Taking control: Cost & Schedule Risk Analysis

SDP- DAAG Workshop Denver
2019

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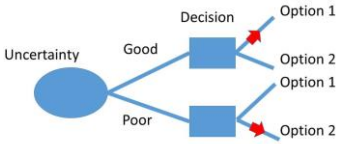


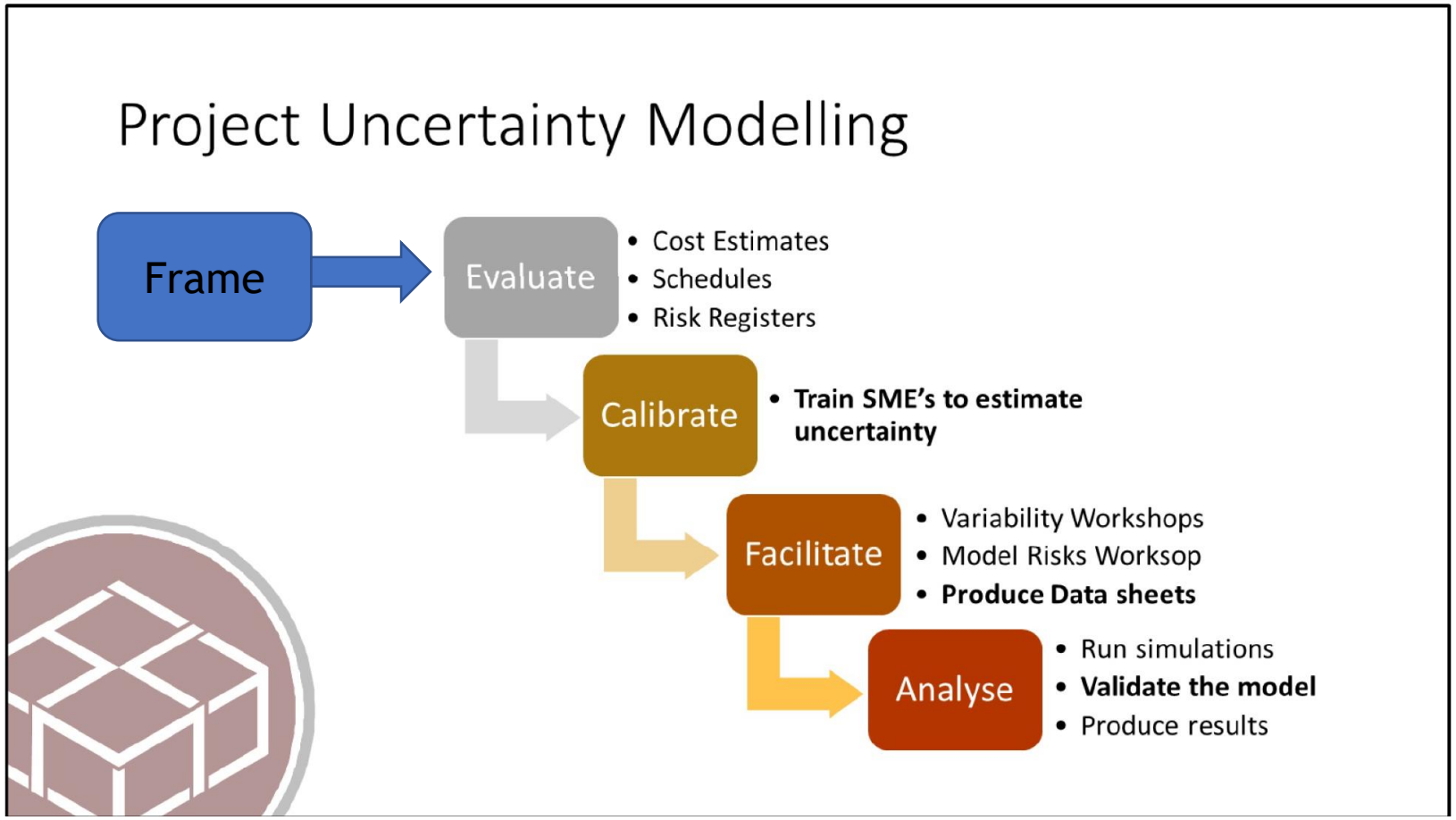
Brian Putt

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
- Calibration Training
- Example Analysis of “Build a House”
  - Graphic oriented PERT model
  - Excel structure tailored to needs
- Group Exercise
- Incorporating Mitigation
- Conclusions and Feedback

Cost and Schedule Risk Analysis (CSRA) Interest Group

- Meeting since May 2018 on monthly basis.
- Working through the steps of CSRA.



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.[1] "(Wikipedia -- Cost Overruns)

[1] *Standish Group (2004). CHAOS Report (Report). West Yarmouth, Massachusetts: Standish Group*

HMAS Hobart destroyer delivery delayed

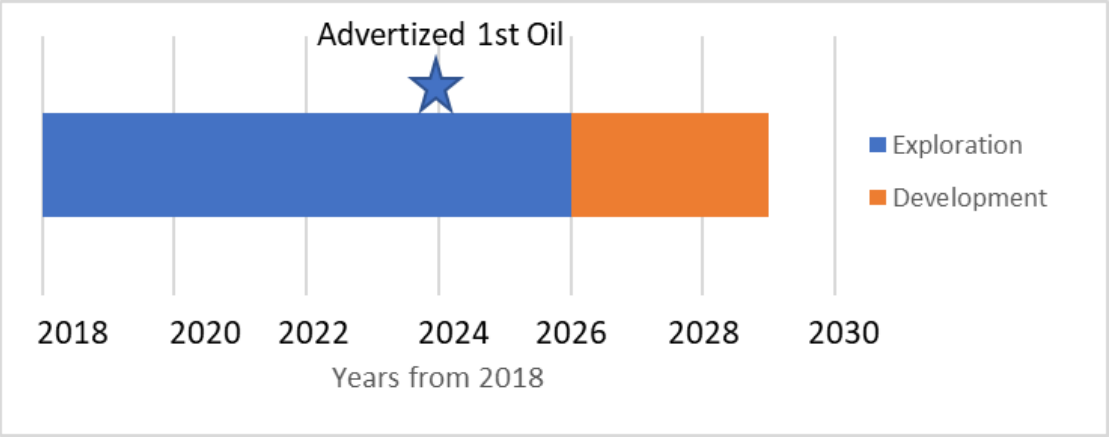
HMAS Hobart destroyer was ordered in 2007 by the Royal Australian Navy, but errors and delays in construction caused extensive schedule slippage. Despite commissioning initially planned for December 2014, the ship was not laid down until September 2012, and launched in May 2015. Department of Defence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

Delivered nearly 3 years late!

Source: https://en.wikipedia.org/wiki/HMAS_Hobart_(DDG_39)

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.

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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

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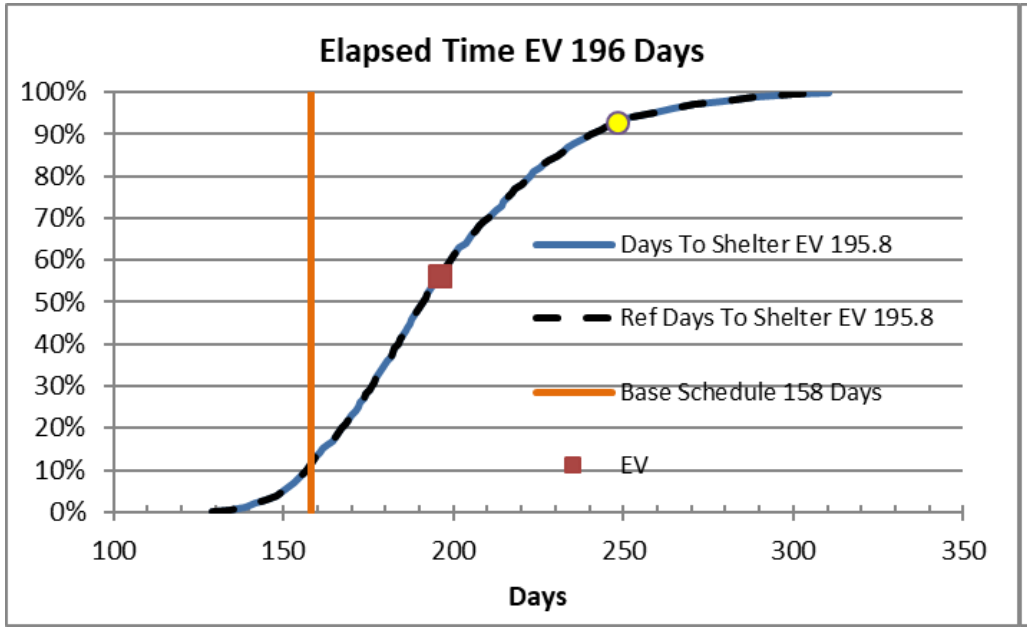
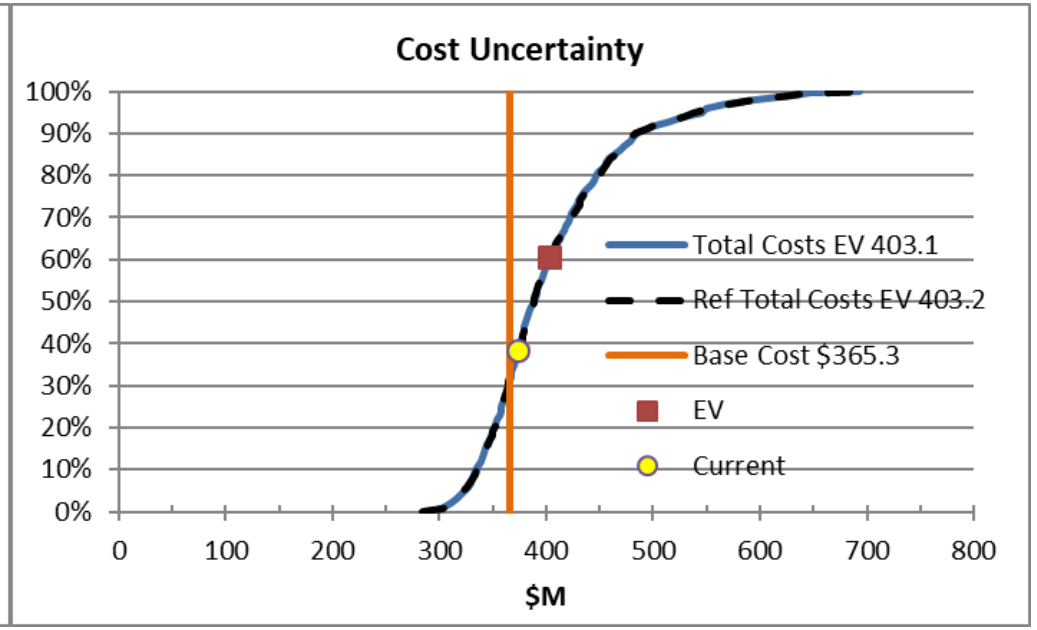
Objective is to understand the uncertainty in Cost and Schedule

For many reasons, estimates often underestimate

- Time required
- Cost required





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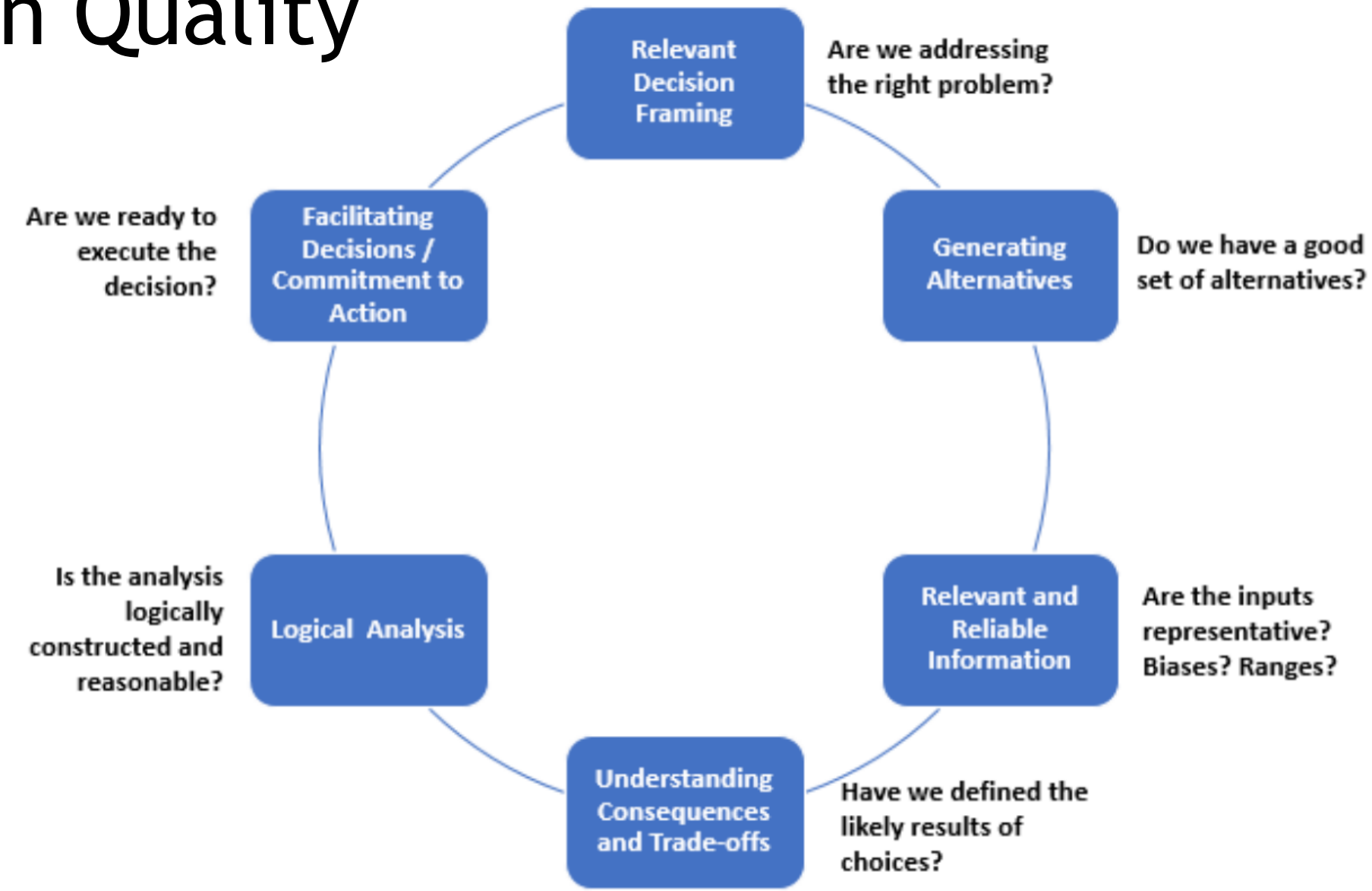
Decision Quality



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

Gantt Chart

PROJECT TITLE

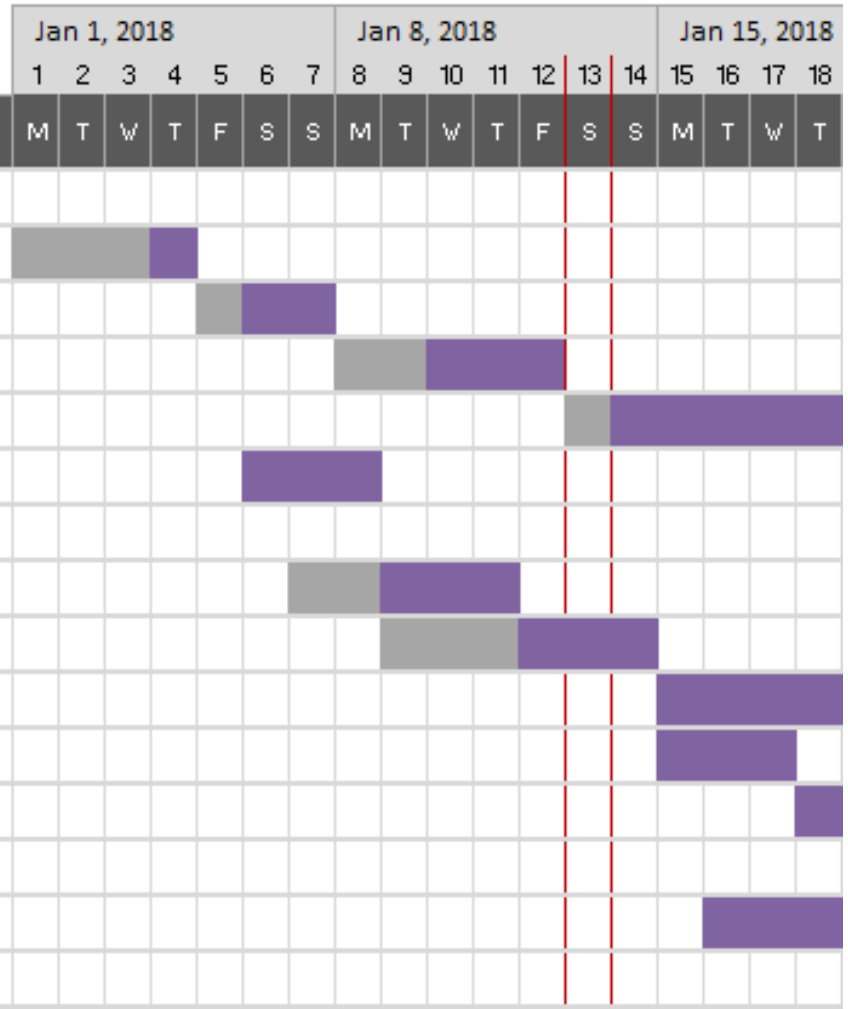
[Company Name]

[Project Lead]

