

# Project Risk Analysis Using @RISK for Project

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# Agenda

- » Background
- » @RISK for Project
- » What is coming!!... The new @RISK for Project

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# Background: PRA Adoption in Federal & State Agencies

- » Federal Transit Administration (**FTA**) requires a risk assessment/mitigation study for any new transit project applying for federal funding
- » Department of Transportation of the State of Washington (**WSDOT**) has a risk-based approach to validate cost estimates
- » **OMB** Capital Programming Guide, 2007: Risk Adjusted Budget and Schedule (ANSI/EIA Standard – 748)
- » **DoD** Integrated Master Plan and Integrated Master Schedule Preparation and Use Guide: Schedule Risk Analysis
- » Risk Management Guide for **DoD** Acquisition (2003)

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# Definitions: Project Risk & Uncertainty

- » Project risk is defined as the *possibility that the outcome of an uncertain event* affects negatively or positively the cost and time performance of project activities and/or their planned execution

$$\textit{Risk} = \textit{Consequence} \times \textit{Probability of Occurrence}$$

- » Uncertainty is defined as the lack of knowledge about the parameters that characterize the system

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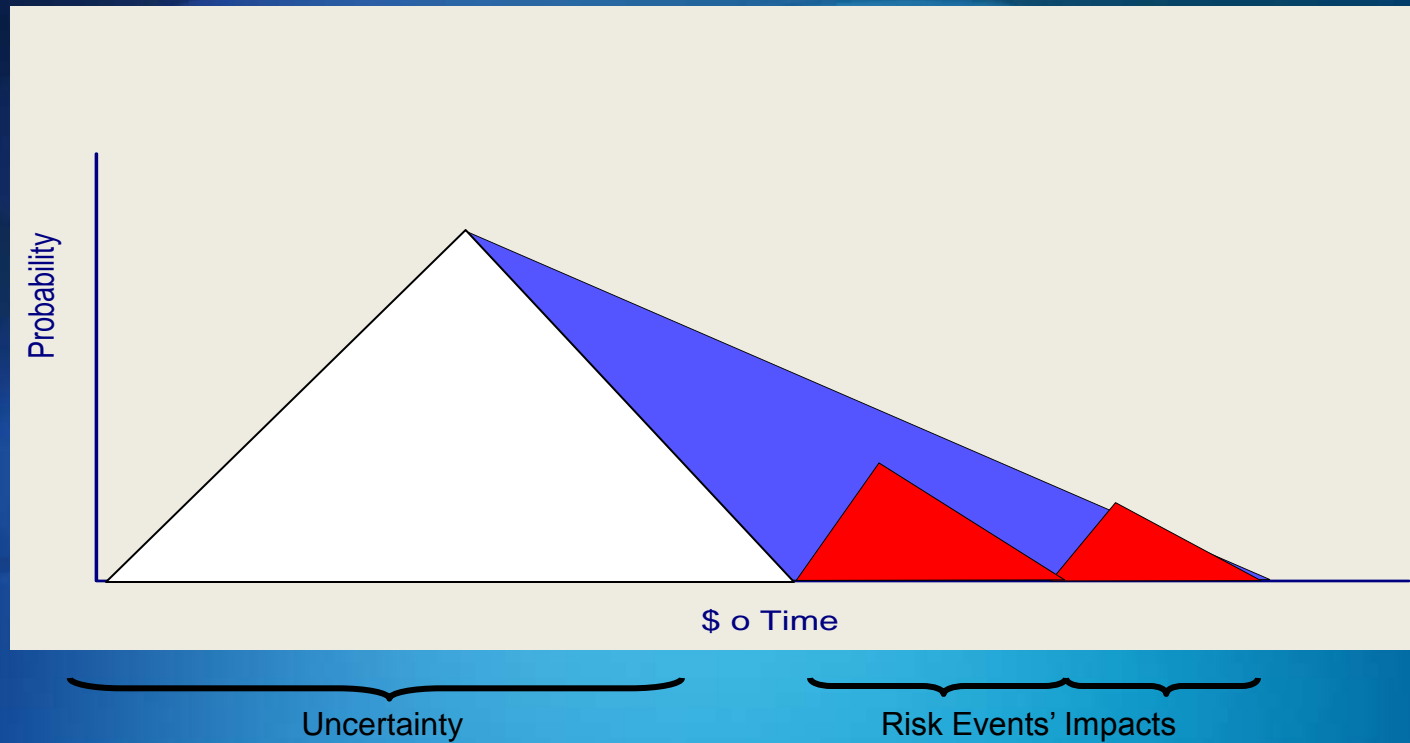


