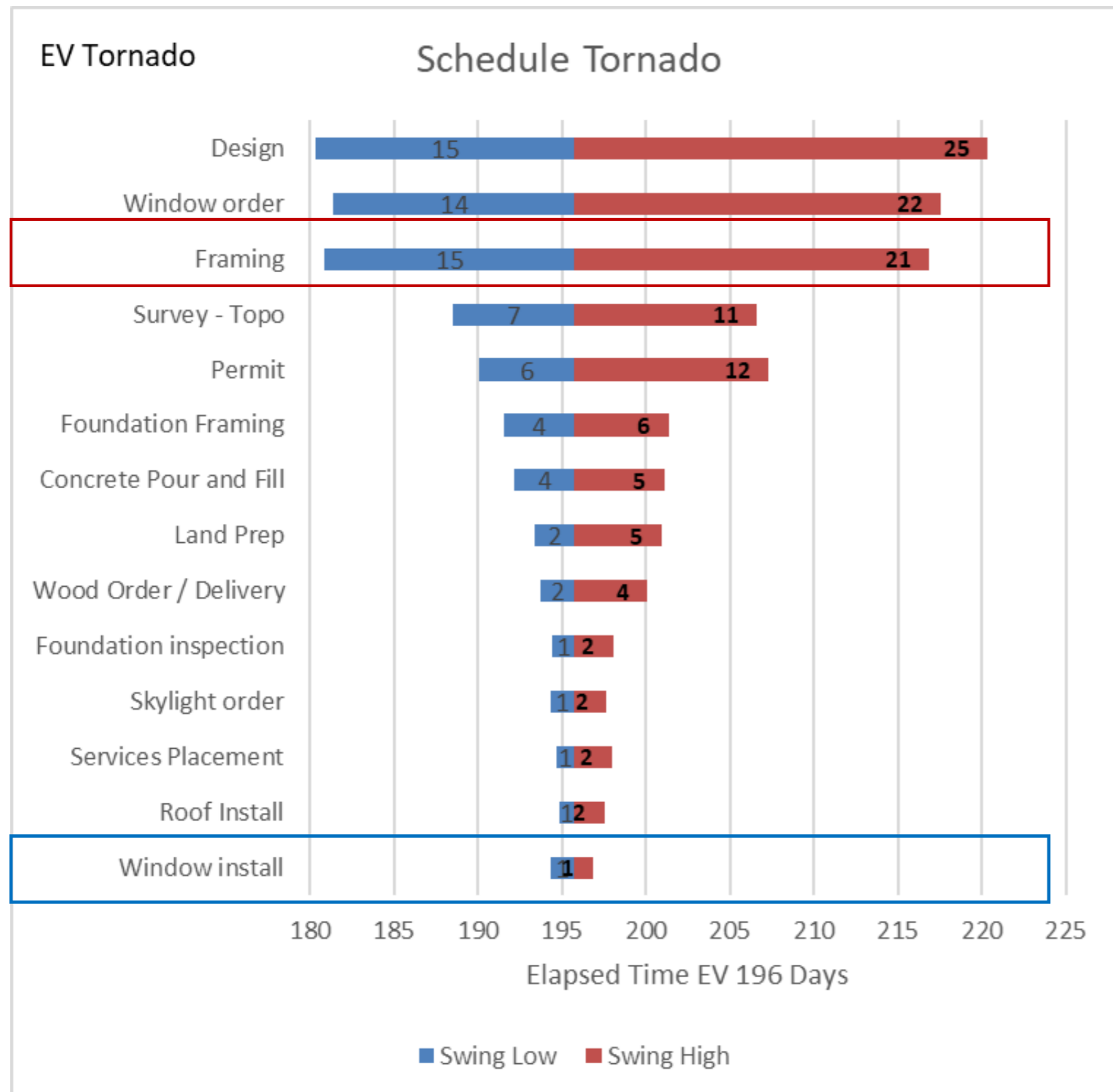- Most cost uncertainty is due to