Project Start: Mon, 1/1/2018

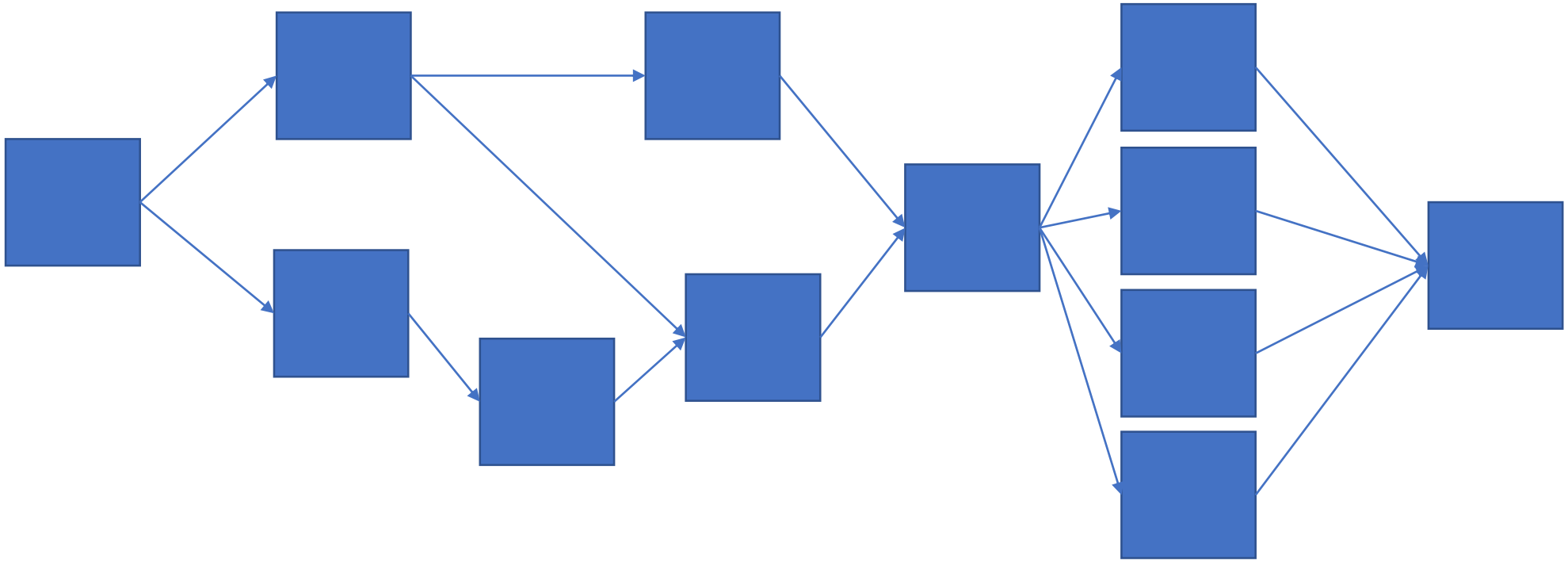
Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Phase 1 Title				
Task 1		75%	1/1/18	1/4/18
Task 2		60%	1/5/18	1/7/18
Task 3		50%	1/8/18	1/12/18
Task 4		25%	1/13/18	1/18/18
Task 5			1/6/18	1/8/18
Phase 2 Title				
Task 1		50%	1/7/18	1/11/18
Task 2		50%	1/9/18	1/14/18
Task 3			1/15/18	1/18/18
Task 4			1/15/18	1/17/18
Task 5			1/18/18	1/21/18
Phase 3 Title				
Task 1			1/16/18	1/21/18
Task 2			1/22/18	1/26/18

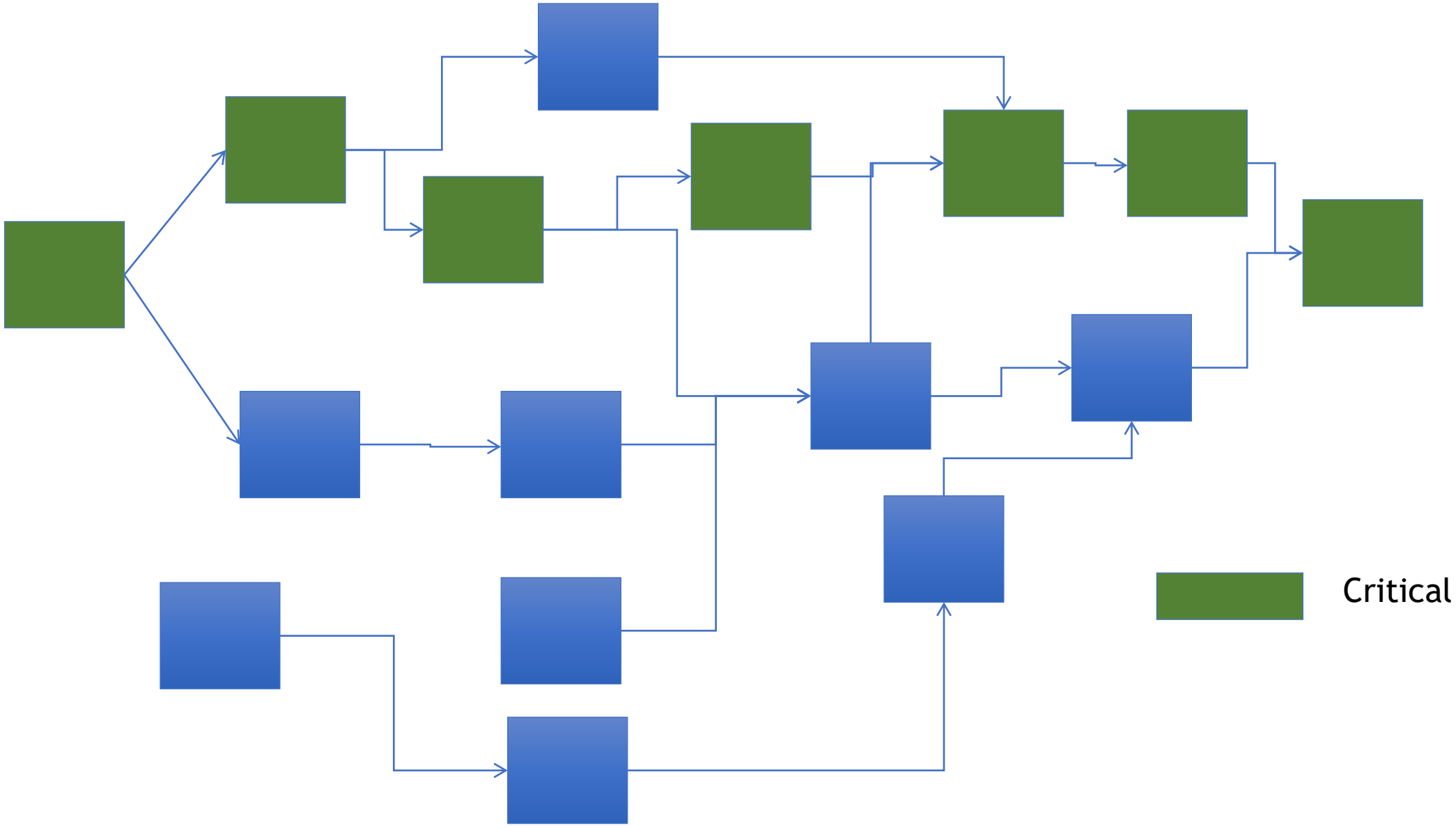


PERT Chart

- Takes the Gantt elements and organizes them as a series of dependent or enabling events.
- Allows the assessment of the Critical Path
- Shows the event sequence in a visual object form

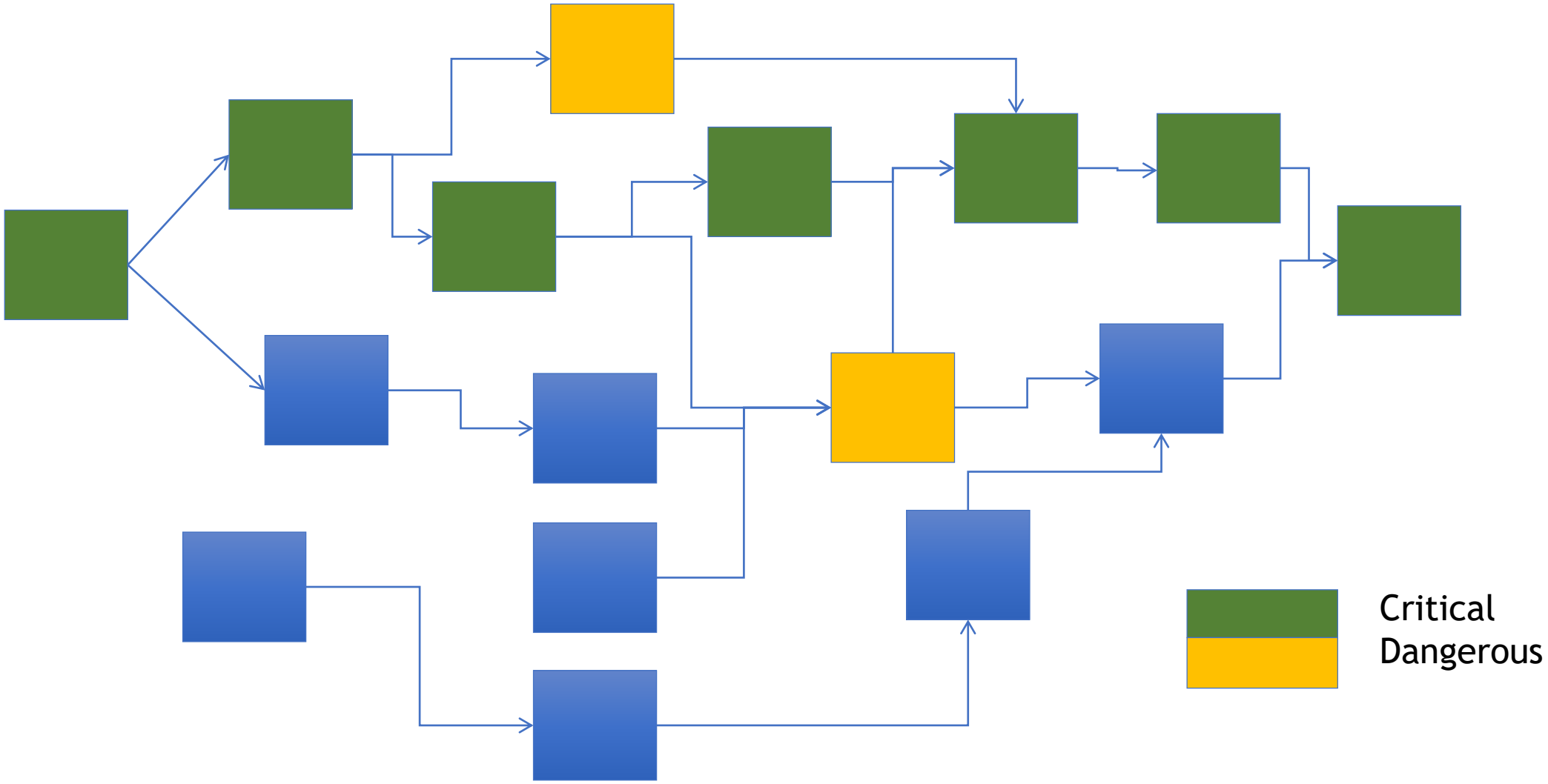


Critical path management



Near critical path assessment

- Critical and “Dangerous” must be spotted and managed



Important Questions

Questions to address

1. What endangers the project?
   - "Stuck" critical path items
   - "Surprise" Critical Path items
2. What penalty does it cause?
3. Can I do anything about it?
4. Is it worth doing anything about it?
5. When outcomes are good, what is NOT on the Critical Path?

Maintain a decision perspective. Refer back to these questions as we go through the workshop

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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)

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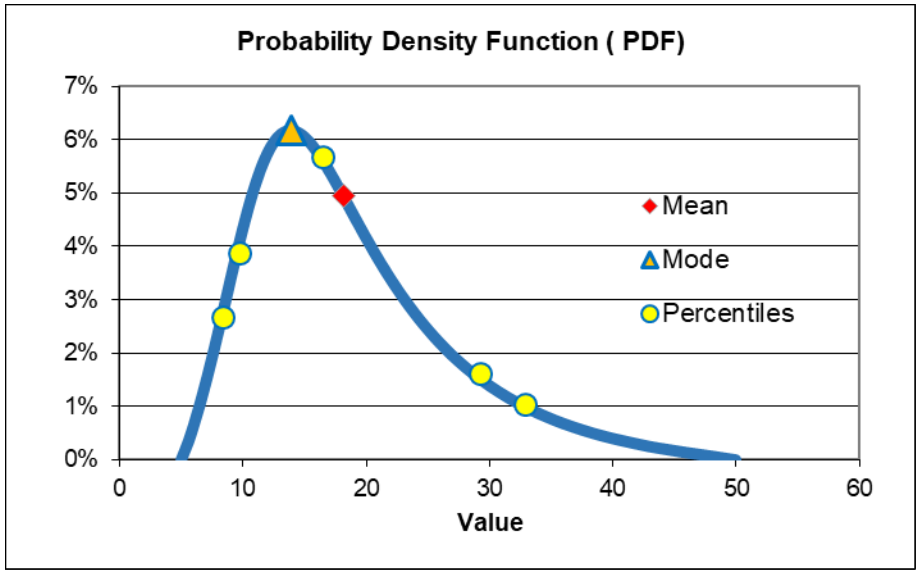
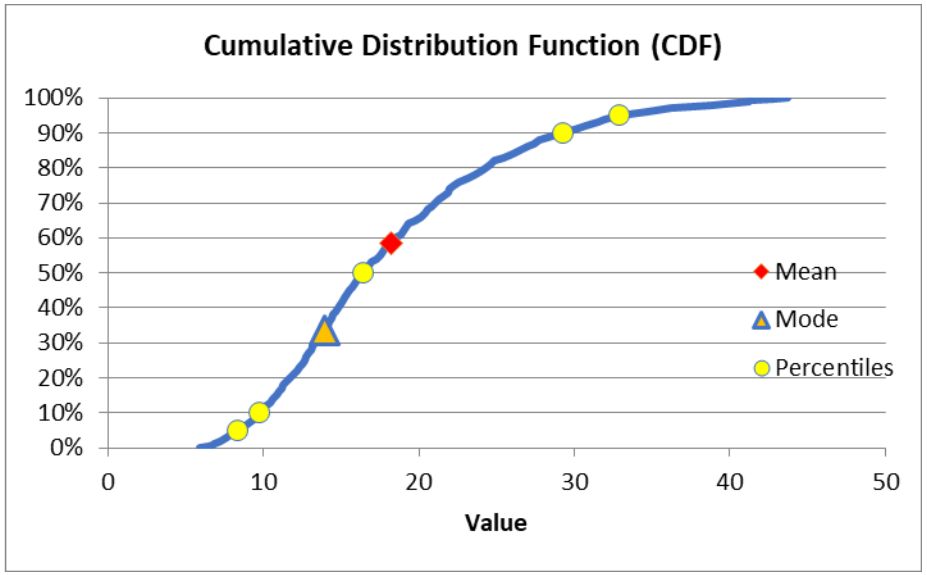
Metrics of a Distribution

- 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

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 to budget for**.

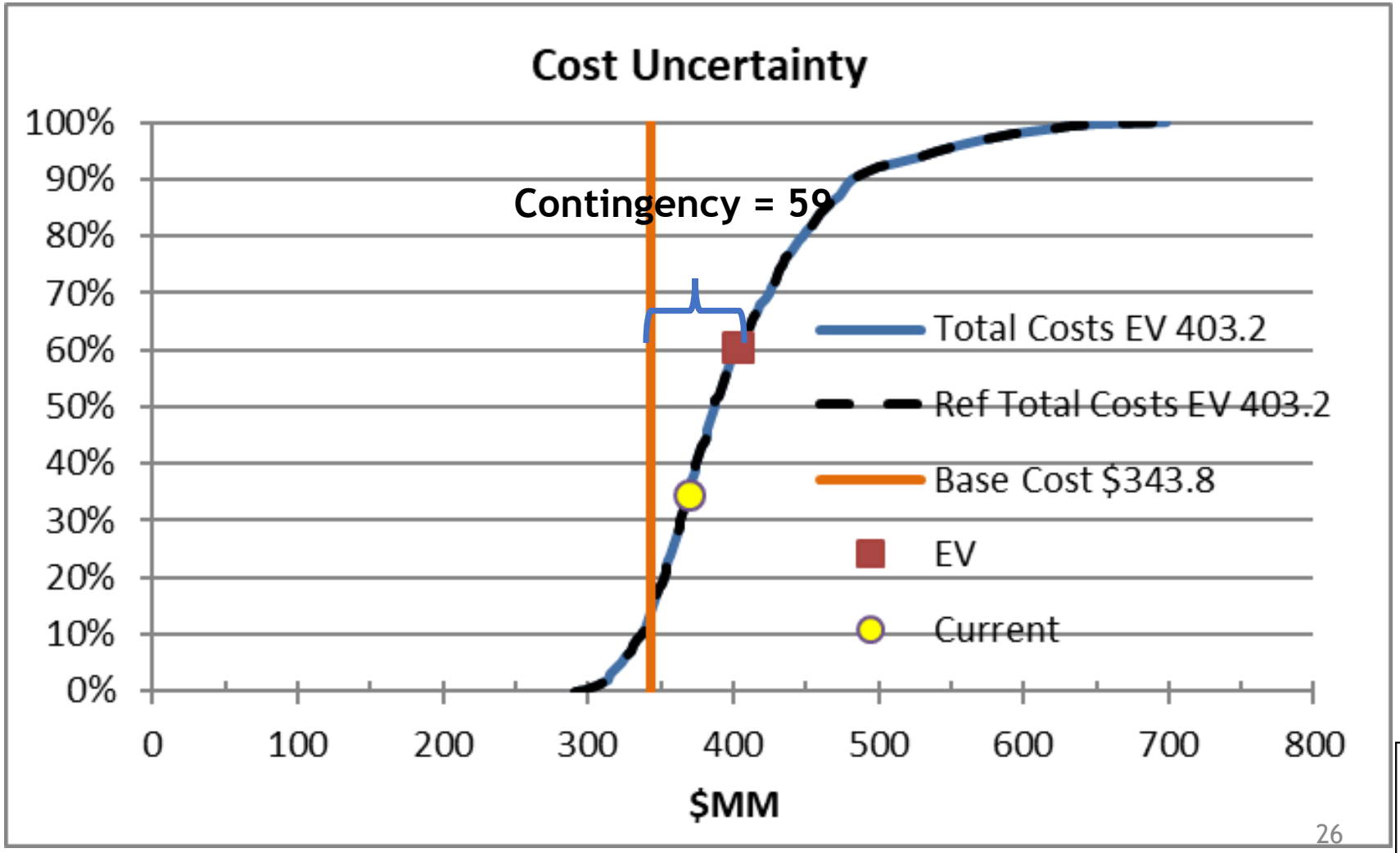
Schedule contingency usually excludes;

- Extreme risks
- Scope changes

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

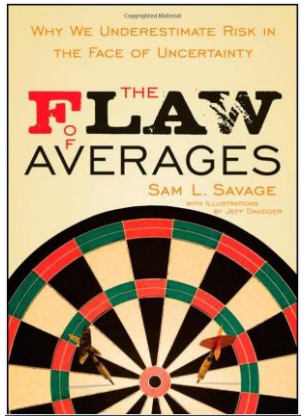
Cost Contingency is generally the difference between the Baseline Value and the CSRA EV result

- 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



So should we always use the mean to represent a distribution?

Interesting reading:



Average starting salary for 1983 graduates from University of Virginia in Rhetoric and Communications: <u>$55,000/yr</u>

(~$117,000 in today's dollars)

How?

Means – pro and con

- Pro
  - Is the Expected Value
  - Sum of means = mean of sums
  - Is the measure of choice if you're attempting a statistically valid number of opportunities?