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# Risks Events vs. Uncertainty



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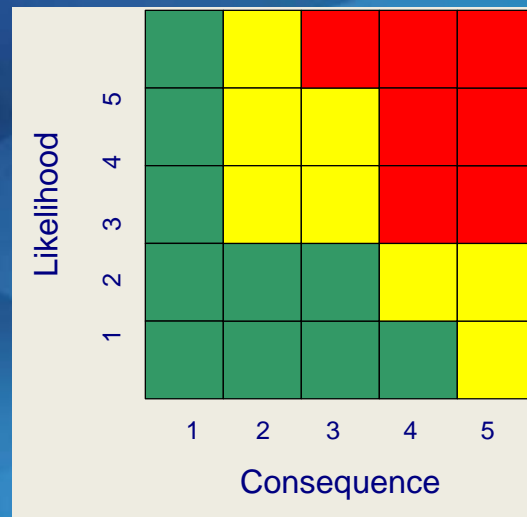
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# Qualitative Risk Analysis

Likelihood	Score
Not Likely	1
Low Likelihood	2
Likely	3
High Likely	4
Near Certainty	5



## Risk Register

Priority	Description	Activities Affected	Cost / Time Impact
1			
...			
n			

Schedule	Cost	Technical	Score
Minimal or no impact	Minimal or no impact	Minimal or no impact	1
Additional activities required; able to meet key dates	Budget increase <1%	Minor performance shortfall, same approach retained	2
Minor schedule slip; will miss need date	Budget increase <5%	Moderate performance shortfall, but workarounds available	3
Project critical path affected	Budget increase <10%	Unacceptable, but workaround available	4
Cannot achieve key project milestone	Budget increase >10%	Unacceptable, no alternatives exist	5

# Project Risk Analysis

## » **Schedule Risk Analysis:**

- Quantification of uncertainty in activity durations
- Quantification of uncertainty in project duration
- Allocation and management of contingencies

## » **Simulation:**

- Overcome the limitations of CPM/PERT
- Generates scenarios involving a random set of durations. Each scenario produce a deterministic CPM deterministic schedule.
- At the end, analyze the results of the scenarios to understand the range of variability in project duration
- It requires activity information and distributions
- Can model correlations among activities' durations
- Can obtain information of how critical is an activity
- Can make use of probabilistic or conditional branching

