Excessive Project Cost – Where It Comes From: A Quantum Perspective

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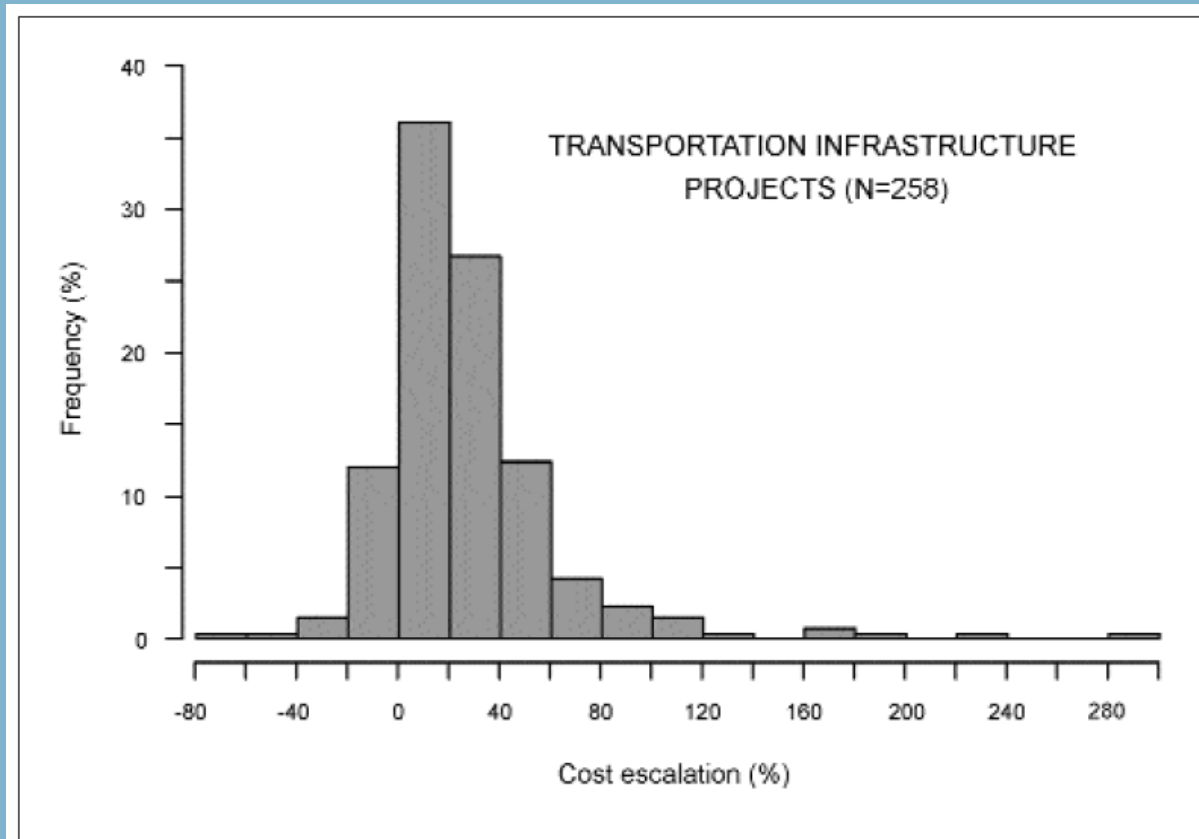
UnderEstimating Project Costs: *Error or Lie?*

FIGURE 1. Inaccuracy of cost estimates in 258 transportation infrastructure projects (fixed prices).

"… a pattern of highly misleading forecasts of costs and patronage could not be explained by technical issues and were best explained by lying"
Flyvbjerg, Holm, Buhl, APA Journal, 2002, No. 3

Cost Underestimate in NASA & DoD Projects

Study	Cost/Budget Growth		% overruns
	Average	Median	
NASA in the 90s	36%	26%	78%
NASA in the 70s	43%	26%	75%
NASA in the 80s			
Gruhl study	61%	50%	95%
GAO study	83%	60%	89%
DoD	45%	27%	76%