- Con
  - Is very sensitive to outliers
  - Has no consistent percentile
  - Is usually unlikely to be achieved on any given project
  - Usually must be calculated; is extremely difficult to estimate

Medians – pro and con

- Pro
  - Is fairly insensitive to outliers
  - Consistent percentile (50%); makes for a fair target
  - Highly motivating
  - May be the statistic of choice for a single opportunity

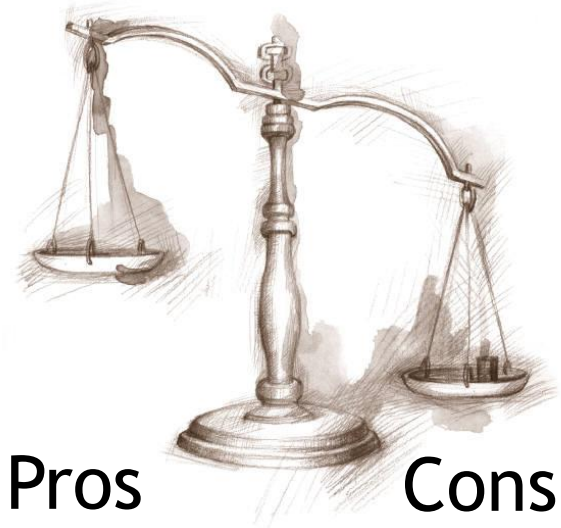
- Con
  - Does not equal the Expected Value
  - Sum of P_{50}s does not equal P_{50} of sums

Modes

The "Most Likely" individual result.

…are fairly useless.

And can be VERY dangerous.



But opinions vary.

Your situation might be different

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

"Most Likely" can be confused by the SMEs for expected or median.

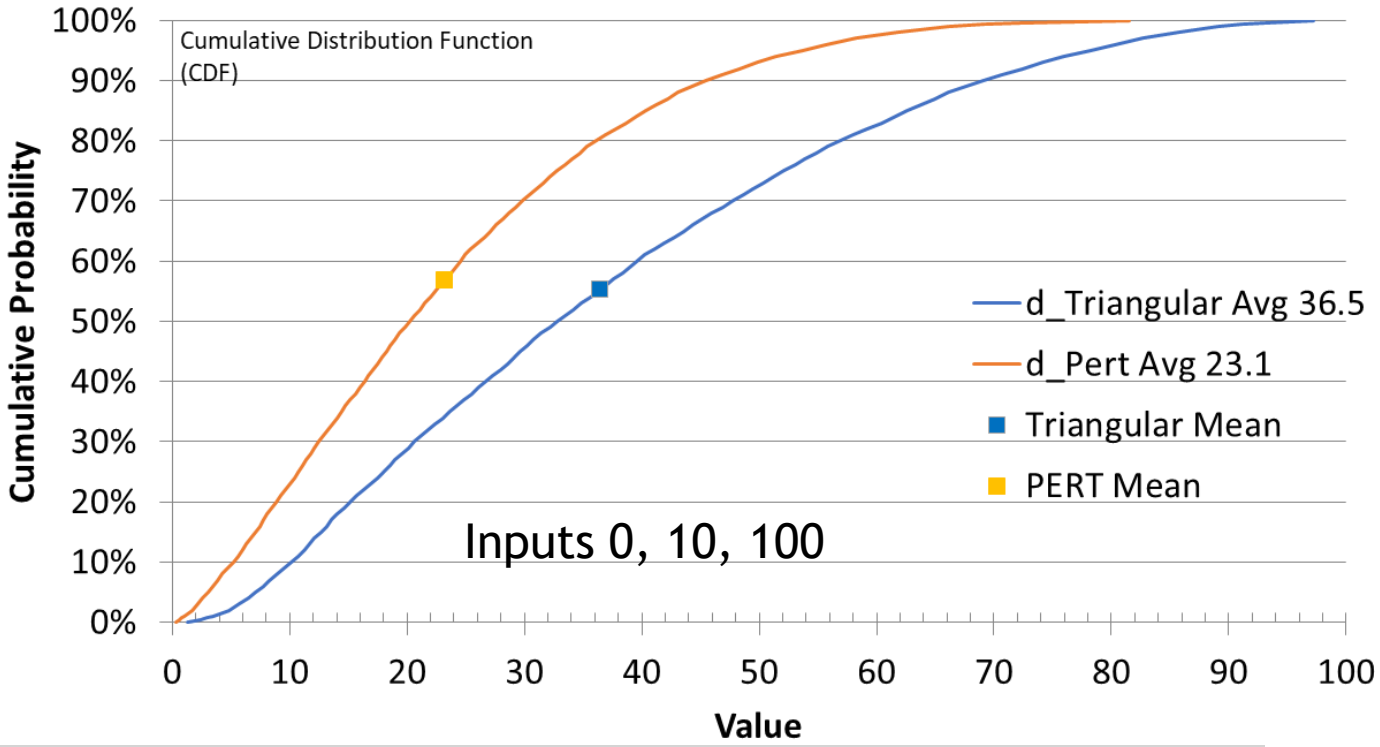
How are the median (P50) or EV assessible without knowing the distribution.

What distribution should be use in the analysis

- Triangular distribution
- Pert Distribution
- Trigen
- Myerson
- Metalog distribution
- No distribution ??
- Adjustments to the SME assessments base on historical data

Triangular has a larger mean value & higher uncertainty

- Academia promotes the use of the PERT distribution
- Triangular considered as a distribution when we don't know anything
- Both typically use Min, Most Likely, Max as inputs.



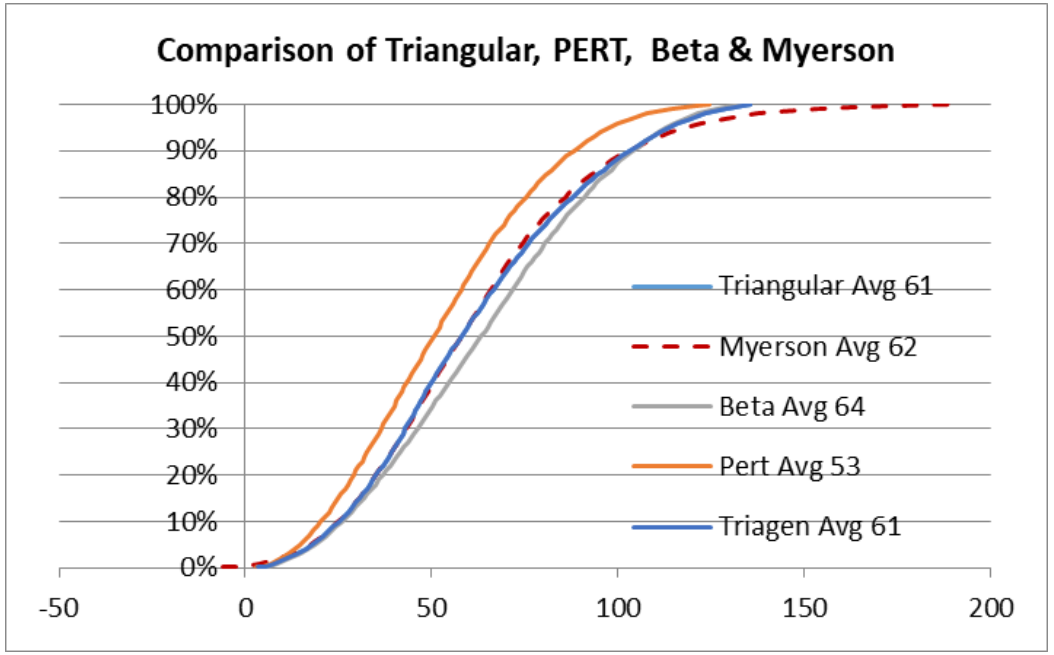
	EV	StdDev	min	max	EV Percentile	10%	50%	90%
Triangular	35.72	21.10	1.44	99.34	55.4%	10.59	32.77	66.83
PERT	22.56	14.81	0.30	90.23	56.7%	5.54	20.17	43.64

Comparison of some distributions

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

All the EV's are similar other than the PERT distribution

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



- All use the same Random numbers
- Triangular and 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

Calibration and Calibration Training

- Introduction to Calibration Training
- March 6, 2019

Introduction

I. background

II. Introduction to Calibration Training concepts

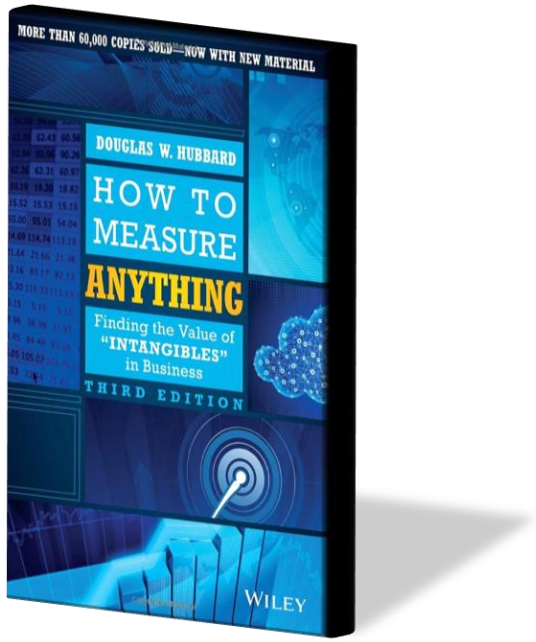
III. Initial bench marking test

IV. Equivalent bet technique

V. Second test

VI. Highlight further techniques and results

Where “Calibration” Comes From



- A partner of ours: Hubbard Decision Research (HDR)
  - Creator of Applied Information Economics (AIE)
  - Author of “How to Measure Anything”, + other books
- This field of study or research has been around for a long time
  - Google “**Calibrated Probability Assessment**”
  - Judgement & Decision Making (JDM) Psychology
- We have executed dozens of risk projects, calibrating hundreds of individuals using these concepts
- HDR has calibrated thousands of individuals, across a spectrum of industries and projects

Hubbard Decision Research

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Why Calibration?

- Decades of studies show that most professionals are statistically "**overconfident**" when assessing their own uncertainty.
- Studies also show that measuring your own uncertainty about a quantity is a **general skill** that can be **taught** with a **measurable improvement**
- We all understand the importance of calibration when it comes to the reliability of our measuring devices:
  - Scales
  - Instrumentation
  - Etc.
- We would want or trust results from an "uncalibrated" instrument?

Calibration Training

- As cost and schedule professionals, we should all be familiar with the inherent “problems” of Single Point Estimates
- Point estimates are never hit exactly, so instead we use range estimates
- Calibration Training can further improve range estimates by:
  - SME more accurately representing their uncertain in the estimate
  - Aligning a group of SMEs on the definition of an optimistic and pessimistic scenario
- The feedback has been positive, and the results have been studied and proven

Training Objectives

- Calibrated Probability Assessment is the skill of being able to describe your uncertainty quantitatively
- The value of the skill is the ability to give someone an estimate as a 90% confidence interval, and actually have a 90% chance of hitting your estimate.
- Or asking an SME for their 80% confidence internal on a question and knowing that they have an 80% chance of getting there question within their range.

Initial Calibration “Benchmarking”

- For the initial calibration test, you will be asked to provide a range:
  - For the questions that ask for a range, provide an upper and lower bound that you are 90% certain contains the correct answer.
- There is also training for answering binary questions (true/false) as well as probability questions in a full calibration workshop. For the sake of time today these topics will not be covered.

Range Question Example

- **“Give me your 90% confidence interval for;**
  - the final cost ($) of the 2014 Sochi Winter Olympics?

Initial Calibration “Benchmarking”

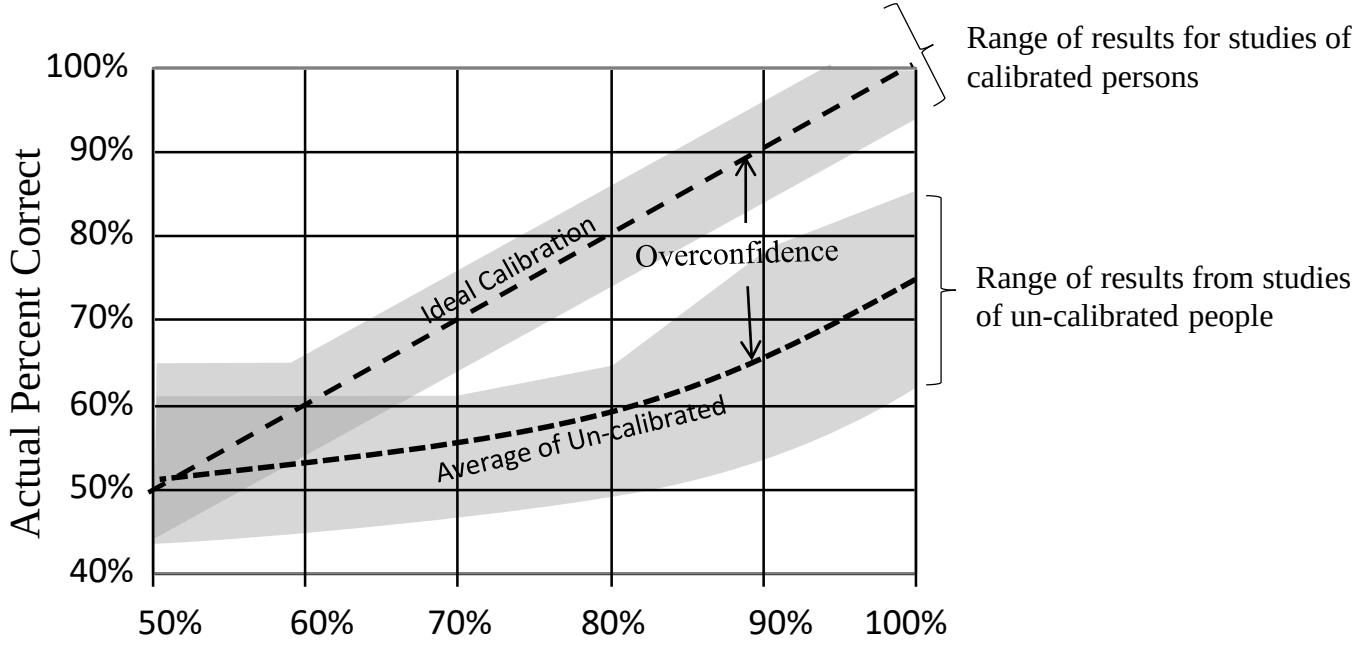
COMPLETE
BENCHMARKING TEST

Expected vs. Actual

- To determine your level of calibration, we need to compare actual outcomes to your “expected” outcomes.
- In decision analysis, the word “expected” literally means probability weighted average.
- For the questions that ask for a 90% confidence interval, you expect to get 90% between your upper and lower bounds by definition.

Overconfidence

- This is the aggregate of 11 studies in how well people subjectively assess odds.
- The overwhelming evidence is that everyone is systematically “overconfident” when assessing probabilities.
- Fortunately, training and other techniques exist that adjust for this effect.
- Unfortunately, almost nobody uses those methods.



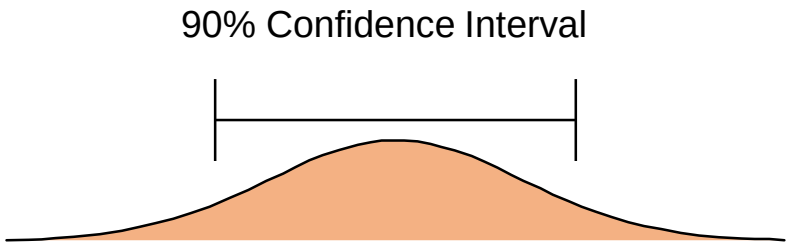
Initial Calibration “Benchmarking”

Results Short Test “A”

#	Question	Answer
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Overconfidence in Ranges

- Most people are significantly ***overconfident*** about their estimates, especially educated professionals



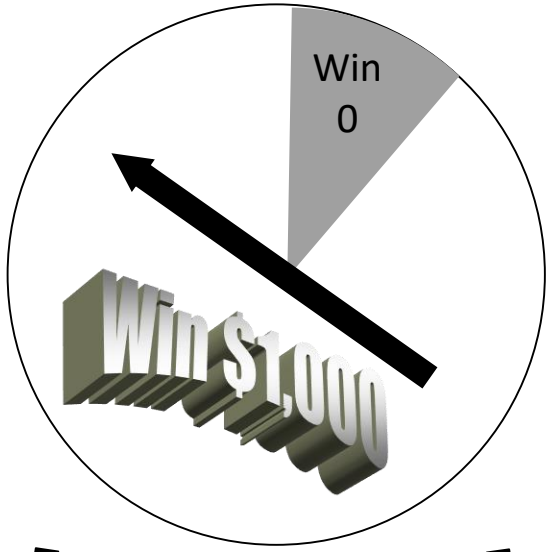
Group	Subject	% Correct (target 90%)
Harvard MBAs	General Trivia	40%
Chemical Co. Employees	General Industry	50%
Chemical Co. Employees	Company-Specific	48%
Computer Co. Managers	General Business	17%
Computer Co. Managers	Company-Specific	36%
AIE Seminar (before training)	General Trivia & IT	35%-50%
AIE Seminar (after training)	General Trivia & IT	~90%

Calibration Aid: “The Equivalent Bet”

For 90% Confidence Interval questions, which would you rather have?

- A: Win $1,000 if your interval contains the correct answer
- B: A 90% chance to win $1,000

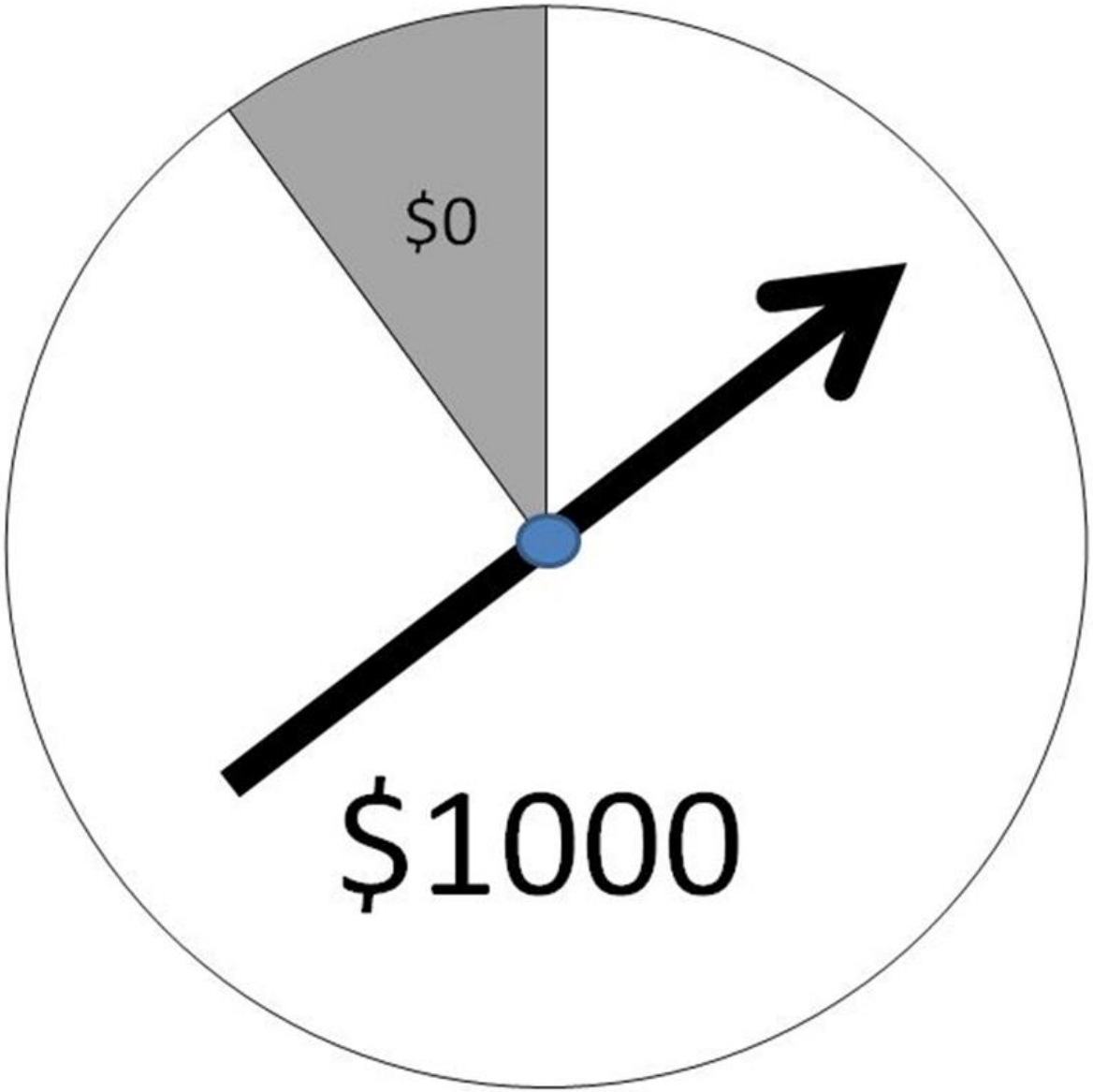
Option B:



Spin the Dial!