variable cost related to schedule.
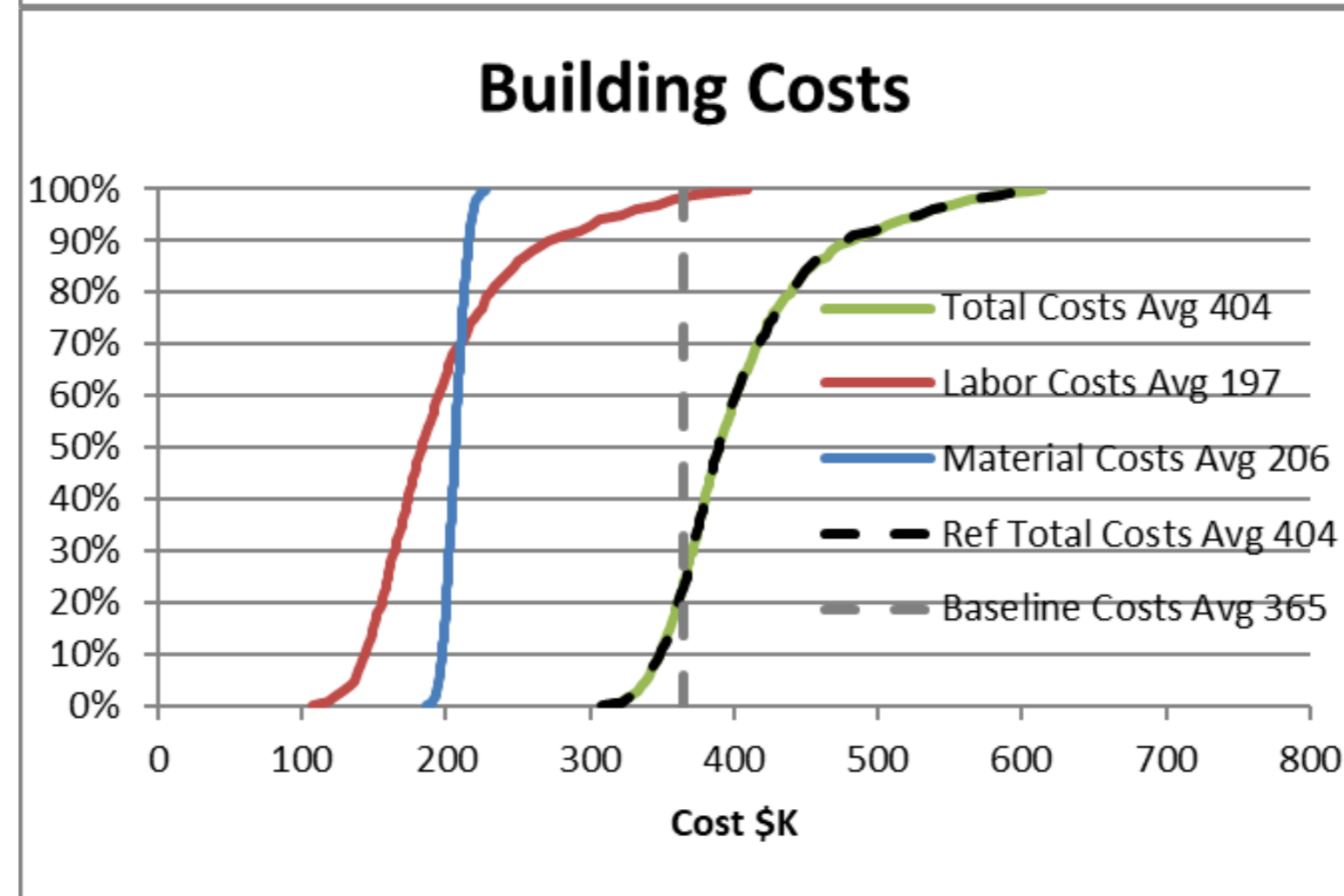