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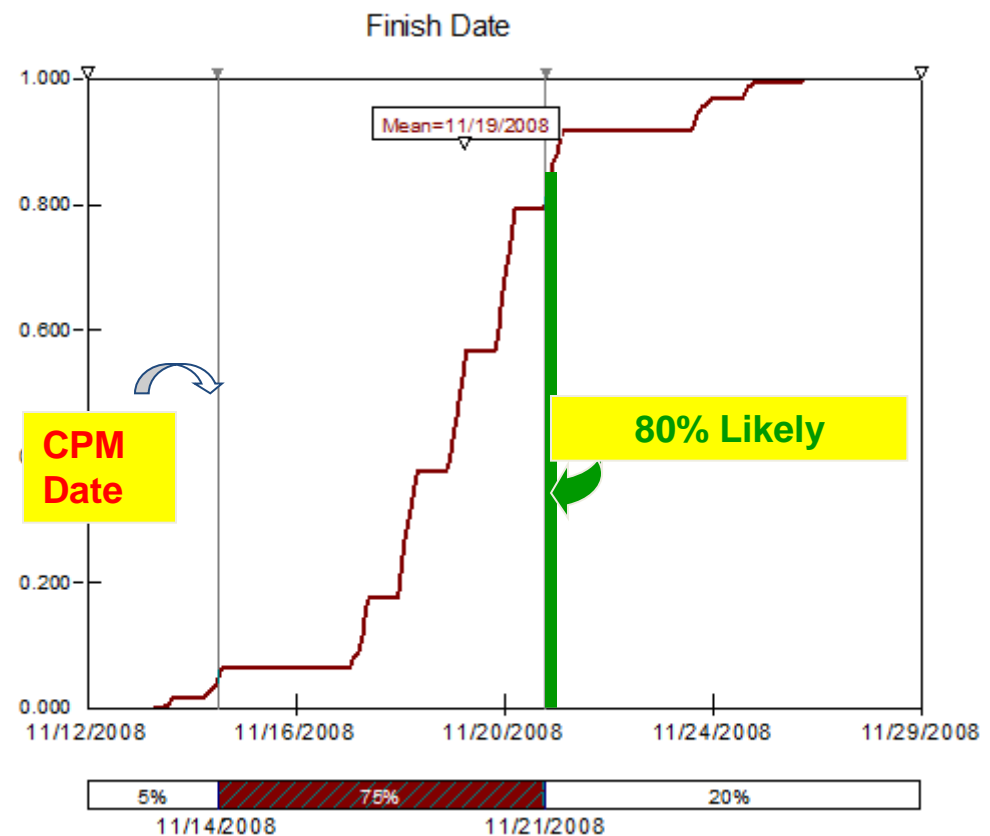
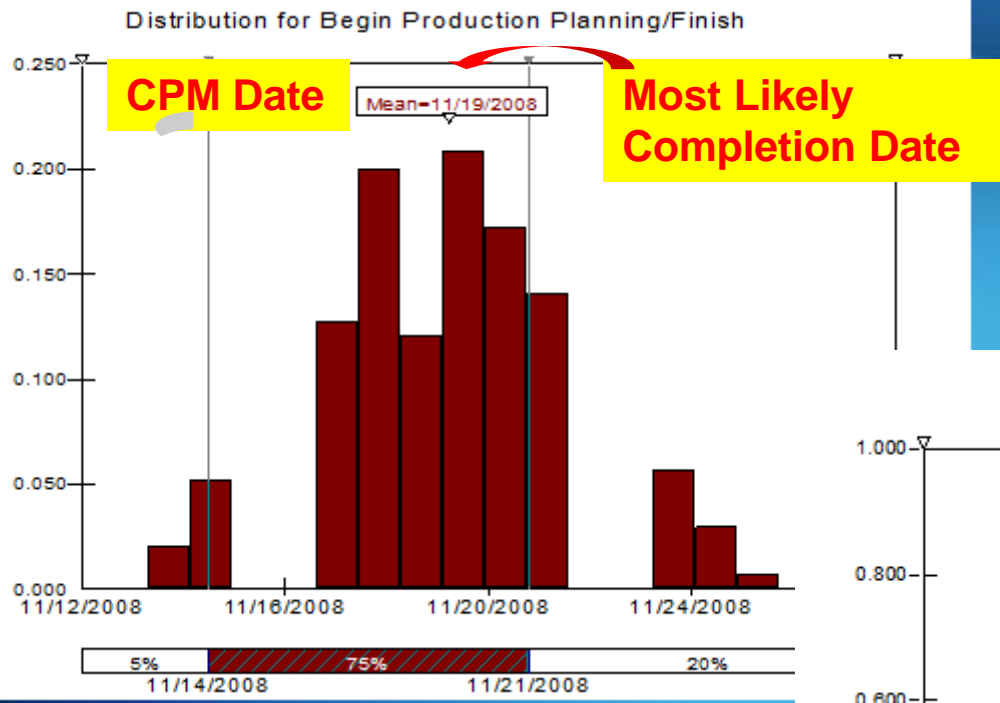


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# Simulation Results



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# Other @RISK tools that help creating a risk analysis model

- » Parameter Entry Tables and Risk Categories
- » Probabilistic Branching and If/Then conditions
- » Using Global Variables (Event simulation) and Probabilistic Calendars for added realism (accuracy)

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# The new version of @RISK for project

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# Parameter Table & Risk Categories

- » Helps to quickly create risk analysis models – Useful when schedule has a large number of activities

**Create Parameter Entry Table**

Assign Uncertainty to:

Field:

Tasks:  Current Selection  All

Using Distribution:

Type:

Read Parameter Values from Fields:

Parameter Locations:

- Text2
- Text3
- Text4

(Note: New columns will be added to the @RISK table to hold parameter values)

OK Cancel

**Risk Categories**

Category List:

- New
- Medium Risk
- Low Risk
- High Risk
- Delete

Name:

Vary Values Using:

Dist Type:  Change Type:

Min:-  Max:+

Apply to:

Field:

Tasks:

- 11 INTERIOR COVER
- 12 FLOORING
- 13 INTERIOR FINISHING

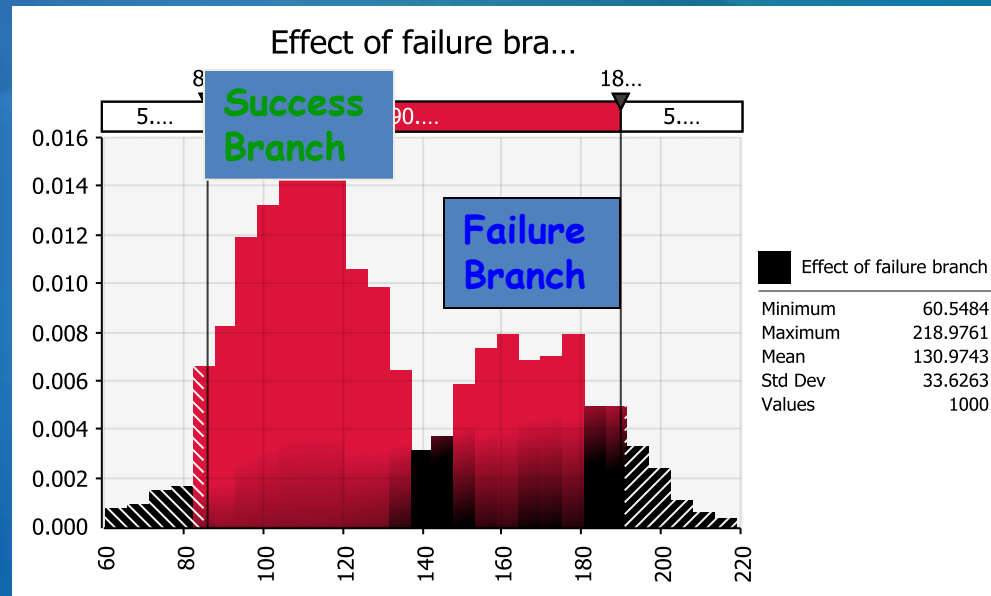
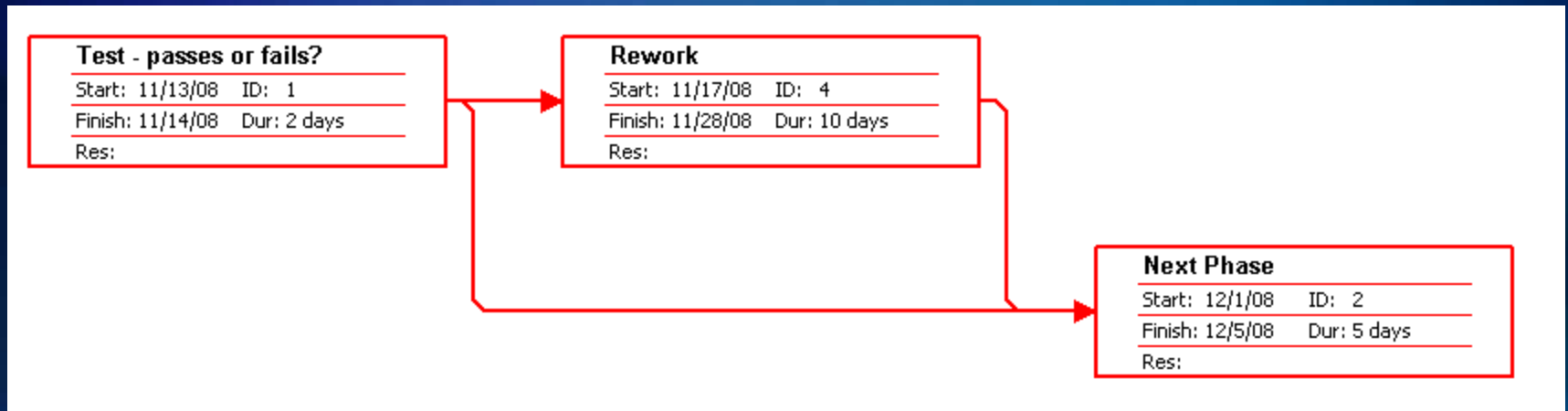
Add... Delete

\* Current distribution does not match category definition

OK Cancel



# Probabilistic Branch



# Conditional Branching

- » Model decisions or possible outcomes, e.g. permit does not get approved and that delay will affect project costs