COMPLETE SECOND TEST

- Spin The Wheel?



Results Short Test “B”

#	Question	Answer
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Further Techniques for Calibration

If you can be systematic about applying each of the following steps, your subjective probabilities and confidence intervals will be much more realistic. It takes practice to force yourself to do each of these. Even when told of improvement strategies, the natural tendency of most people is to fall right back into their prior estimation habits.

On each question:

1. **Apply an equivalent bet.**
2. **Klein's Pre-mortem:** Assume your estimate is wrong. Now state why it was wrong.
3. **Actively consider how to adjust given your previous feedback from calibration tests.** (e.g. You thought you would do well on the last test and you still weren't calibrated – so why do you think you will be more calibrated this time?)
4. **Try ways to avoid "anchoring" on ranges:**
   - Don't think of one number then add and subtract an error. Instead, treat each bound as a separate binary question (e.g. are you 95% certain the value is less than the upper bound?).
   - Think of absurdly wide ranges and then narrow them based on your knowledge instead of starting with narrow ranges and widening them.

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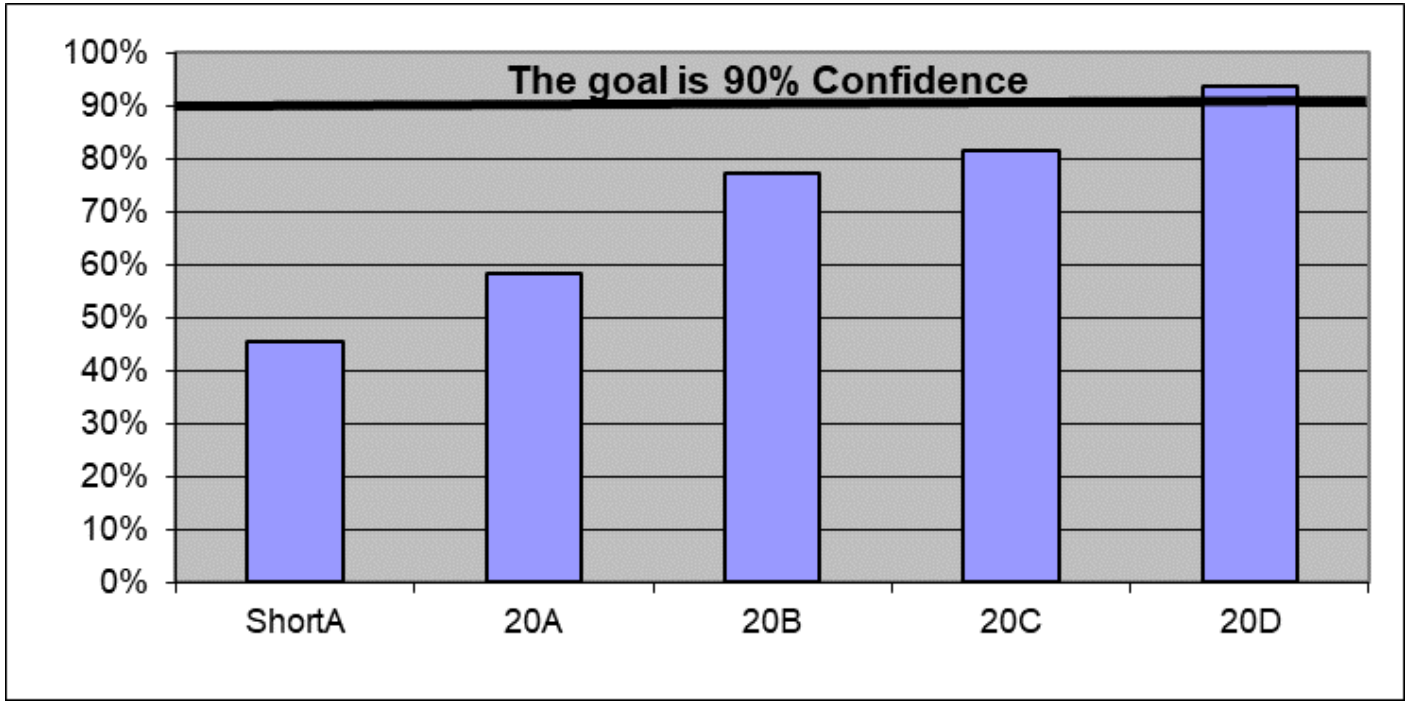
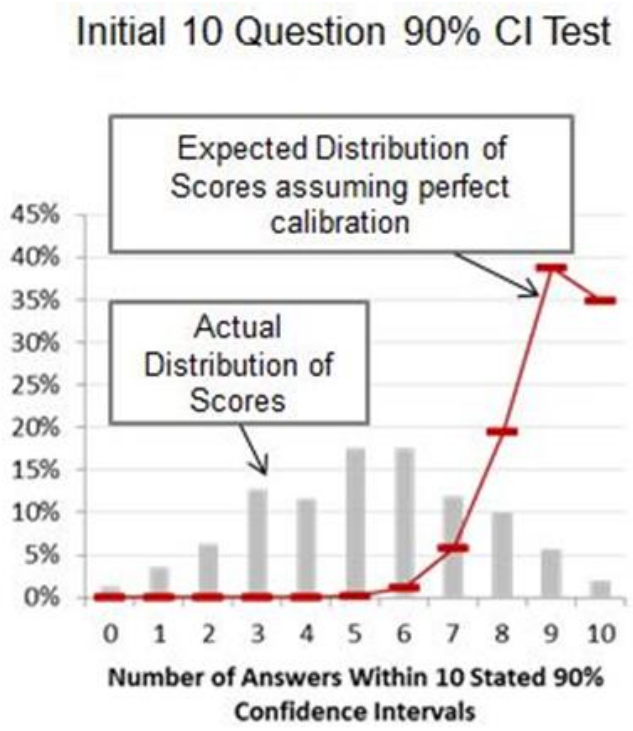
Expected Results for Full Calibration Training

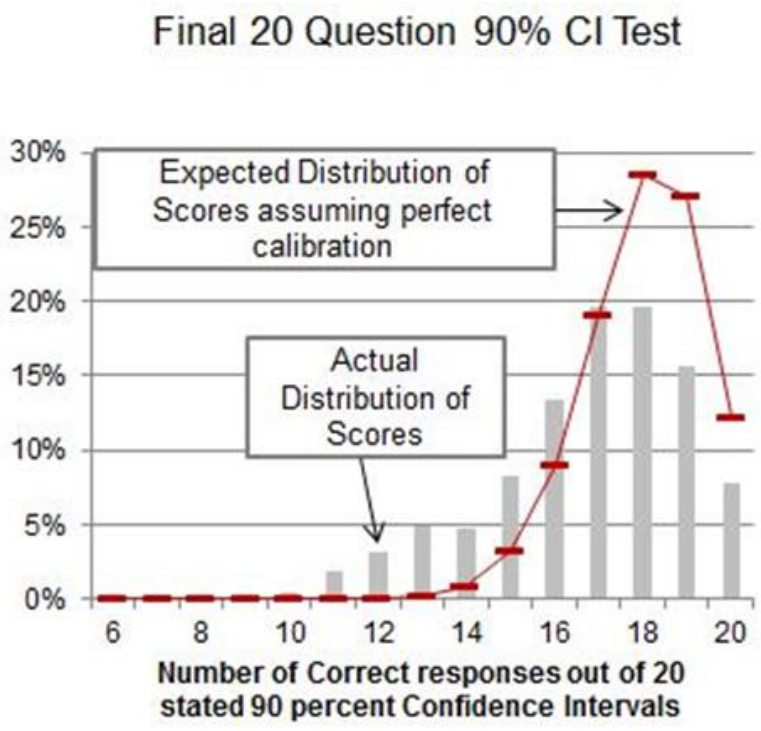
Results from a workshop held October 30th, 2018



Newest Study on 90% CI Calibration

- With 880 subjects and over 100,000 individual responses a clear pattern emerges.
- Training has a major impact on 90% CI tests.
- About 15% don't quite reach calibration

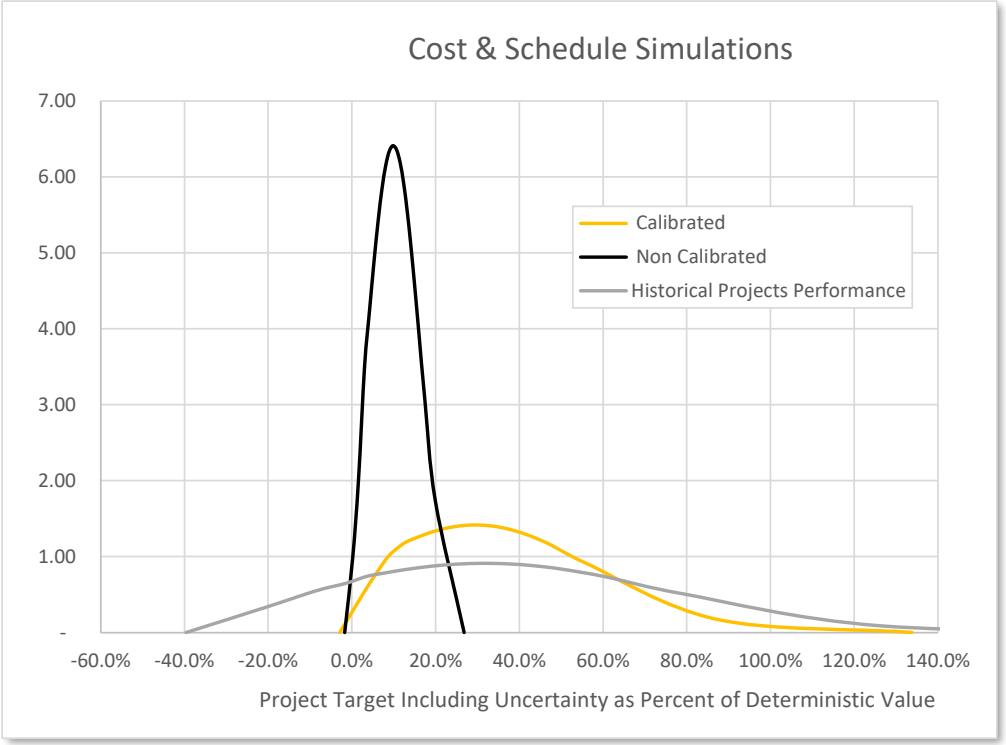




Why Calibration - Projects Study

- Project target including uncertainty as **percent of deterministic value** for 46 project uncertainty models
- Shows that **Calibration Training** vastly improves uncertainty modelling performance

Statistics		Calibrated	Non-Calibrated	Historical Projects
Number of Projects		14	32	1,000
Model Inputs	Total	6,486	1,775	
	Min	30	13	
	Max	4,755	555	
	Average	463	55	
Min		-11.7%	-7.2%	-69.2%
Mean		**29.5%**	**9.9%**	**31.8%**
Max		325.2%	39.4%	260.9%
P10		6.1%	1.6%	-8.5%
P50		**24.6%**	**10.7%**	**23.6%**
P90		55.9%	17.5%	78.6%
Deterministic Probability		4%	12%	16%



Taking Control:
Cost and Schedule Risk Analysis Agenda

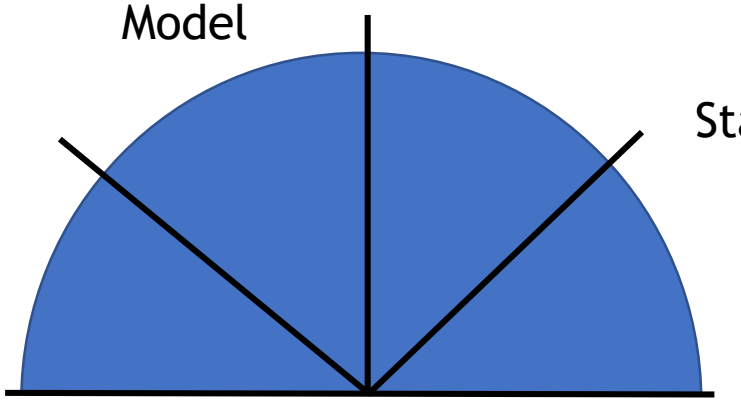
- Introductions
- Why is Cost and Schedule Risk Analysis Important
- How does DQ relate to the CSRA
- Issue: What are the inputs to a CSRA
- Calibration Training
- Example Analysis of "Build a House"
  - Graphic oriented PERT model
  - Excel structure tailored to needs
- Group Exercise
- Incorporating Mitigation
- Conclusions and Feedback

Types of CSRA Models

Today's Example Models

PERT Model

SIPmath Model



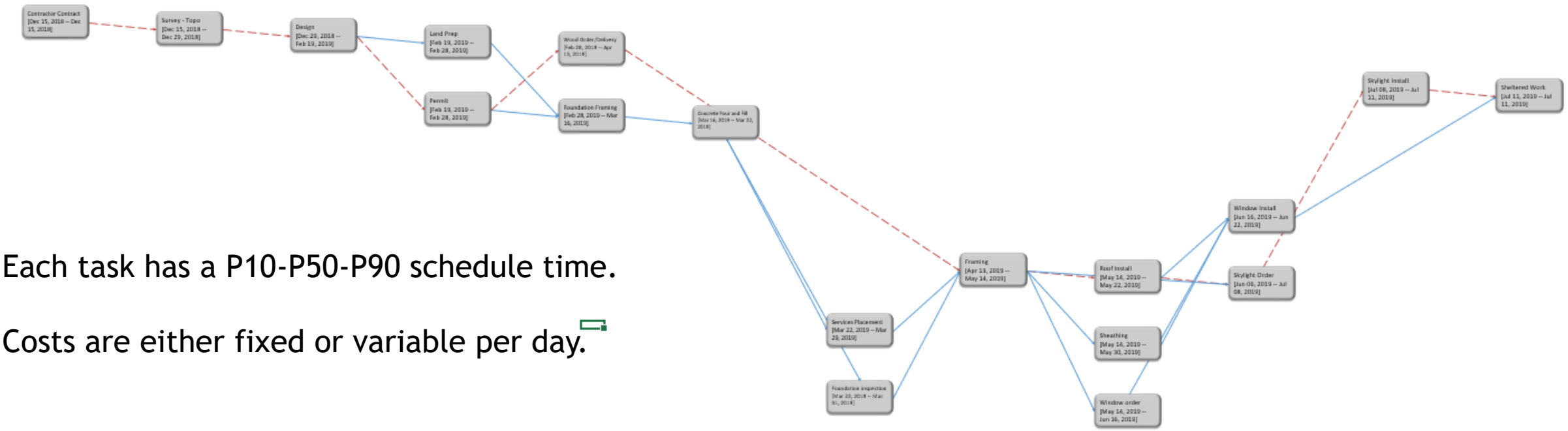
- **Continuum of models**
  - Extremely detailed tailored for the project
  - Allows modification to match SME or project requirements (SIPmath Model)
  - Procedural template with common way of inputting the uncertainties (PERT model)
  - Static format model and sometime specified distributions
  - Static Model constrained to corporate guidelines (template)

The Graphic-Object Tool (PERT Model)

- Originally created within Decision Strategies led by James Maffione
- Exists as a freely downloadable item from James' post DSI website (www.freestrategytools.com)
- Is currently undergoing modifications and advancements by Haskett Consulting Intl.

- Our model example today: Initial house construction
  - Today's Example Model: Downloadable at haskettconsults.com

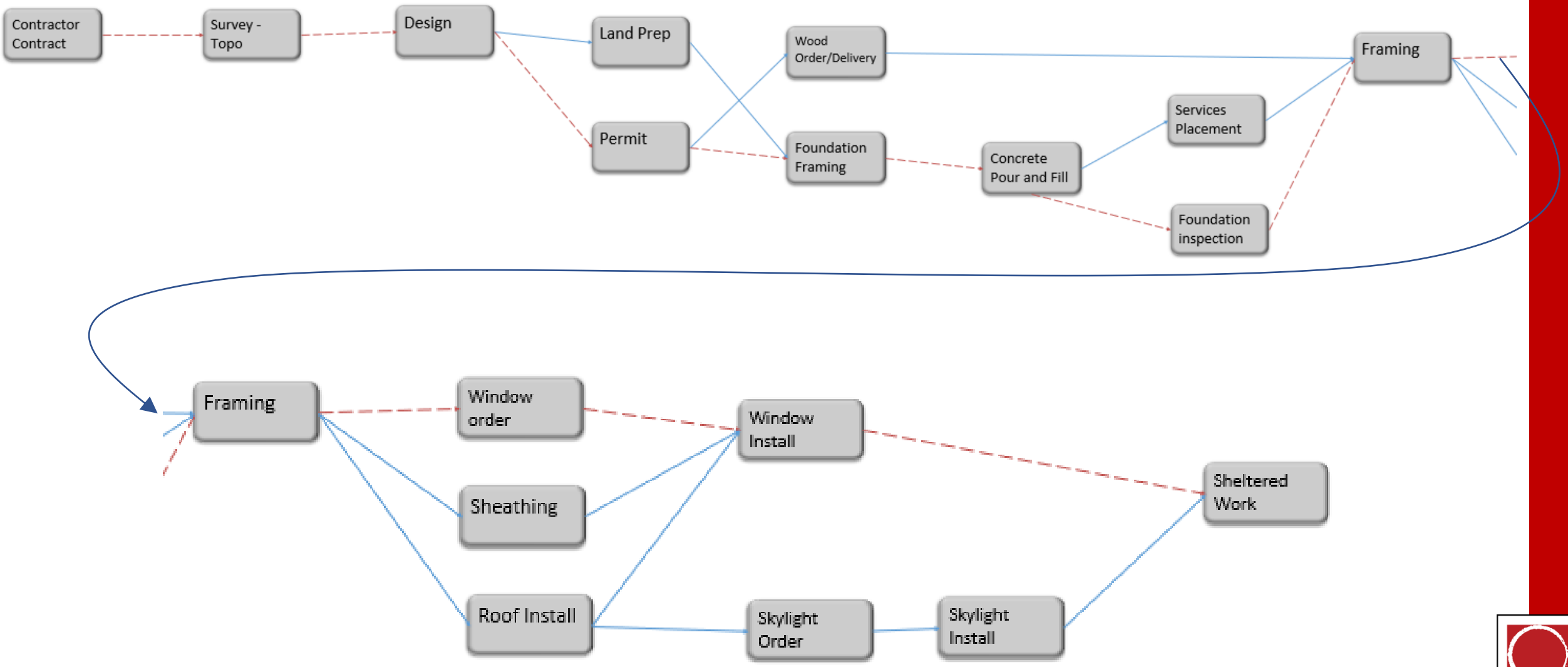
PERT Diagram – Constructing a House



Each task has a P10-P50-P90 schedule time.