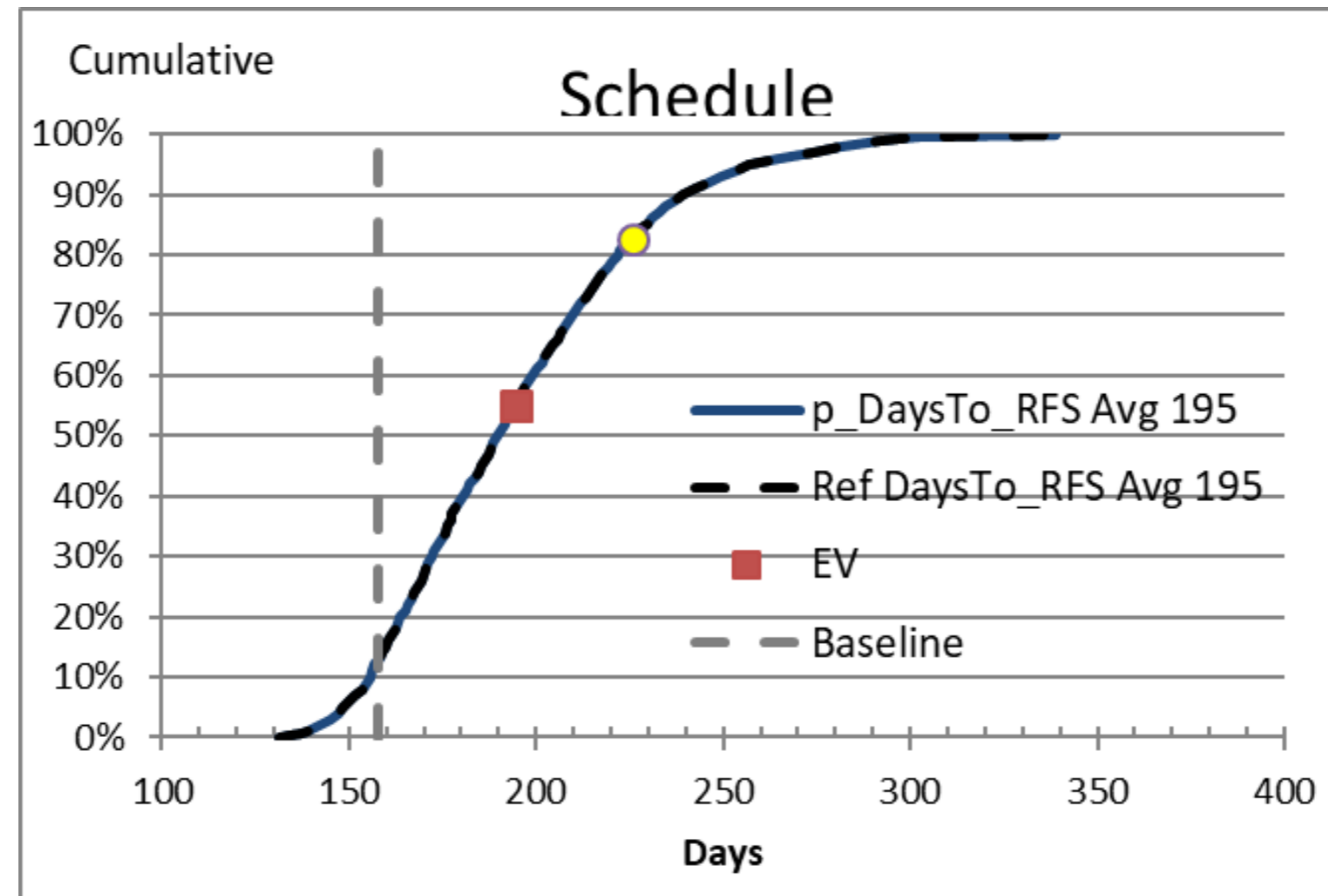
Let us now play with the live model