Name	Duration	Start	Finish	@RISK: Functions
<input checked="" type="checkbox"/> <b>NEW BUILDING</b>	<b>237 days</b>	<b>10/25/07</b>	<b>9/19/08</b>	<b>Duration=RiskOUTPUT()</b>
PERMIT APPLICATION	2 days	10/25/07	10/26/07	RiskBRANCH(.15,.85,{t18},{t1})
<b>Permit Denied - Resubmit Application</b>	15 days	10/29/07	11/16/07	RiskIF(t18[Duration]>0,t18[Cost]=2000)
EXCAVATE	10 days	11/19/07	11/30/07	
FOUNDATION	20 days	12/3/07	12/28/07	
FRAMING	50 days	12/31/07	3/7/08	
ROOF	30 days	3/10/08	4/18/08	
EXTERIOR PLUMBING	20 days	3/10/08	4/4/08	
INTERIOR PLUMBING	25 days	4/7/08	5/9/08	
EXTERIOR COVER	35 days	4/21/08	6/6/08	
EXTERIOR FINISHING	45 days	6/9/08	8/8/08	
ELECTRICAL	35 days	3/10/08	4/25/08	
INTERIOR COVER	40 days	5/12/08	7/4/08	
FLOORING	20 days	7/7/08	8/1/08	
INTERIOR FINISHING	25 days	7/7/08	8/8/08	
EXTERIOR FIXTURES	10 days	8/11/08	8/22/08	
INTERIOR FIXTURES	30 days	8/11/08	9/19/08	
END	0 days	9/19/08	9/19/08	RiskIF(t16[Finish]>9/15/2008,t16[Cost]=50000)



# Global Variables and Event Simulation (Risk Registers)

» Use EnableWhen function:

- $\text{Duration} = \text{RiskTRIANG}(4, 5, 8, \text{EnableWhen}(\text{Variable}[\text{Event1}] = 1))$
- $\text{Duration} = \text{RiskTRIANG}(2, 5, 9, \text{EnableWhen}(\text{prob} = 0.5))$

ID	Variable Name	Definition
	Event1	BINOMIAL(1, .4)
	Event2	BINOMIAL(1, .7)

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Risk

EnableWhenE

# Project Budgeting

- » Typically budgets are deterministic
- » Simulation Approach
  - Individual cost components are unimodal and skewed
  - Common use of 3 point estimate and triangular, beta, lognormal distributions
  - Model cost items prone to variation with suitable statistical distributions
  - Generate random numbers hundred of times according to specified distributions and calculate total cost
  - Total cost dist is used to calculate probability of cost overrun and to establish adequate contingencies

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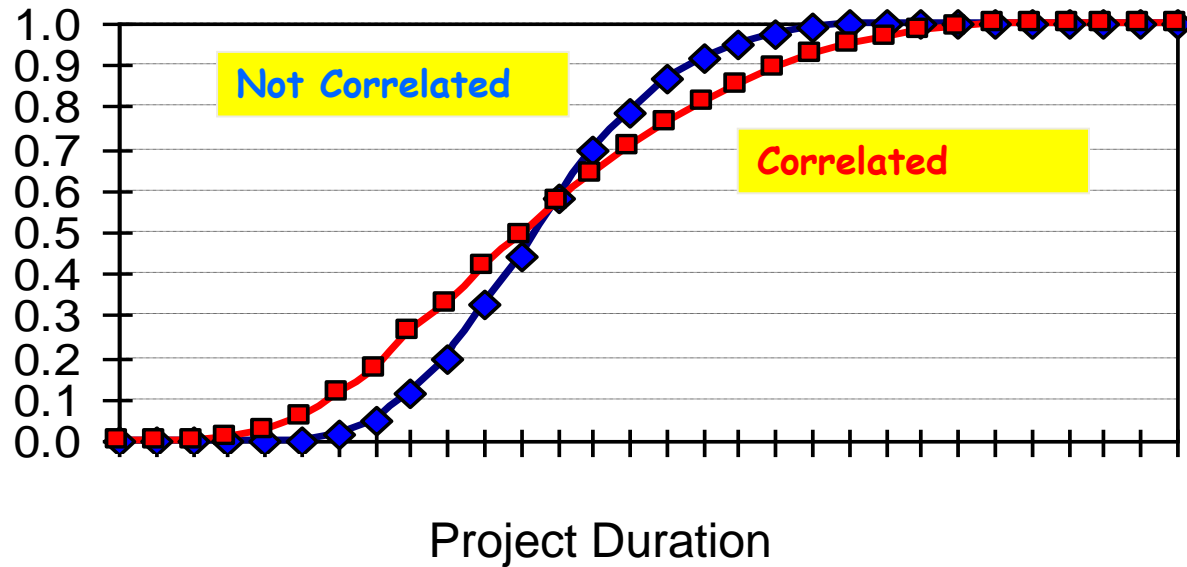
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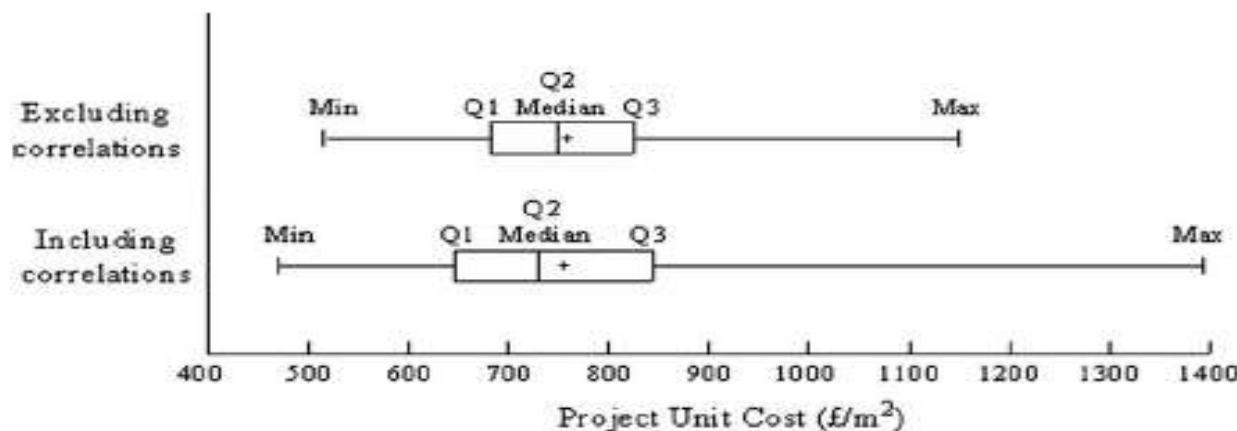
# Correlation Effects on Schedule