Costs are either fixed or variable per day.

PERT Diagram – Constructing a House - A closer view

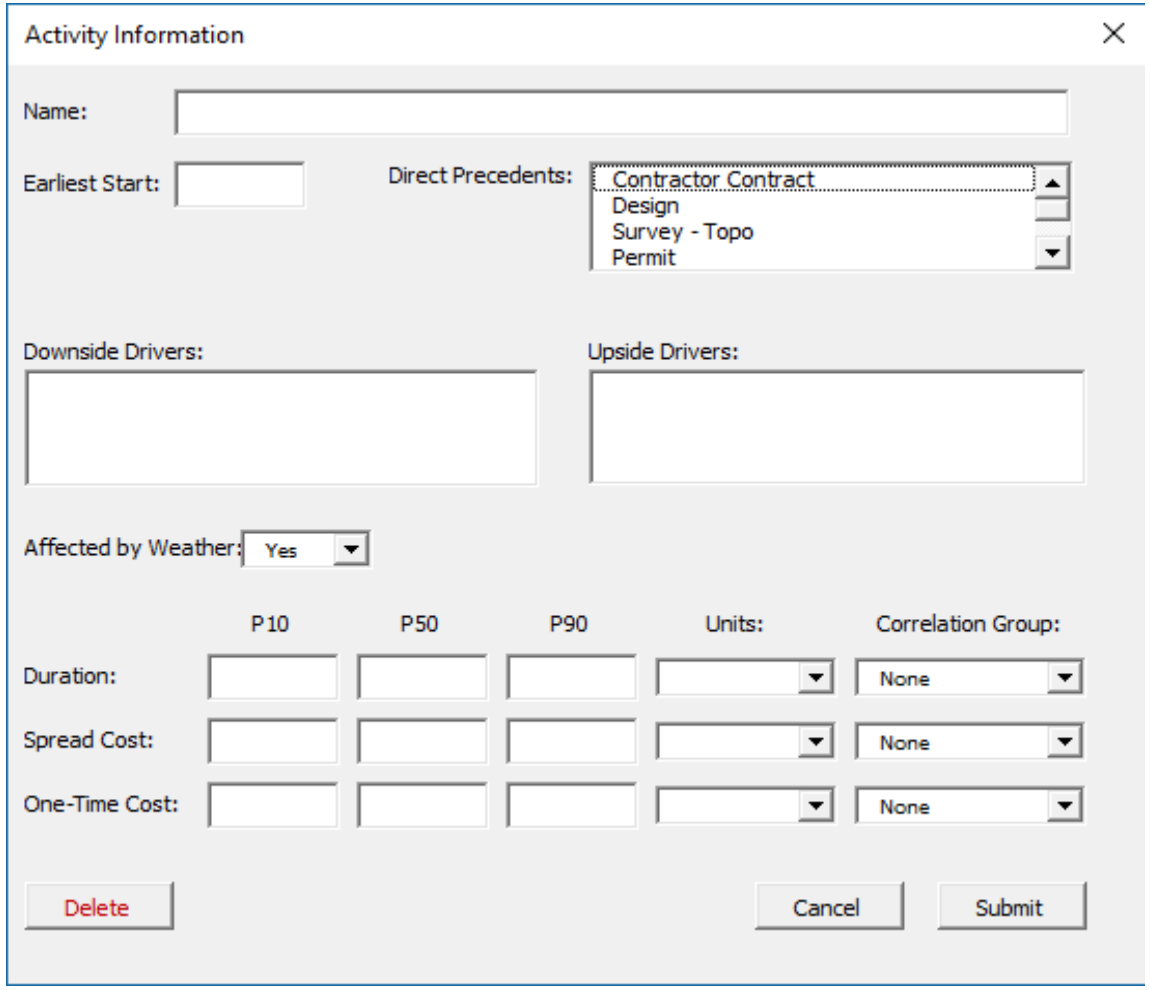


Graphic Elements have cost and time

Identifier and start constraint

De-biasing discussion notes

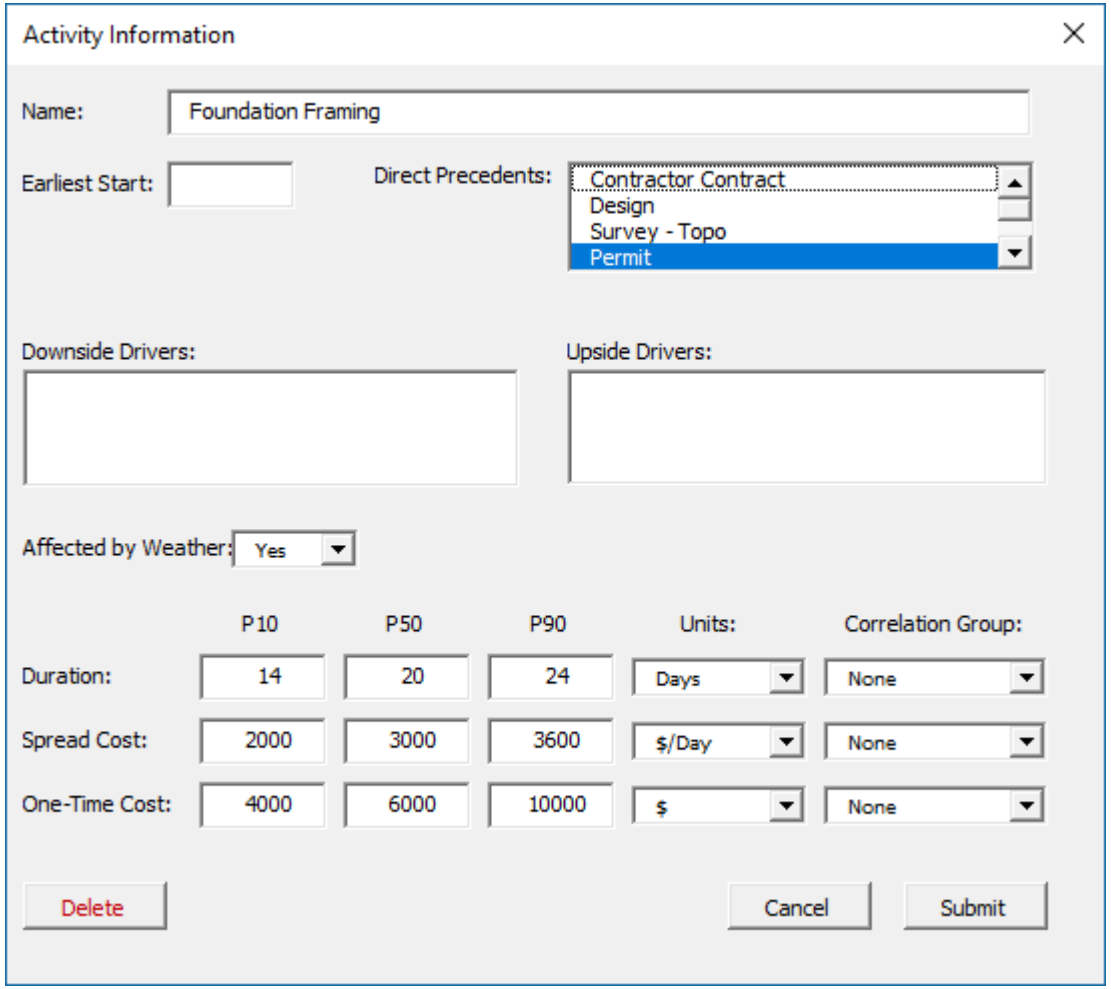
Common external risk



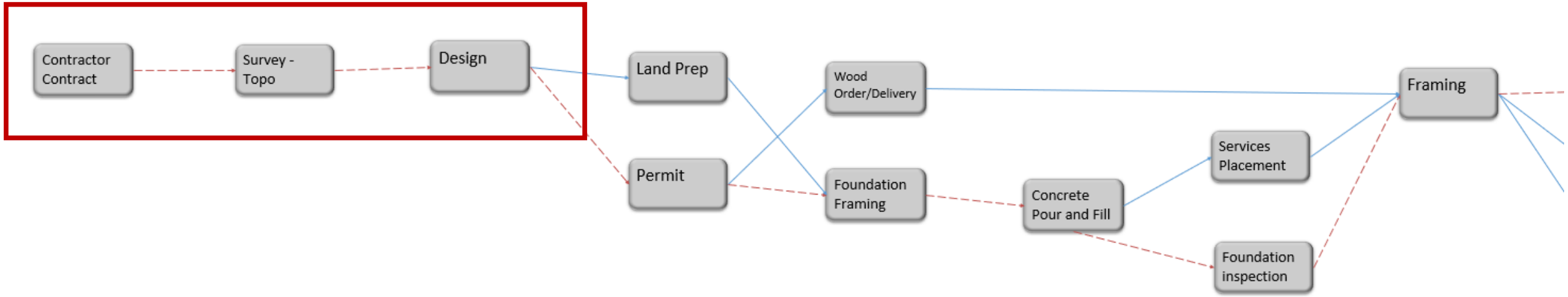
Precedents – multiple can be selected

Ranges for duration, fixed and variable costs

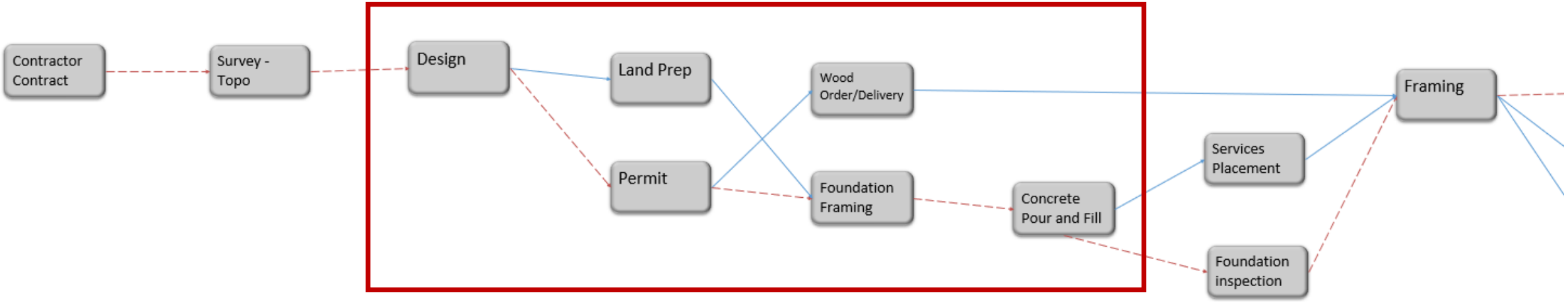
Example Input from PERT Model



Preparatory elements are often “simple contingent”

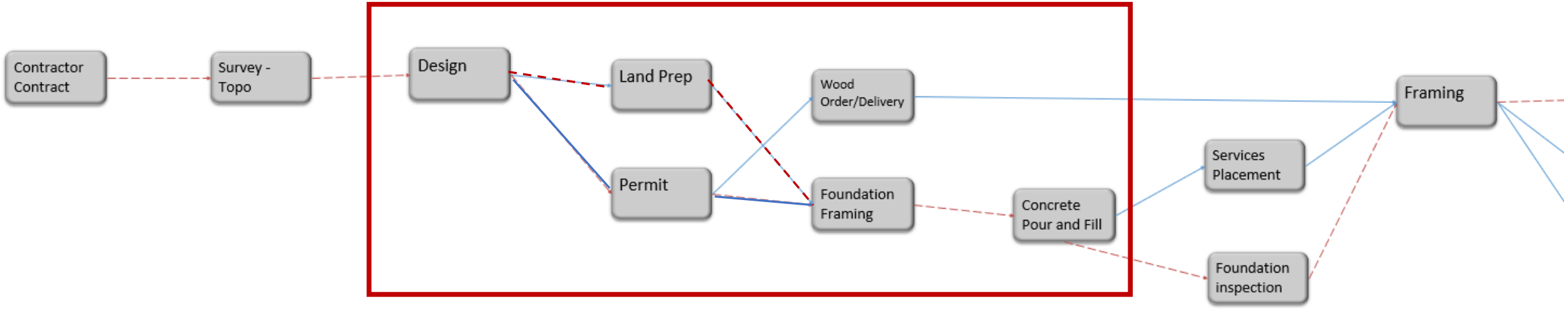


But some elements can occur at the same time



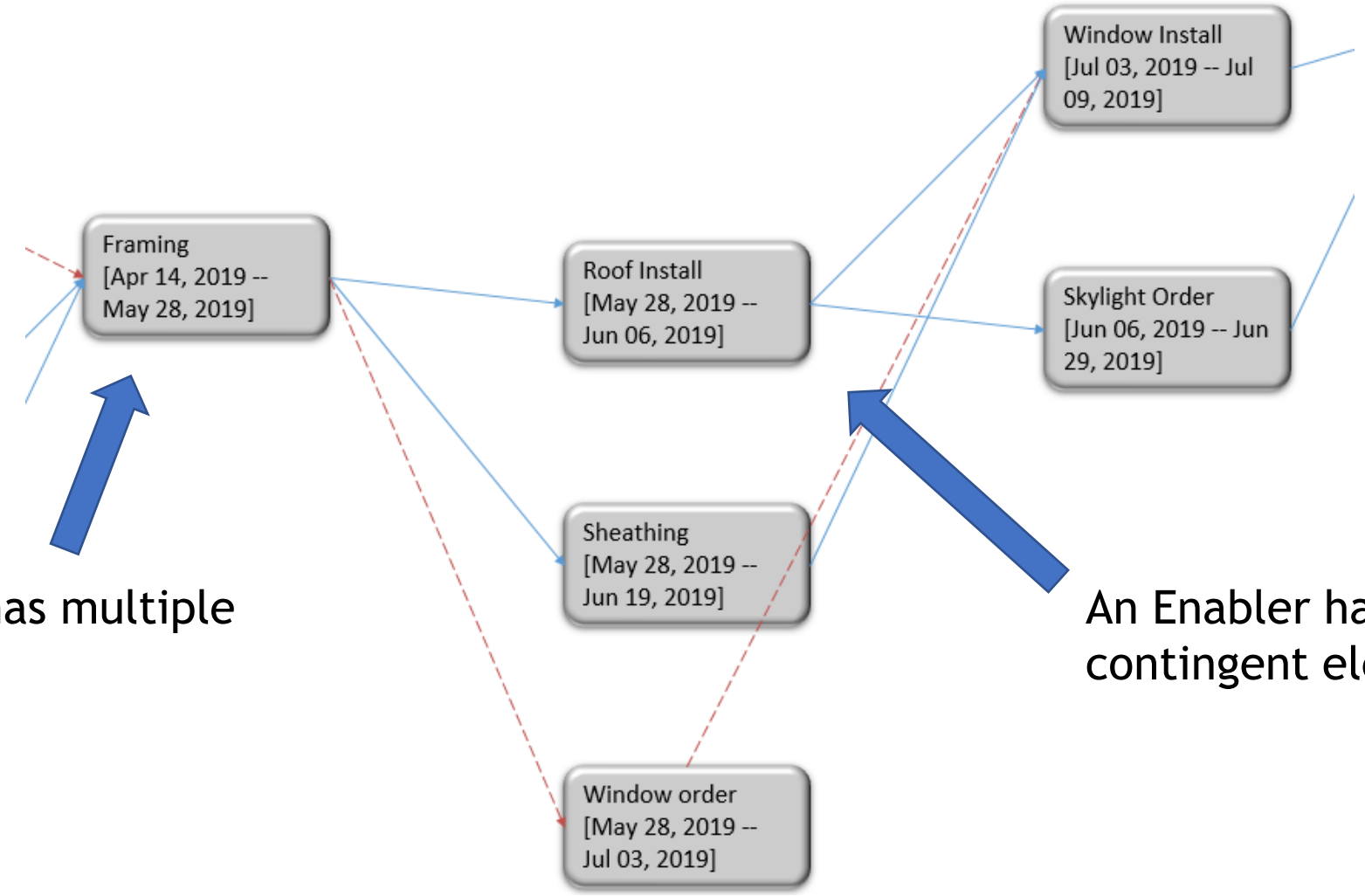
Critical Path: Design → Permit → Foundation Framing → Concrete Pour & Fill

But the Critical Path is not constant



Critical Path: Design → Land Prep → Foundation Framing → Concrete Pour & Fill

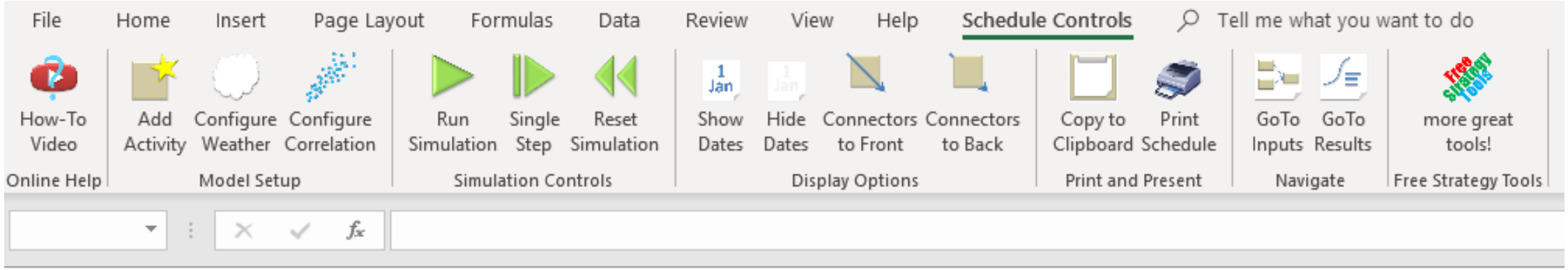
Pinchpoints… and Enablers



A Pinchpoint has multiple predecessors.