How should the results be displayed?

- Cumulative Distribution Graphs (CDF's)

- Probability Distributions (PDFs)

- Critical Path Frequency

- Tornado Diagrams

Percent of Trials on Critical Path

EV Tornado — Schedule Tornado

Probability Density Function (PDF)

Cumulative Distribution Graph (CDF)

# Sensitivity of the EV Schedule Result to the variables.

Combining the Critical Path and Tornado Chart

- Focus on top right corner with high criticality and severity

- High criticality requires revisiting the PERT diagram to see if the relationship of activities can be changed.

- Look at mitigation alternatives for these as well.

Criticality and Severity
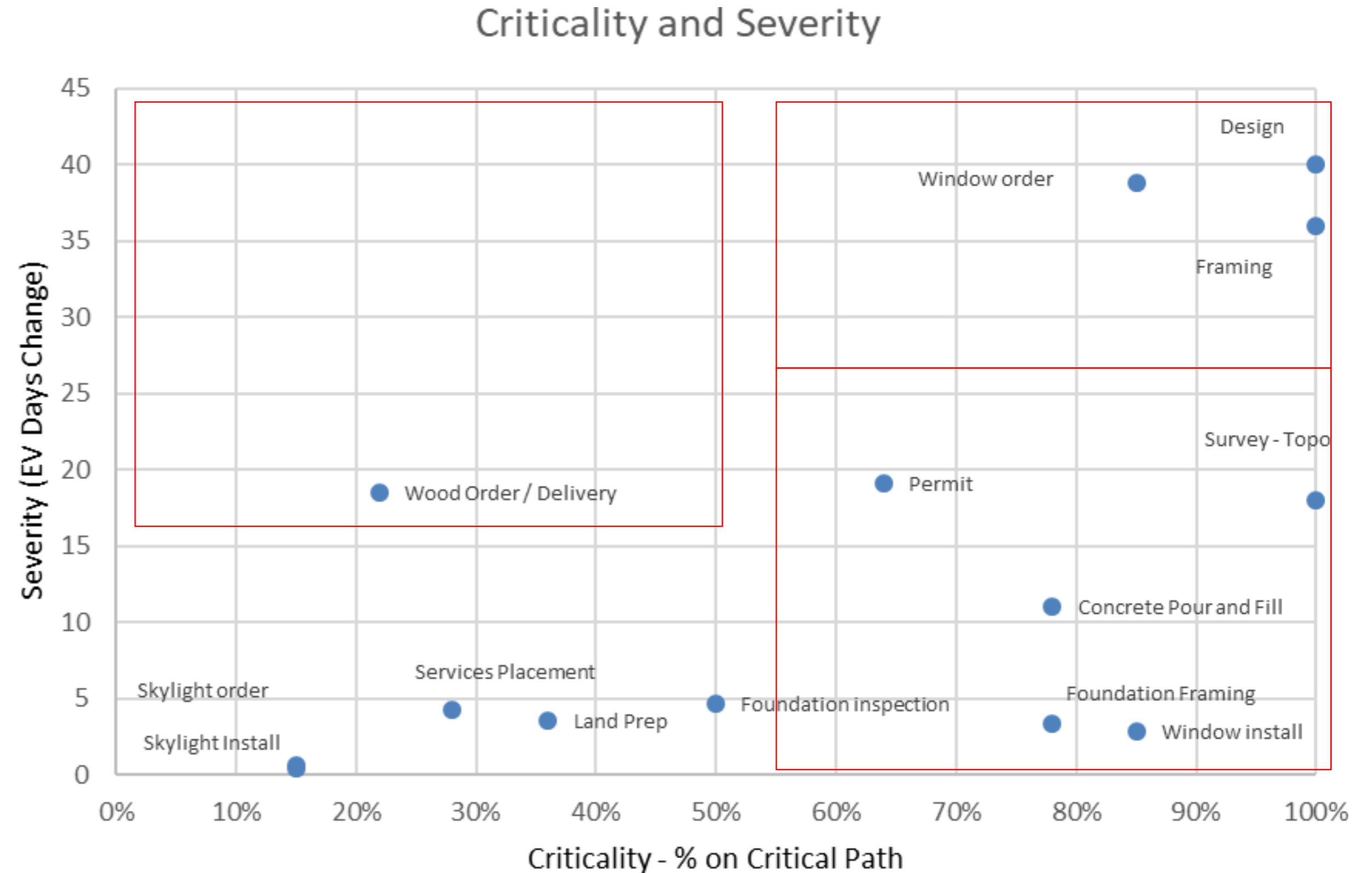
Joint Confidence Level (JCL)

- US Government wants 70% chance of being under budget **and** 70% chance of being on schedule or better
- P70 for both leads yields 55% confidence level
- Something like 80% & 82% gets us to the 70% JCL.