## Correlated vs. Independent Case



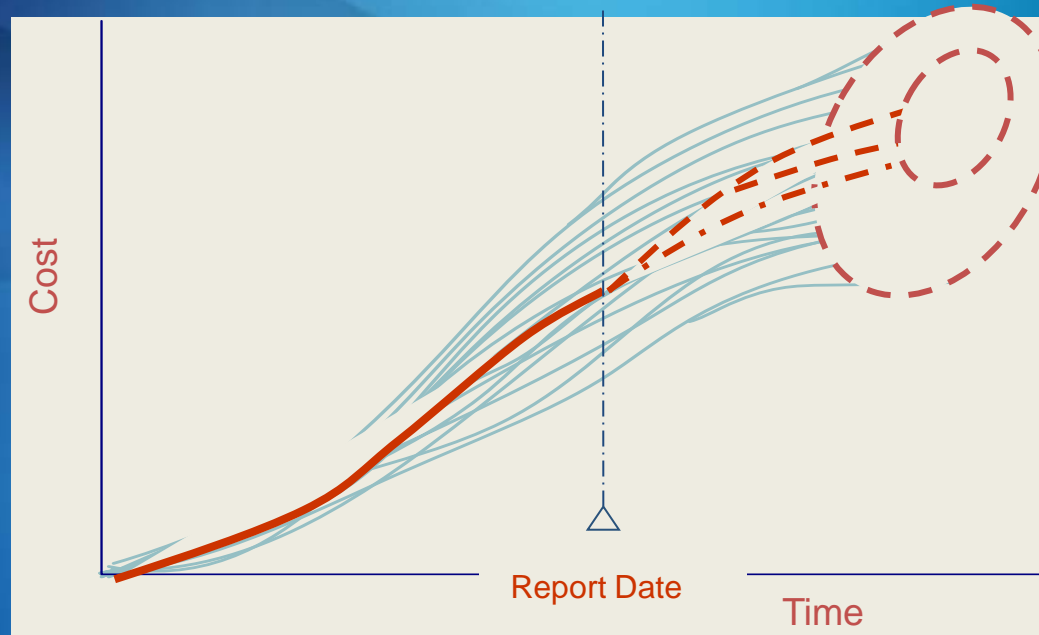
# Cost Correlation Issues

- » If correlation is ignored the total cost variance is underestimated
- » Data limitations during planning stages of most engineering projects
- » Correlation between variables makes use of historical data or subjective estimation from experts
- » Relationship between variables are shaped by many uncontrollable factors, and are best at subjective estimates based on experience and judgment
- » PDF that cost estimator specifies is the marginal distribution of that cost item; if cost items are correlated, the joint density function of the cost items needs to be calculated



# Cost Schedule Integration

- » Project cost and schedule estimates are often disconnected. i.e.: If schedule is too optimistic the cost is underestimated
- » When the risk of schedule is disregarded in estimating cost risk, cost risk is underestimated



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# Cost Methodology

- » Use WBS
- » Non-biased quantification of cost elements: local uncertainty
- » Model correlation or avoid stochastic dependencies by applying generic risks
- » Include internal and external risks, and fixed and variable