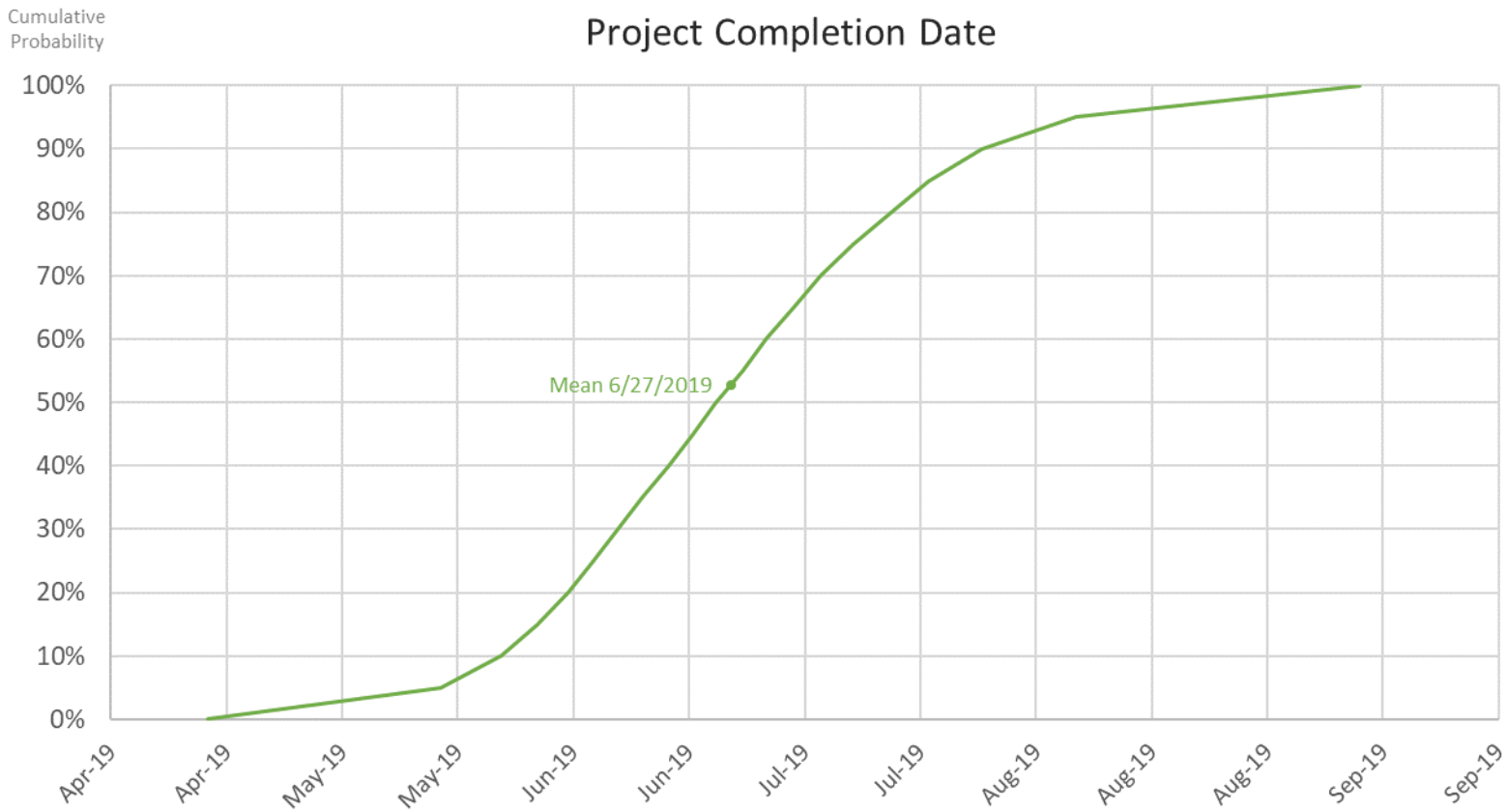
An Enabler has multiple contingent elements

Toolbar Controls



Schedule Risk to Shelter (194 days)

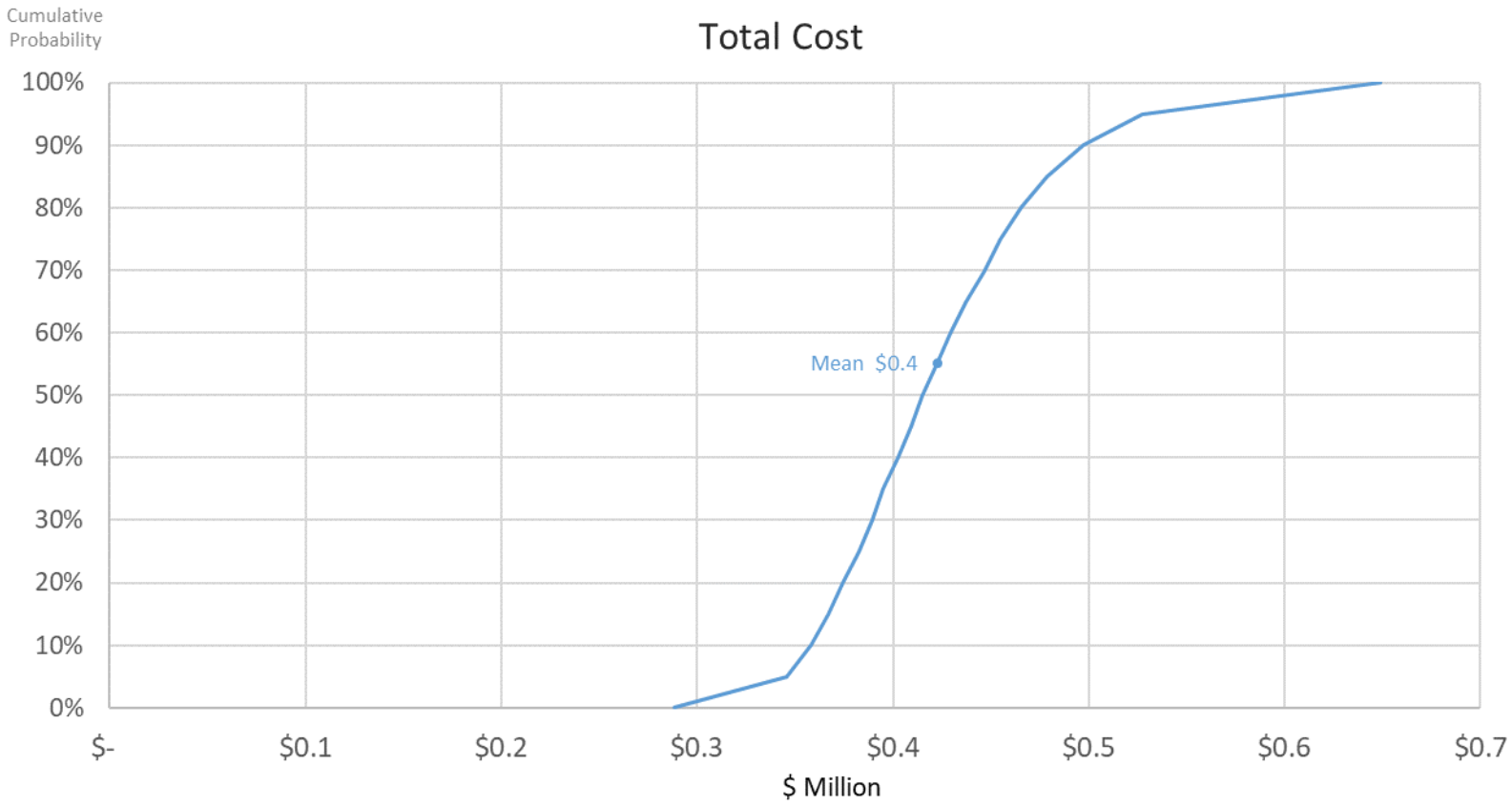
	Completion Date
P0	4/24/2019
P5	5/22/2019
P10	5/30/2019
P15	6/3/2019
P20	6/7/2019
P25	6/10/2019
P30	6/13/2019
P35	6/16/2019
P40	6/19/2019
P45	6/22/2019
P50	6/25/2019
P55	6/28/2019
P60	7/1/2019
P65	7/4/2019
P70	7/7/2019
P75	7/11/2019
P80	7/16/2019
P85	7/20/2019
P90	7/27/2019
P95	8/7/2019
P100	9/11/2019
Mean	**6/27/2019**



Cost Uncertainty (EV $423K)

	Total Cost
P0	$ 0.288
P5	$ 0.345
P10	$ 0.358
P15	$ 0.367
P20	$ 0.374
P25	$ 0.383
P30	$ 0.389
P35	$ 0.395
P40	$ 0.402
P45	$ 0.409
P50	$ 0.415
P55	$ 0.422
P60	$ 0.430
P65	$ 0.437
P70	$ 0.446
P75	$ 0.455
P80	$ 0.465
P85	$ 0.479
P90	$ 0.497
P95	$ 0.527
P100	$ 0.649
Mean	**$ 0.423**

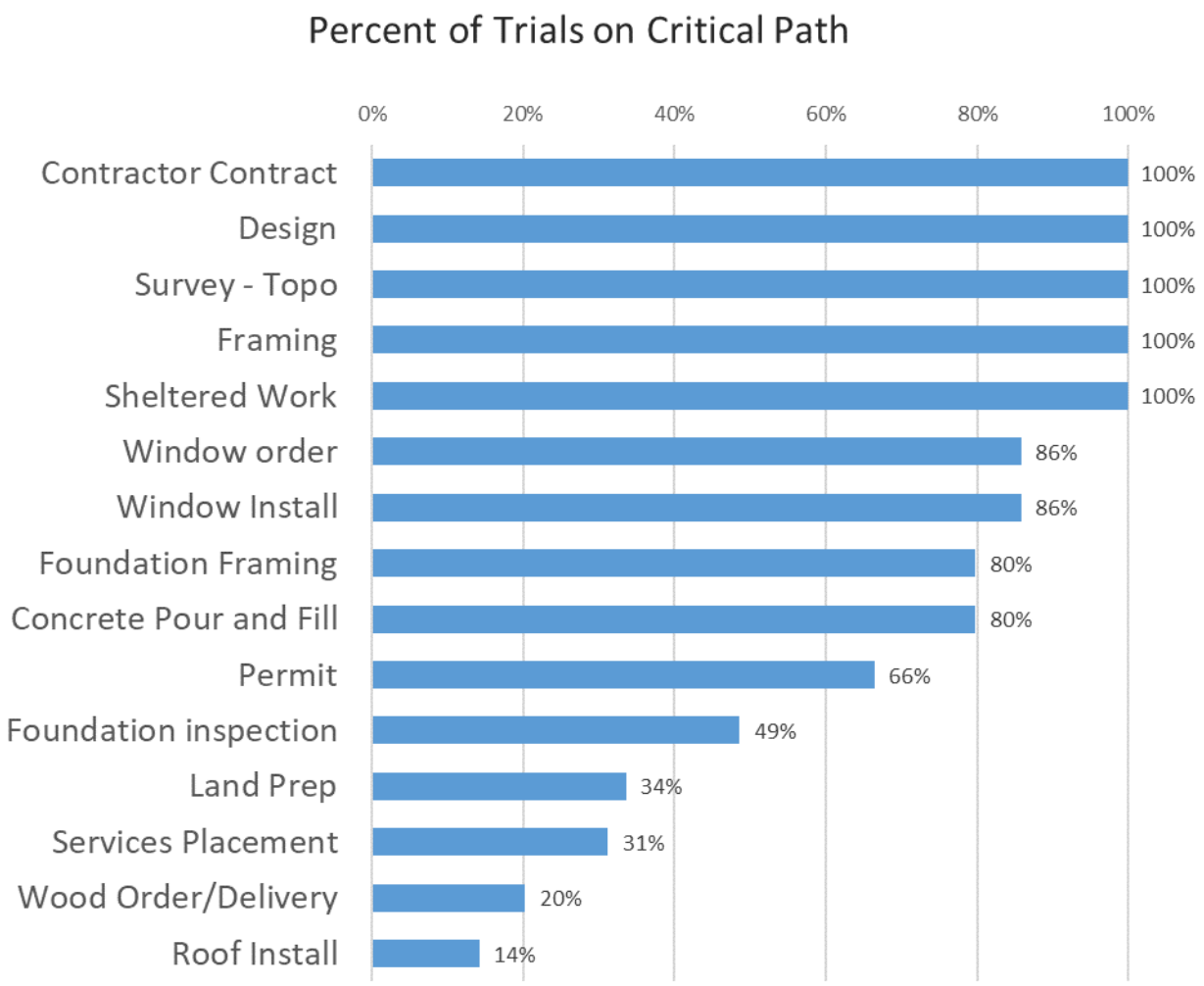
$ Million



Percent of Time on Critical Path

<u>Questions to address</u>

1. What endangers the project?
   - “Stuck” critical path items
   - “Surprise” Critical Path iten
2. What penalty does it cause?
3. Can I do anything about it?
4. Is it worth doing anything abou it?



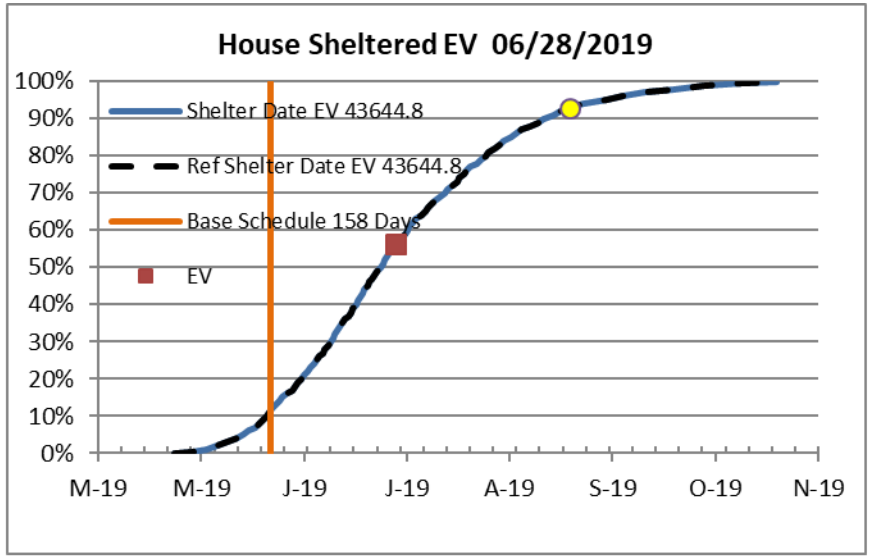
Excel Model with Flexibility CSRA with SIPmath Tool

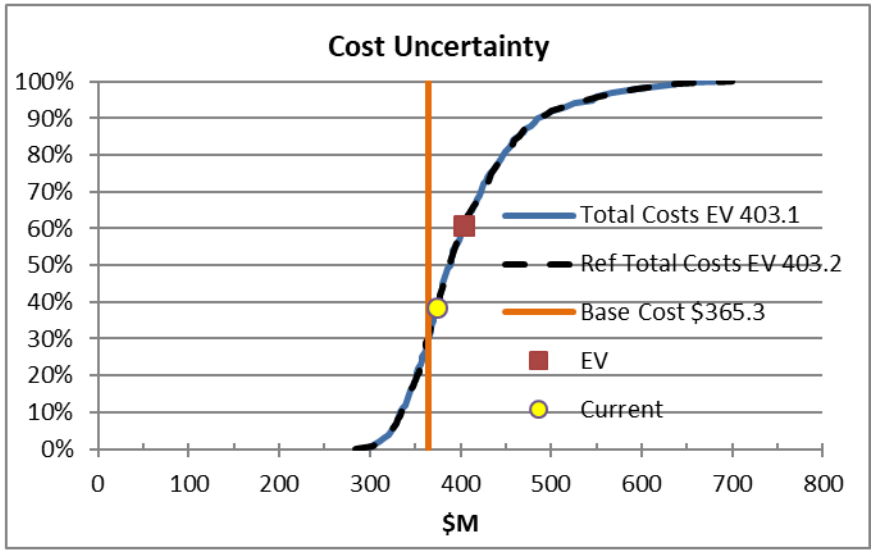
- CSRA Model Requires no macros to run
- Uses a DataTable to calculated trials.
- Uses standard Excel graphics editable by user
- SIPmath Tool Developed by Probability Management and Dr. Sam Savage
  - An Add-In to Excel available FREE from www.ProbabilityManagement.org
  - Enterprise version available with correlation and data libraries

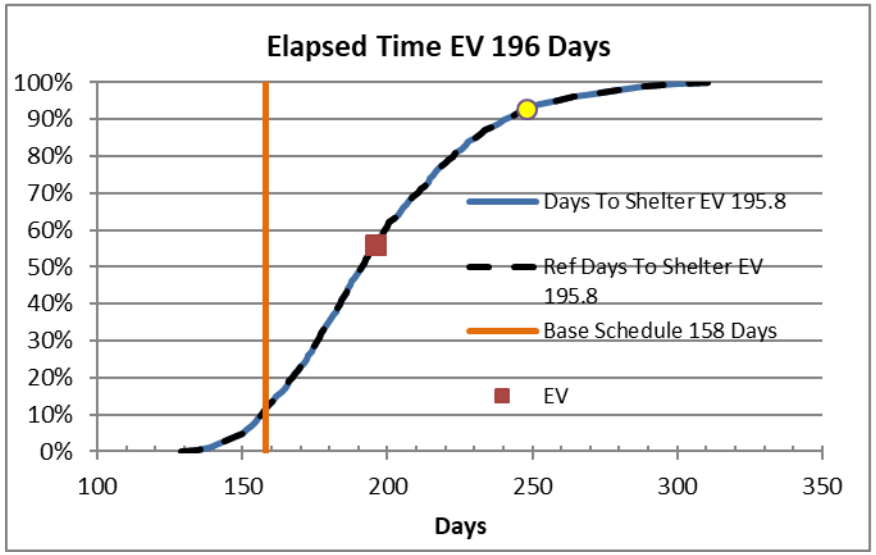
Data is table input by User

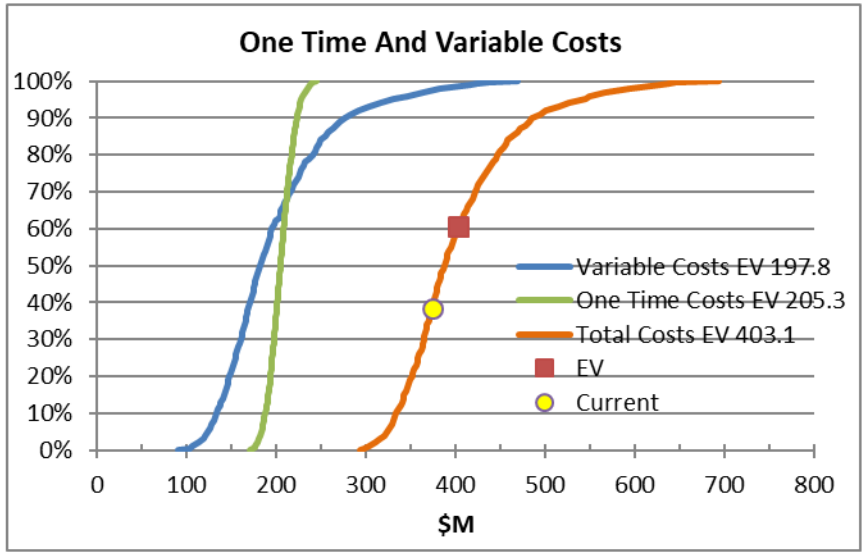
Task #	Schedule Activities	Schedule Comments / (leads) or Lags	Schedule Days			Variable Cost Per Day		
			P10	P50	P90	P10	P50	P90
							10.8	13.55
1	Contractor Contract		0	0	0			
2	Survey - Topo		6	10	24			
3	Design		20	30	60			
4	Land Prep		6	9	21	1.200	1.300	1.600
5	Permit		7	10	28			
6	Wood Order / 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		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			

Built in graphics provide reference and helps identify the source of uncertainty





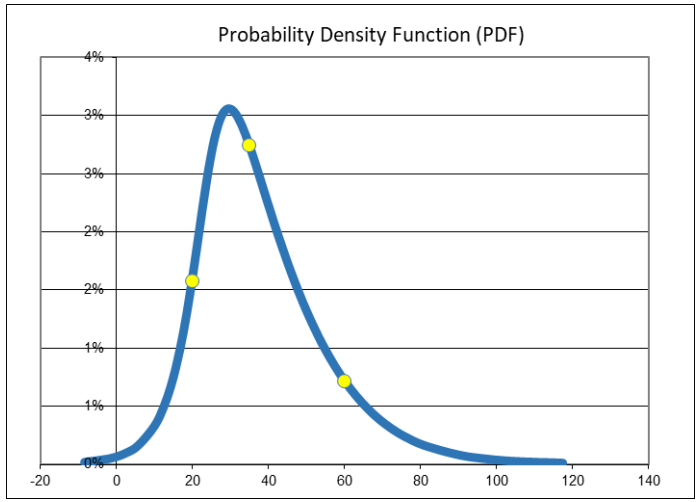


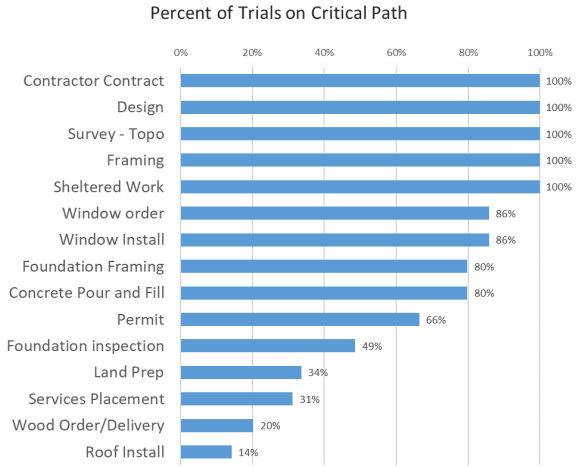


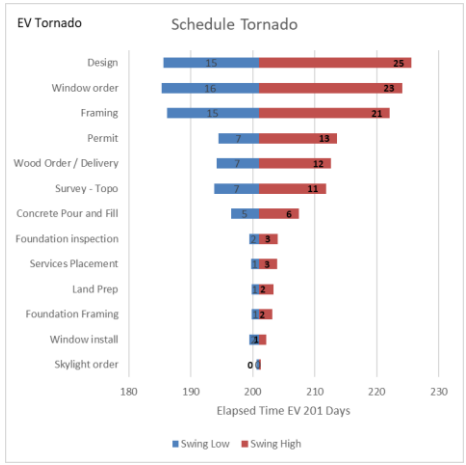
- Baseline schedule and cost about the P15
- Most cost uncertainty is due to variable cost related to schedule.