JCL Chart - P70 Schedule P70 Cost & 55% Confidence
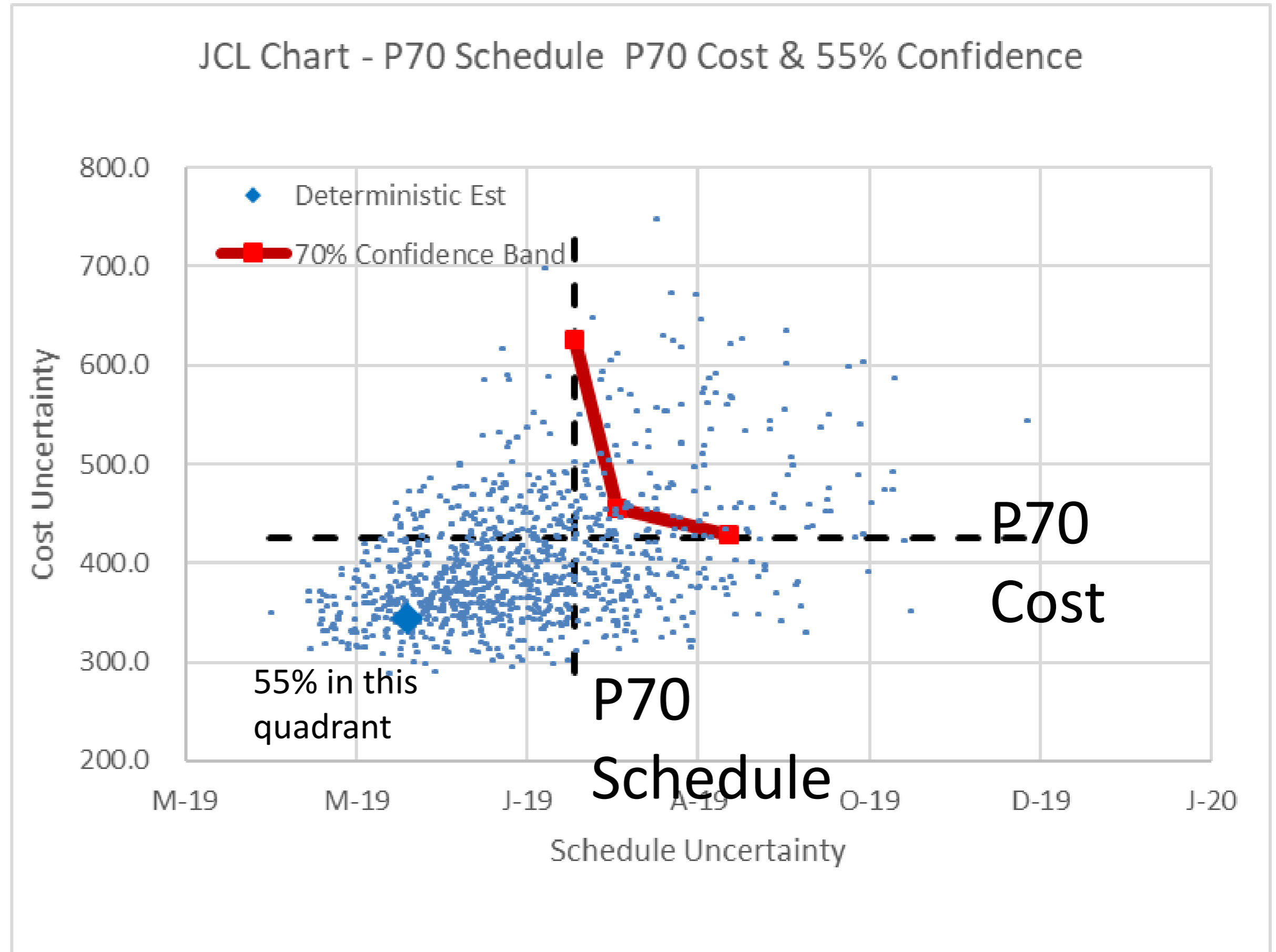
What is the purpose of the CSRA?

Make a Decision

- What do we need to know to make a good decision?

✓ What is important to move the needle
✓ What can we do about it?
✓ What is the probability of success.

What Can We Do?