## Traditional

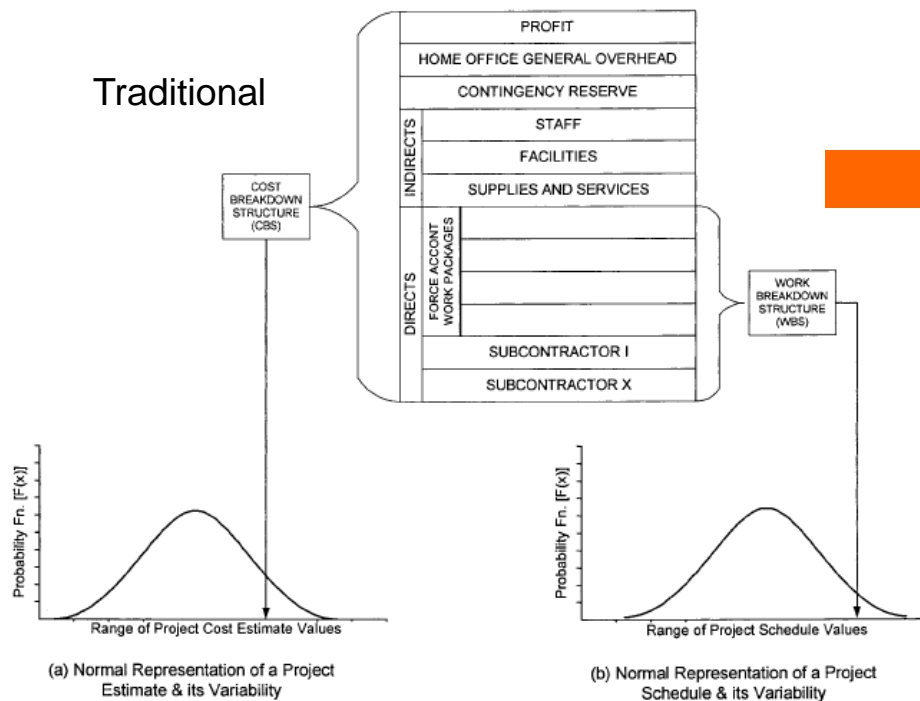


Figure 1 Data generation approach for traditional non-integrated range estimating and probabilistic scheduling