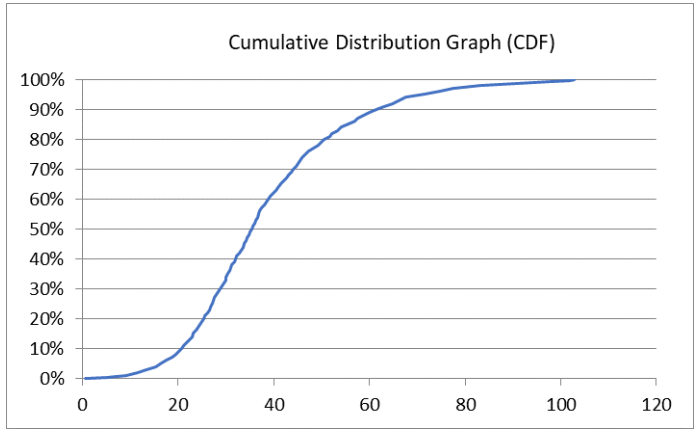
How should the results be displayed?

- Cumulative Distribution Graphs (CDF's)
- Probability Distributions (PDFs)
- Critical Path Frequency
- Tornado Diagrams

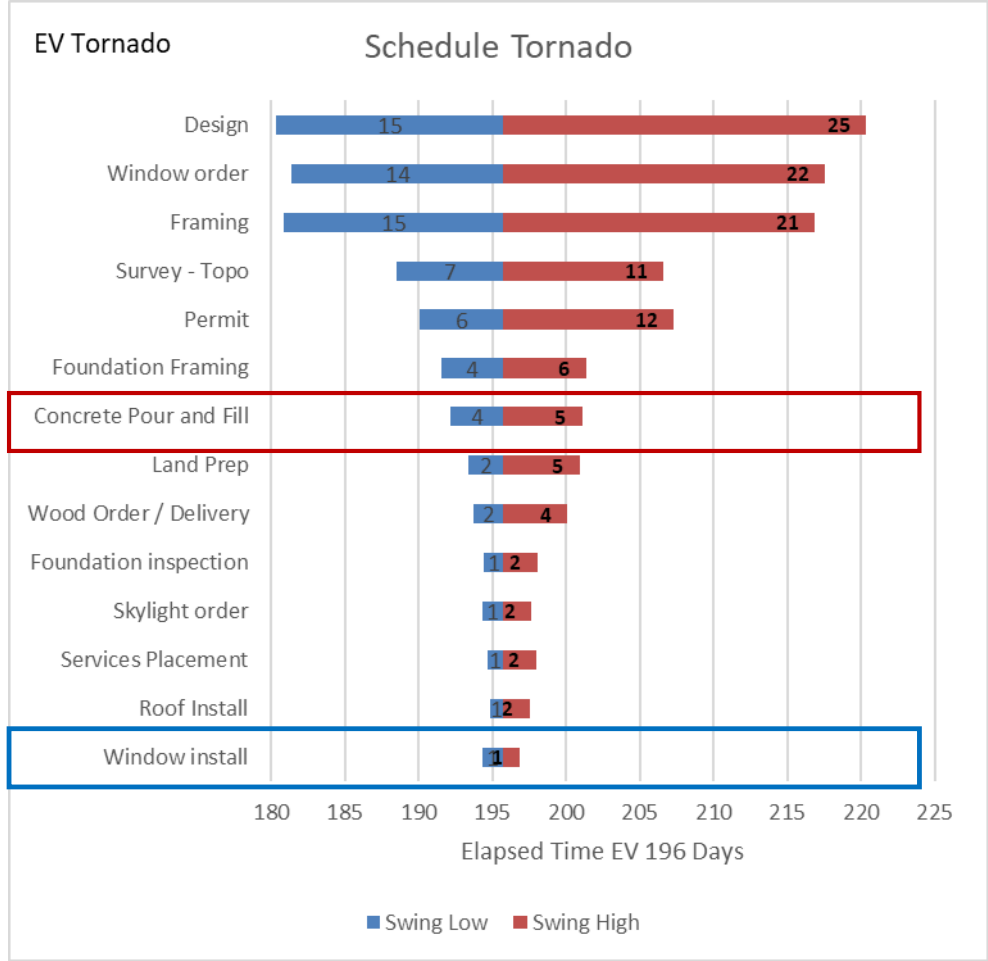


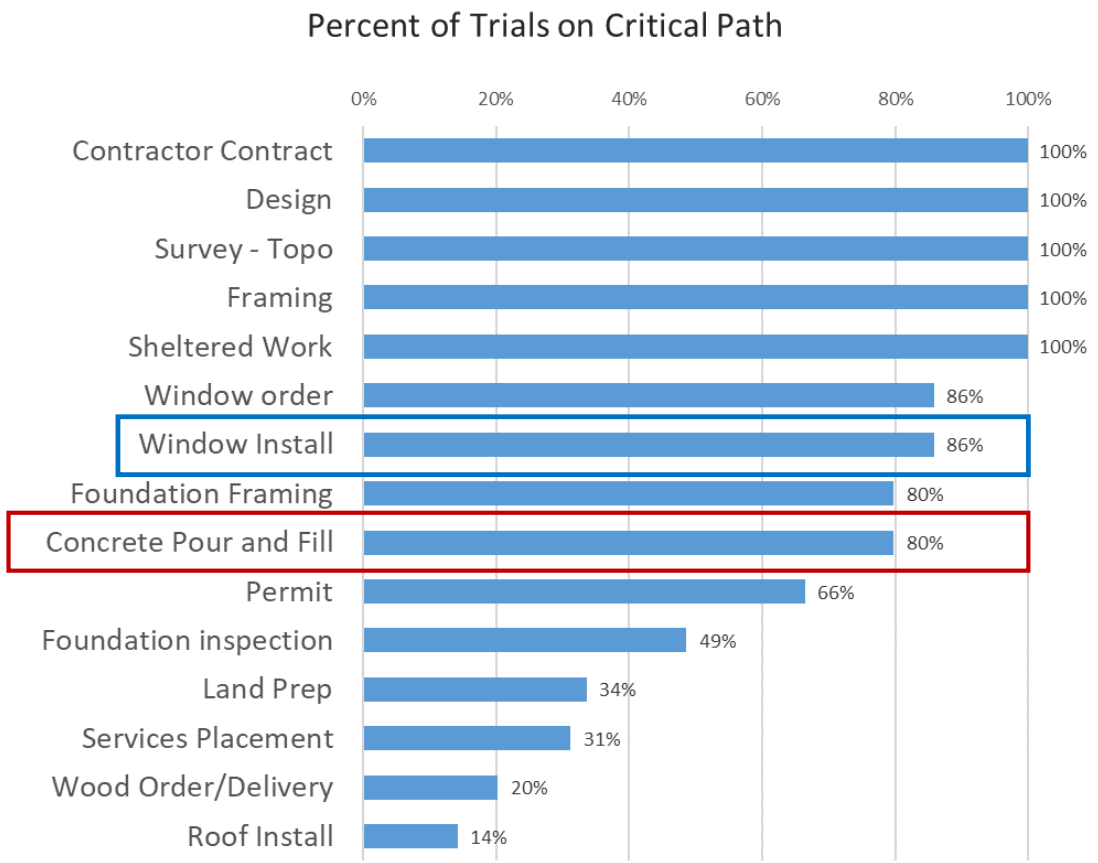






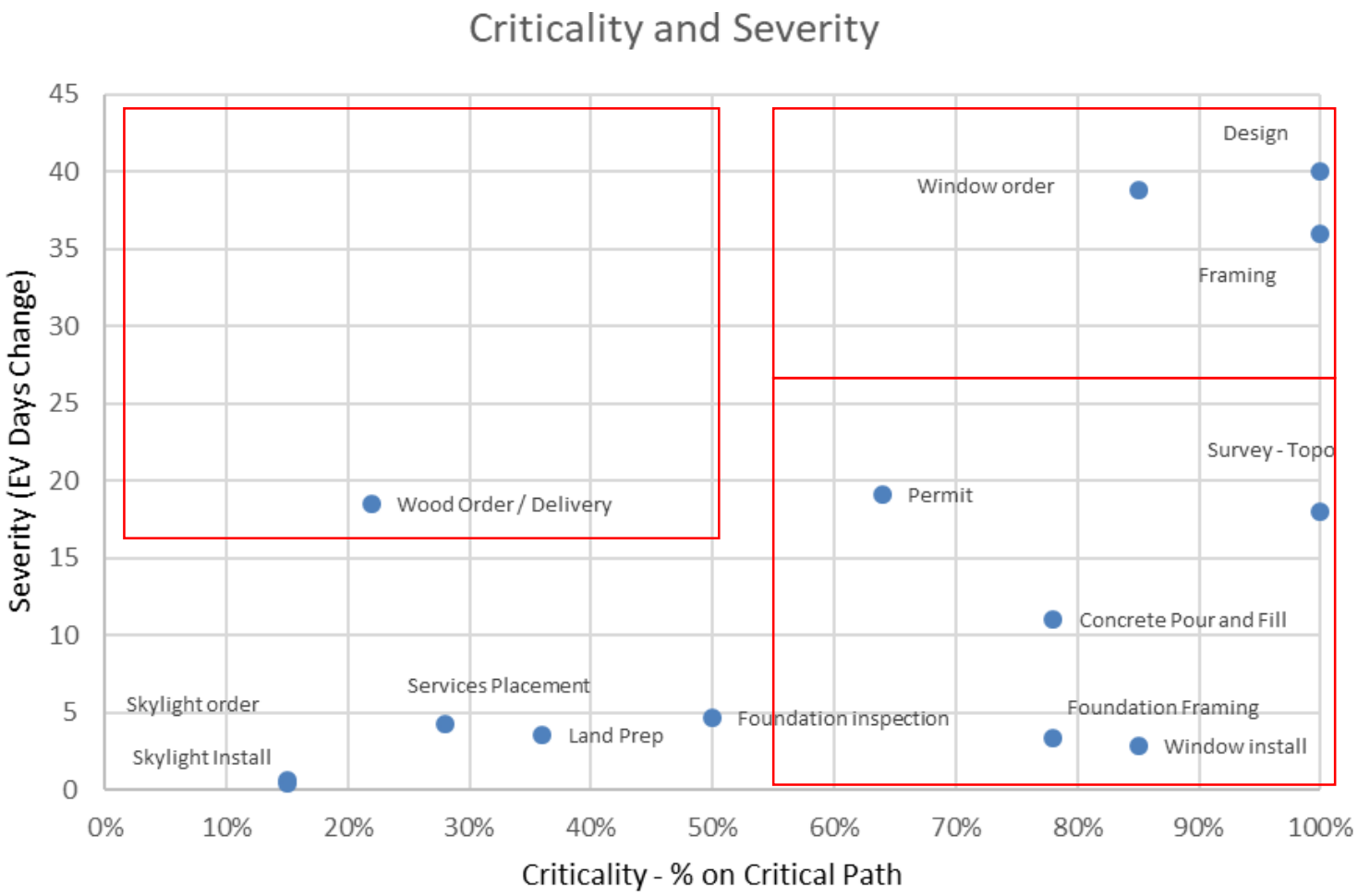
Sensitivity of the EV Schedule Result to the variables.



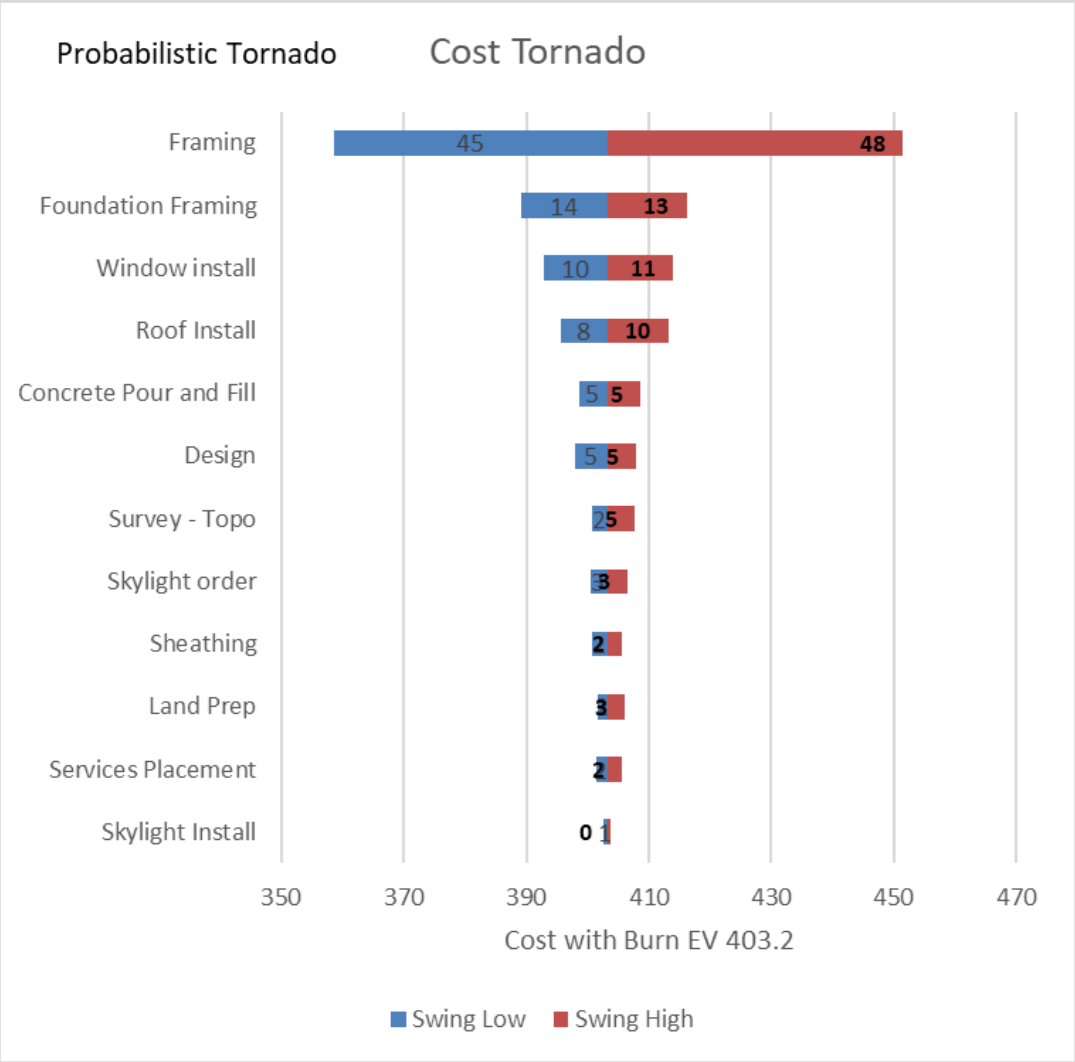


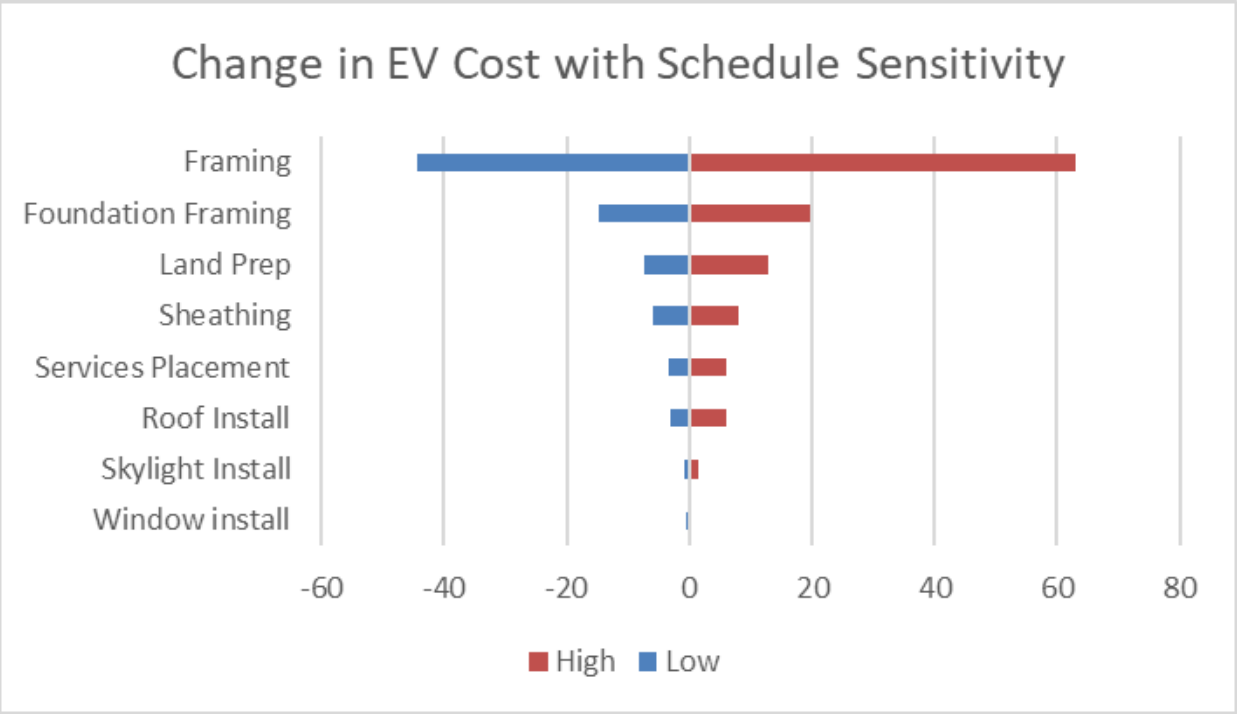
Combining the Critical Path and Tornado Chart

- 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.