- Expedite the Window order for a cost (50% POS)

- Rather than doing the framing on-site, use some pre-fab components.   (75% POS)

	Schedule Mitigation					Burn Rate Mitigation (Mitigation Linked to Sched		
Schedule Mitigations	P10	P50	P90	Prob of Scen		P10	P50	P90
Used Window Order	35	45	75			0	0	0
Base Case	35	45	75	50%		0	0	0
Expedited	25	40	60	50%		0.1	0.2	0.4
Used Framing	24	32	60			2	3	4
Base Case	24	32	60	25%		2.0	3.0	4.0
Prefab	22	28	45	75%		3.0	4.5	5.0

Cost Mitigations			P10	P50	P90	Prob of Scen
Used Framing Cost			25	27	35	
Base Case		$K	20	25	35	25%
Prefab		$K	25	27	35	75%

POS = Probability of Success

Mitigation Results - CDF graphs help to understand the impact

- Doing something differently that improves the schedule or cost

- Typically would associate a probability of success to the mitigation

- Generally will not improve both the schedule and the cost. Decision Maker will have to make a trade-off between the two value measures.

Schedule reduced 22 days, but at a cost of $15k
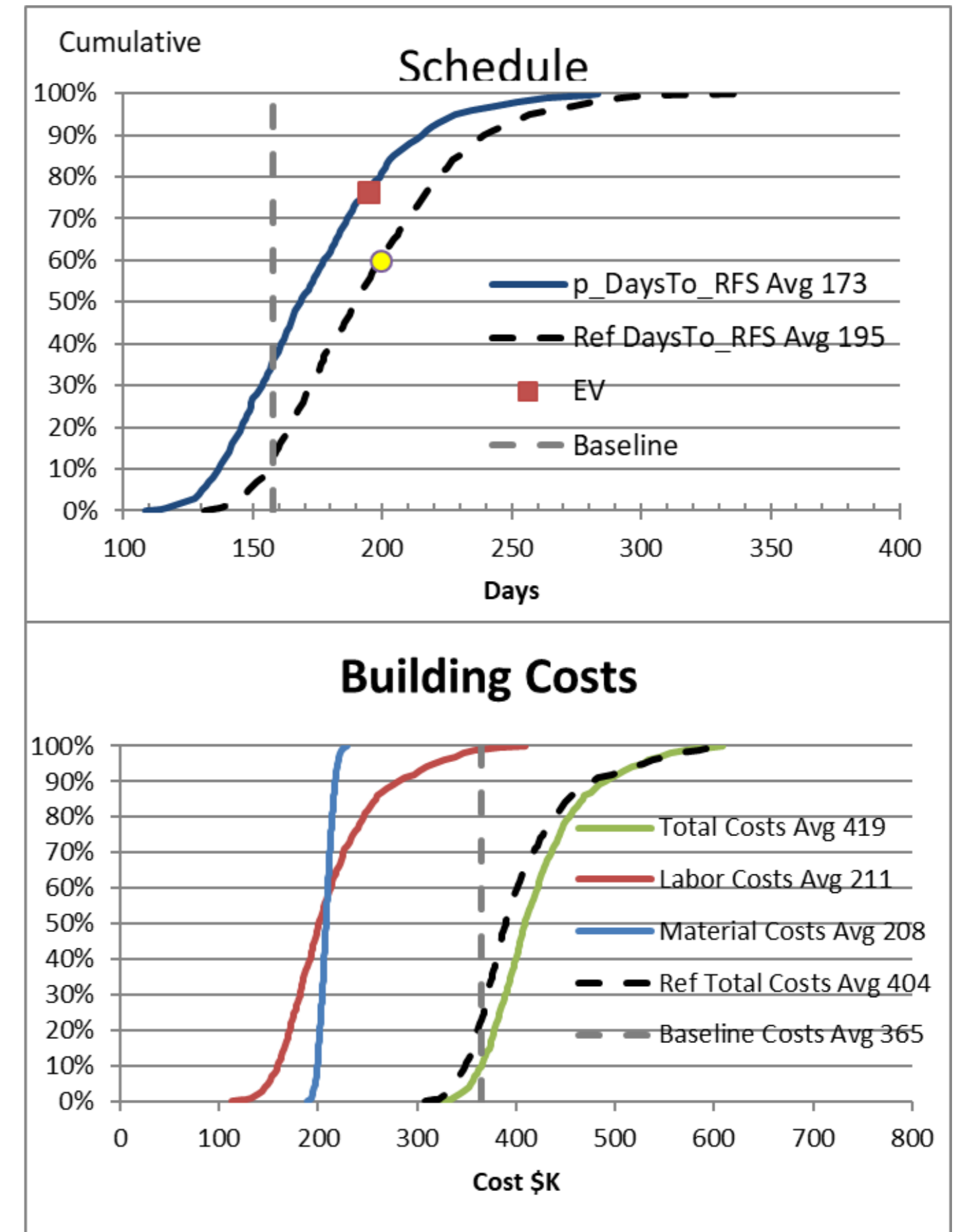
Take-Aways from Discussion