## Modified for integrated analysis

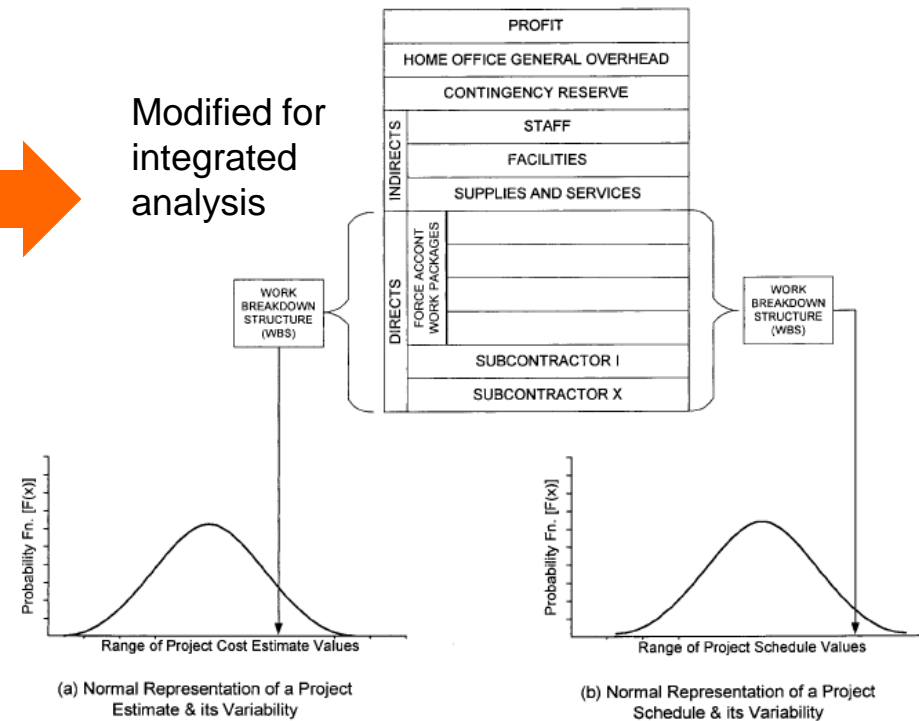
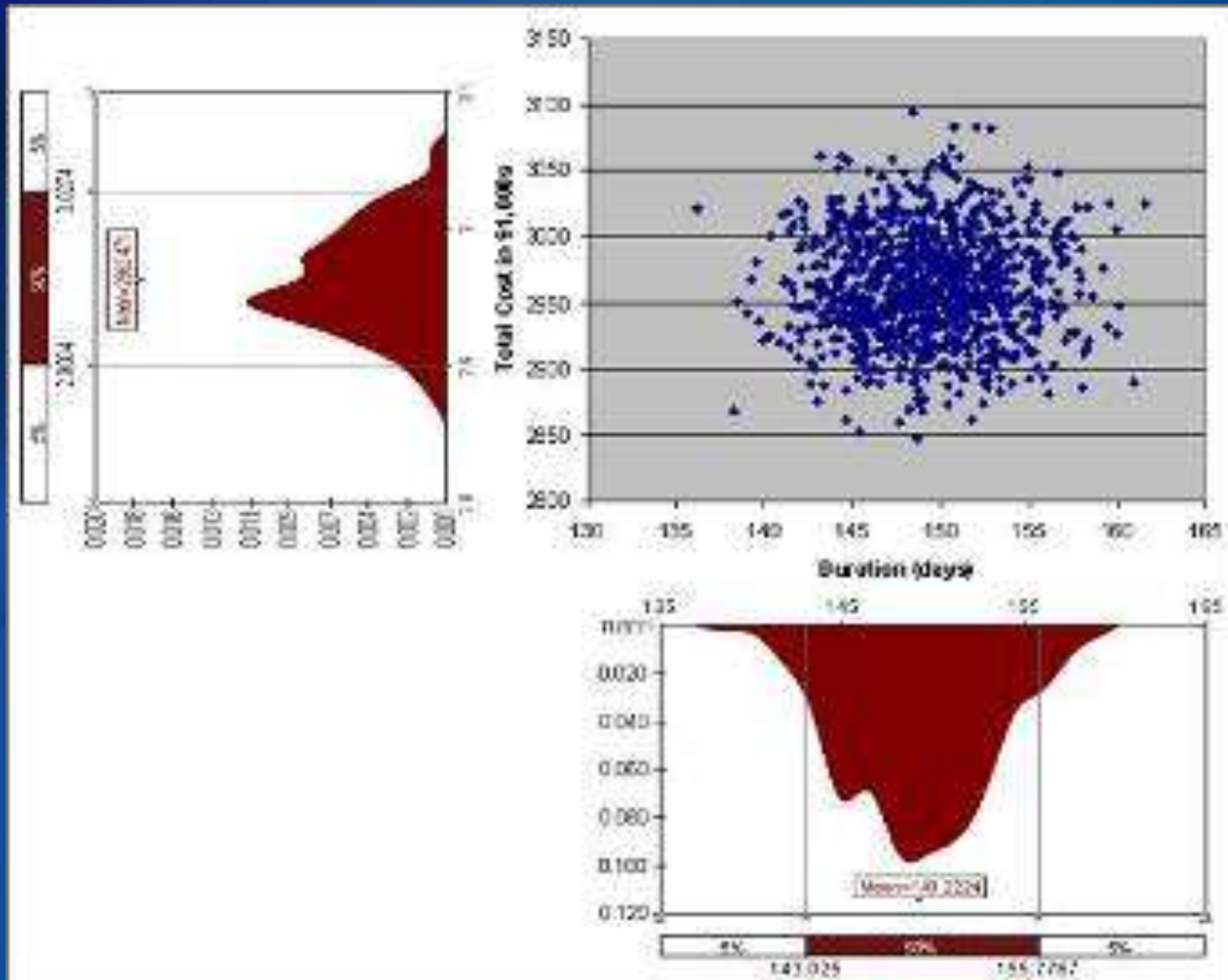


Figure 2 Data generation approach for integrated range estimating and probabilistic scheduling

# Integrated Risk Analysis Results



# Contingency calculation w/o PRA

- » The percentage figure is, most likely, arbitrarily arrived at and not appropriate for the specific project.
- » There is a tendency to double count risks because some estimators are inclined to include contingencies in their best estimate.
- » A percentage addition still results in a single-figure prediction of estimated cost, implying a degree of certainty that is simply not justified.
- » The percentage added indicates the potential for detrimental or downside risk; it does not indicate any potential for cost reduction and may therefore hide poor management of the execution of the project.
- » Because the percentage allows for all risk in terms of a cost contingency, it tends to direct attention away from time, performance, and quality risks.
- » It does not encourage creativity in estimating practice, allowing it to become routine and mundane, which can propagate oversights.

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