Sensitivity of EV Cost





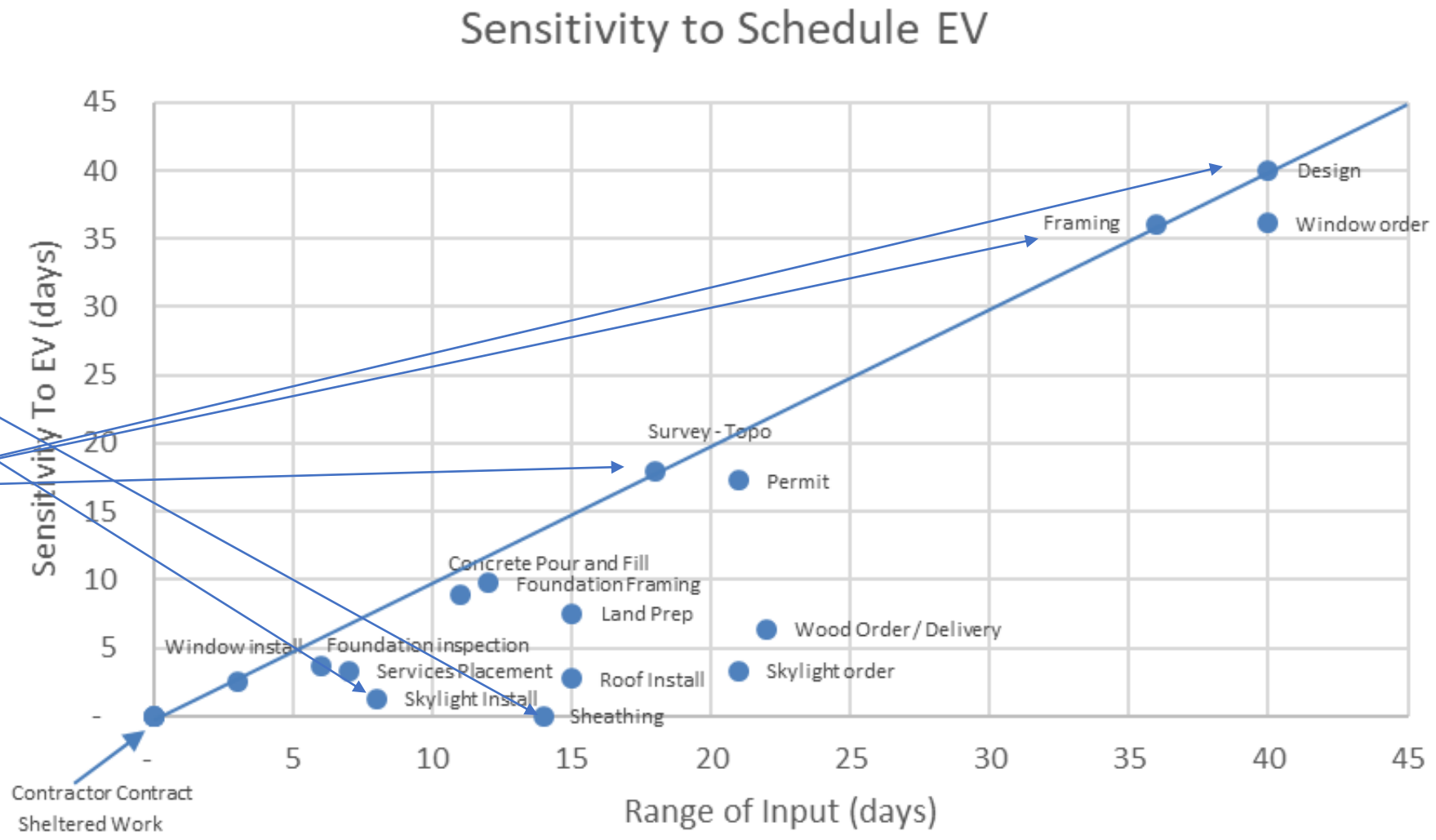
- Left chart shows EV cost sensitivity to **fixed cost** uncertainty
- Right chart shows EV cost sensitivity to **schedule uncertainty**

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.

What tasks deserve management attention

- Some activities can have a large uncertainty but have little impact on the result
  - Sheathing
  - Skylight install
- The activities that are on the diagonal line will have the greatest impact on the EV, close to 1:1



Group Exercise – Estimating Framing Schedule and Cost

Jason to introduce Data Sheet.
Three of us circulate and provide direction to groups as needed.

Assess “Wood Framing” of the House.

The three of us will facilitate and then select a scribe.

After 15 minutes we bring back the results and compare the results of the groups.
They will be different.

Need 3 flip charts. Put one each corner of the room. Participants stand to complete the Data Sheet.

Capturing all relevant information for a range item

The **datasheet**

1. What is it?
2. Why is it so important?
3. Ranging workshop exercise

What is a datasheet?

This is a **tool** containing all relevant information for a given item that needs to be ranged as an input to a CSRA model

It has 8 key areas of information;

1. Range item title
2. Scope of Work
3. Assumptions
4. Status of work to date
5. Sources of uncertainty
6. Range cost or schedule data
7. Pessimistic scenario description
8. Optimistic scenario description

Elements of a Datasheet

Range Item Title;

- For a range model, the ranged items are usually a “roll-up” of several items that together are assumed to have the same variability for the purposes of the analysis.
- The title is a succinct description of the roll-up item that is used in the model

Elements of a Datasheet

Scope of Work;

- This is a general outline of what is included in this part of the project or “roll-up”.

Elements of a Datasheet

Assumptions;

- Identify key assumptions that have been made for this part of the project
- It's important to think about these assumptions as the basis for design or estimating and if they change later it could have material impact on the budget or schedule.

Elements of a Datasheet

Status of Work to Date;

- Identify the level of engineering completeness, study phase, level of estimate or class of estimate here.
- It's possible that there are parts of this range item that are better defined than others in terms of level of design – identify that here too.

Elements of a Datasheet

Sources of Uncertainty;

- Identify unknowns, issues, risks, or general uncertainties that relate to this part of the project specifically.
- It will be important to consider these when working on the range estimate so that they are taken into account in the contingency calculation.

Elements of a Datasheet

Range cost or schedule data;

- This area contains the base estimate amount (cost or schedule duration) and a place to identify the low amount (Optimistic) and high amount (Pessimistic) for the range that is estimated in the workshop.

		Optimistic	Base Estimated Cost	Pessimistic
Cost Ranges		$ 106,000	$ 106,000	$ 106,000
Cost Range Percentages:		0%		0%

Elements of a Datasheet

Pessimistic Scenario;

- This is the space where notes are taken during the range workshop to identify all of the things that could go wrong to align with a “worst case” scenario.
- It’s important to brainstorm these items before estimating the high range number so that all bad scenarios can be taken into account in the range estimate.

Elements of a Datasheet

Optimistic Scenario;

- This is the space where notes are taken during the range workshop to identify all of the things that could go well to align with a “best case” scenario.
- It’s important to brainstorm these items before estimating the low range number so that all good scenarios can be taken into account in the range estimate.

Exercise

- Break into **3 groups**
- **One of us will facilitate** each discussion
- Each group will **nominate a scribe** to take notes on the flip chart
- Using the example datasheet provided we will each **brainstorm the pessimistic and optimistic scenarios**
- With the scenarios defined, **estimate the low and high** values for the range.
- We will compare the results at the end and discuss

Report out of Group Exercise

Why Datasheets are so Important

- Makes the workshop more efficient having the background info pre-defined
- **Creates a focal point to get SME's in the right frame of mind to estimate the low and high values for a range**
- Provides a record to defend the range later if reviewers of the model don't like the initial results
  - Shows non- participants in the range workshop what was considered by the SME's
- Next to Calibration, this is the second most important feature of a defensible CSRA model using subjective range estimates.

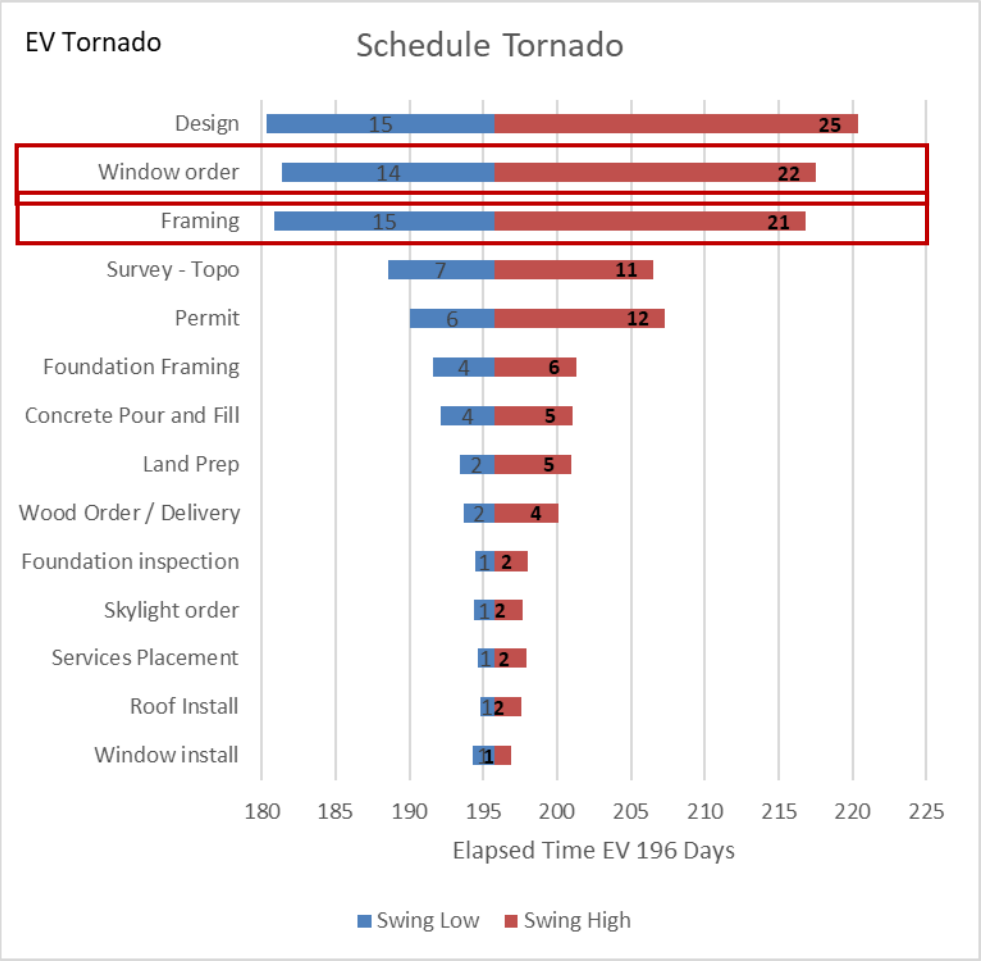
What is the purpose of the CSRA?

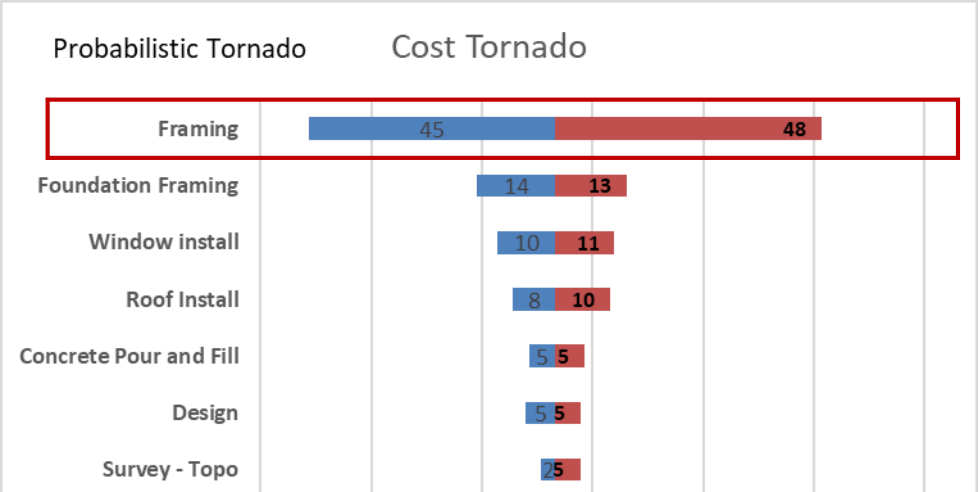
Make a Decision

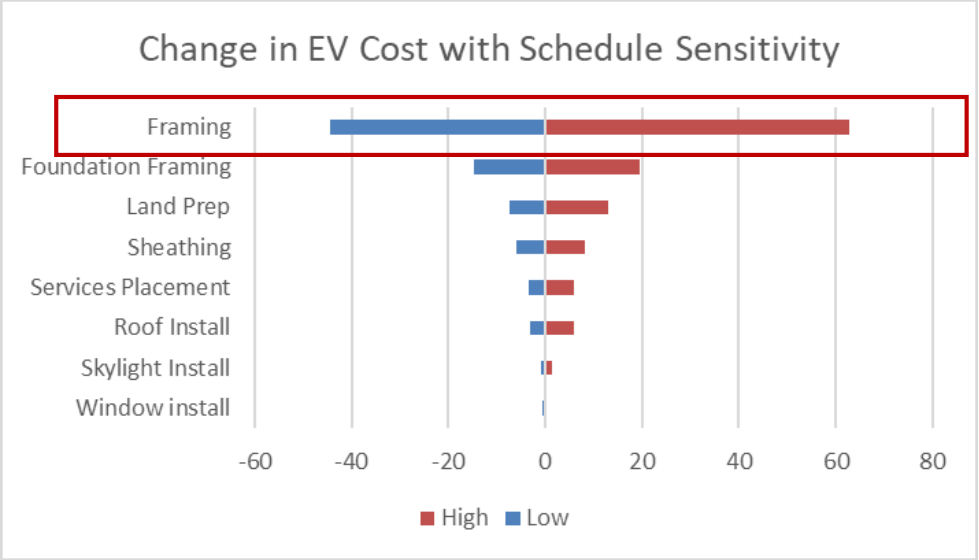
- What do we need to know to make a good decision?

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

What is Important Looking at these Graphics







What Can We Do?

	Schedule Mitigation				Burn Rate Mitigation (Mitigation Linked to Sche		
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

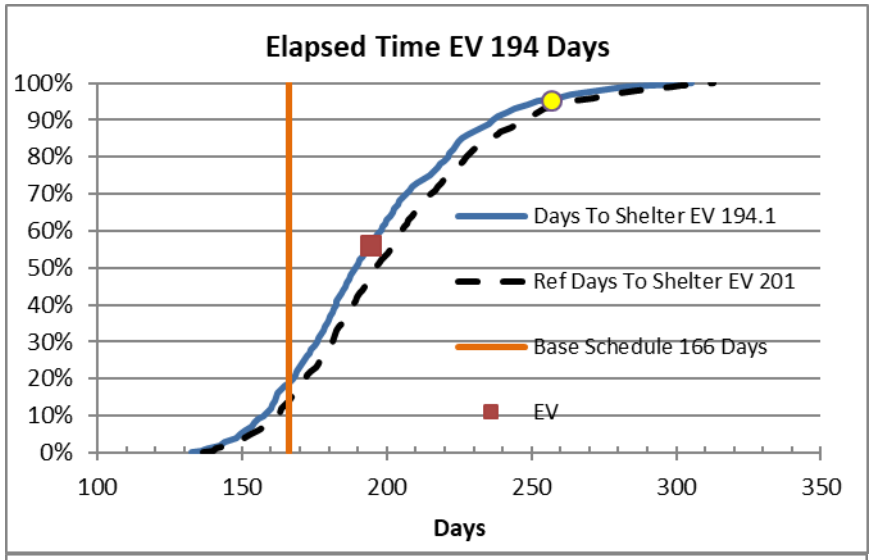
- Expedite the Window order for a cost (50%)
- Rather than doing the framing on-site, use some pre-fab components. (75%)

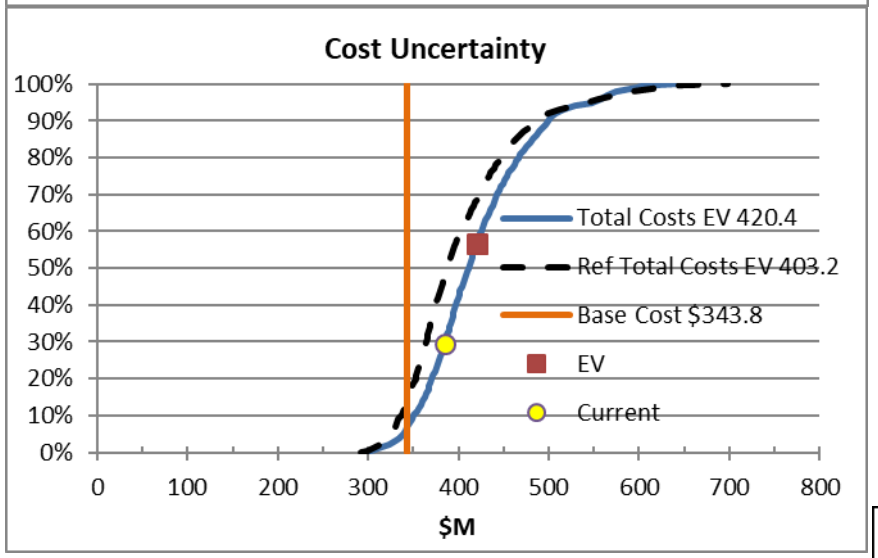
Cost Mitigations		P10	P50	P90	Prob of Scen
Used Framing Cost		25	27	35	
Base Case	$K	20	25	35	25%
Prefab	$K	25	27	35	75%

Mitigation Results - CDF graphs help to understand the impact

- Doing something differently that improves the schedule or cost
- Typically would have 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 7 days, but at a cost of $17k





Participant Feedback on the CSRA Process and workshop

Thank You for your participation