- Conducting a CSRA is important to good Decision Quality

- CSRAs can be conducted at any time

- Be clear on the frame of the CSRA – What is included and Excluded

- Make sure the SMEs understand what they are assessing

- Does the base CSRA analysis pass the "Gut Check"

- Generate EV Tornado Diagrams and CPM Graphs to gain insights

- Determine what is important to mitigate

- Frame mitigation options and evaluate
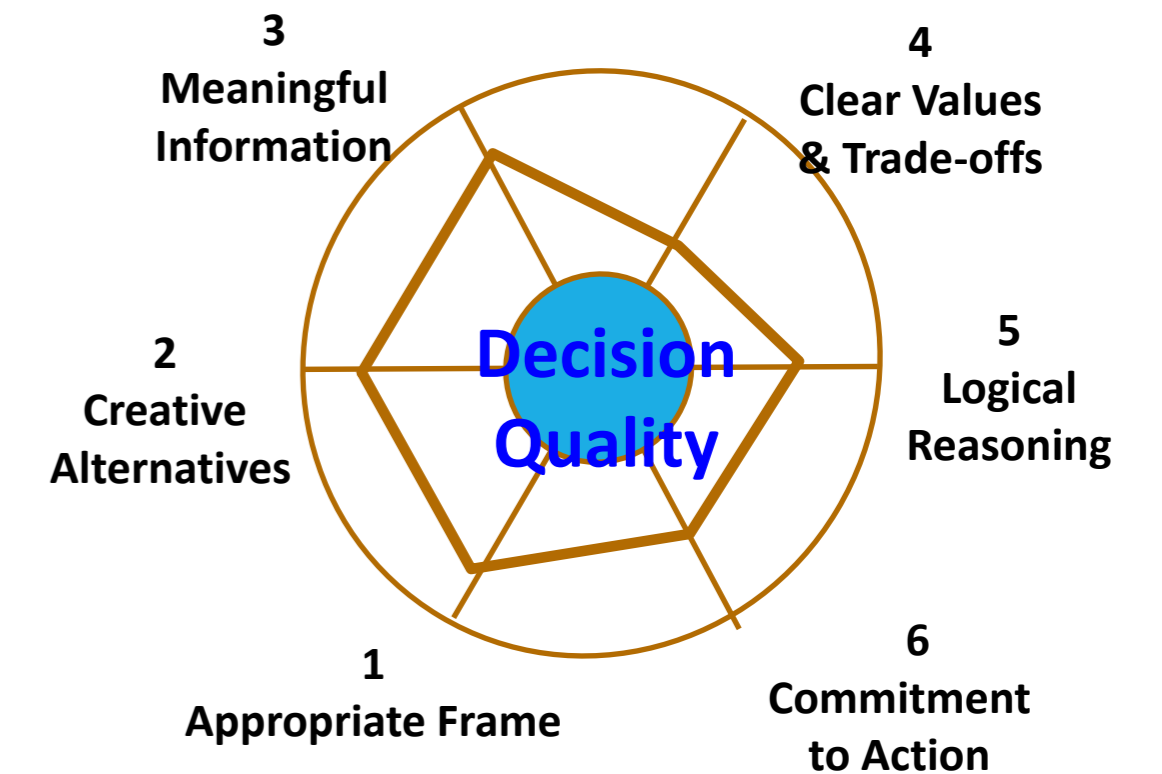
Source: Spider Diagram attributed to Strategic Decision Group

Thank You for your participation

Brian Putt   (Brian@ThePutt.com)