Source: Schaffer, 2004

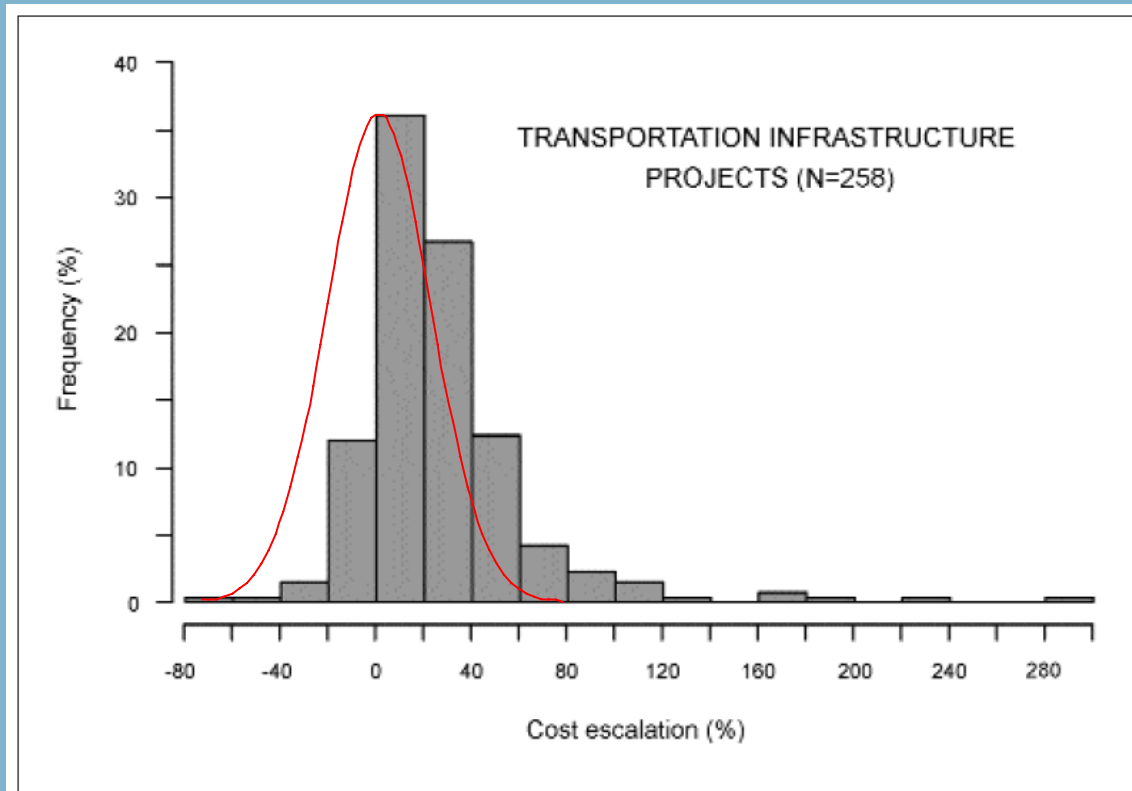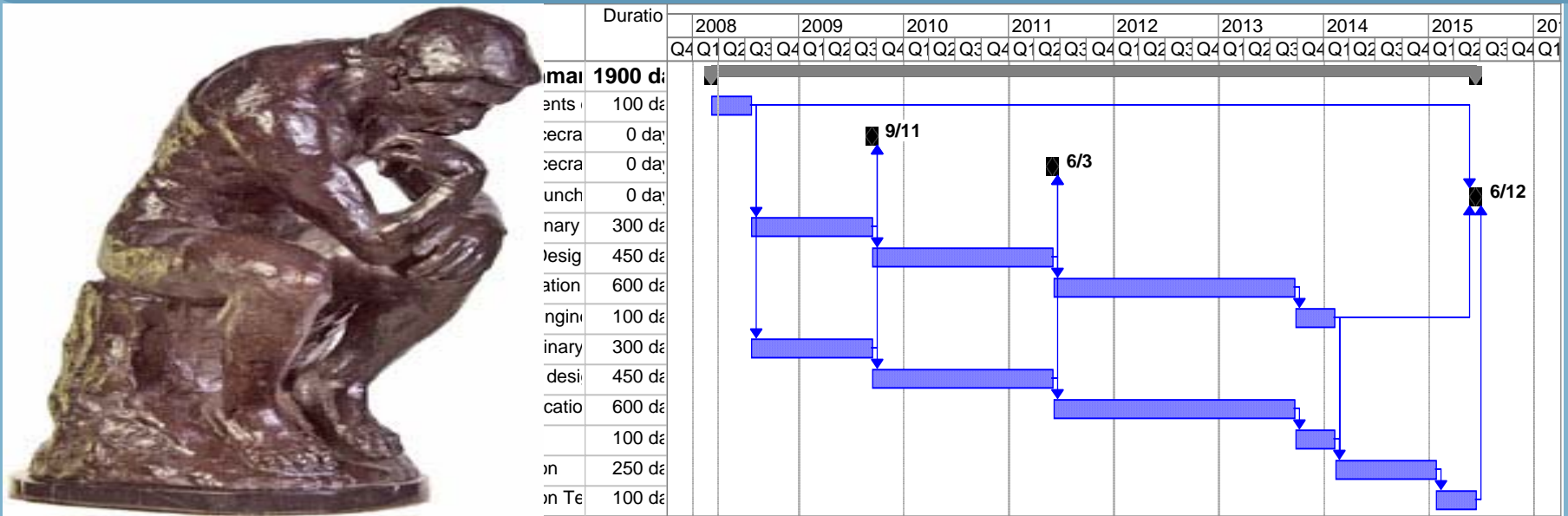# Project Statistics and Central Limit Theorem

FIGURE 1. Inaccuracy of cost estimates in 258 transportation infrastructure projects (fixed prices).

CLT:
"Sum of a sufficiently large number of independent random variables,
each with finite mean and variance, will be approximately normally distributed"

How to Foresee the Contingency?

Problem:
Planners suggest what they consider Mean task costs or durations

Solution:
Separate planning from risk estimate, seek possible delays / overbudgets from risk experts
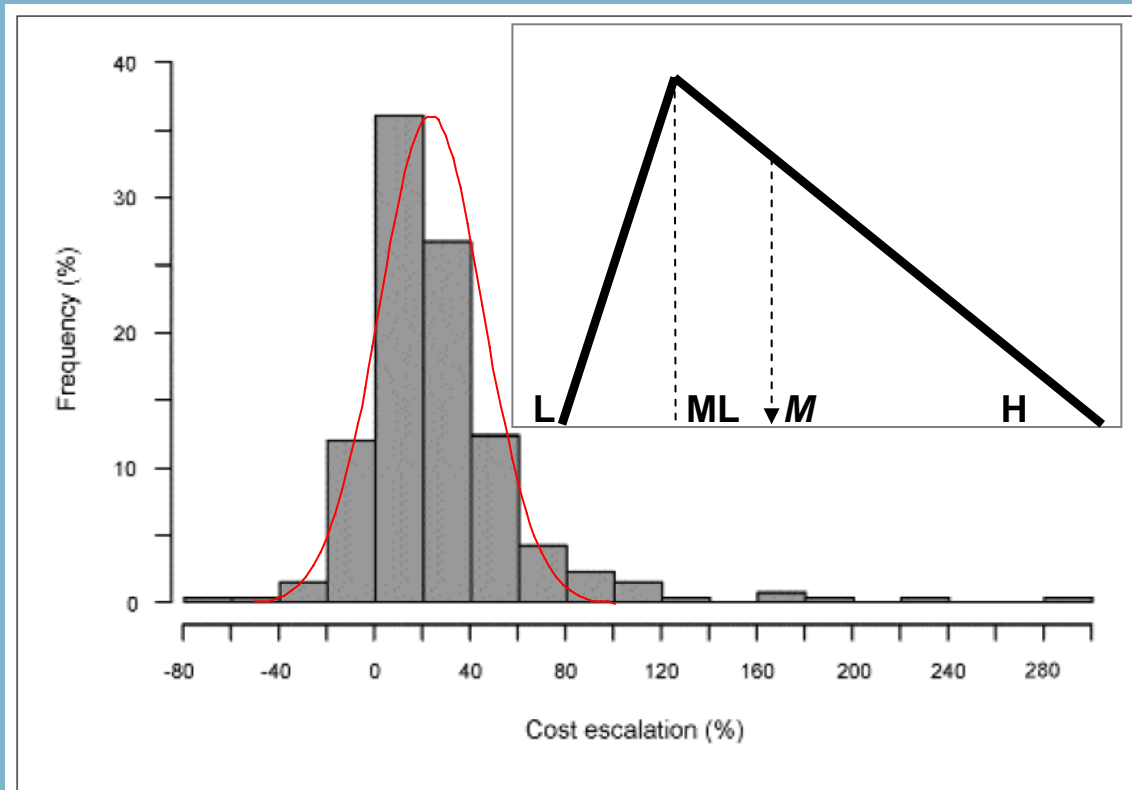
Task and Milestone Distribution Functions

FIGURE 1. Inaccuracy of cost estimates in 258 transportation infrastructure projects (fixed prices).
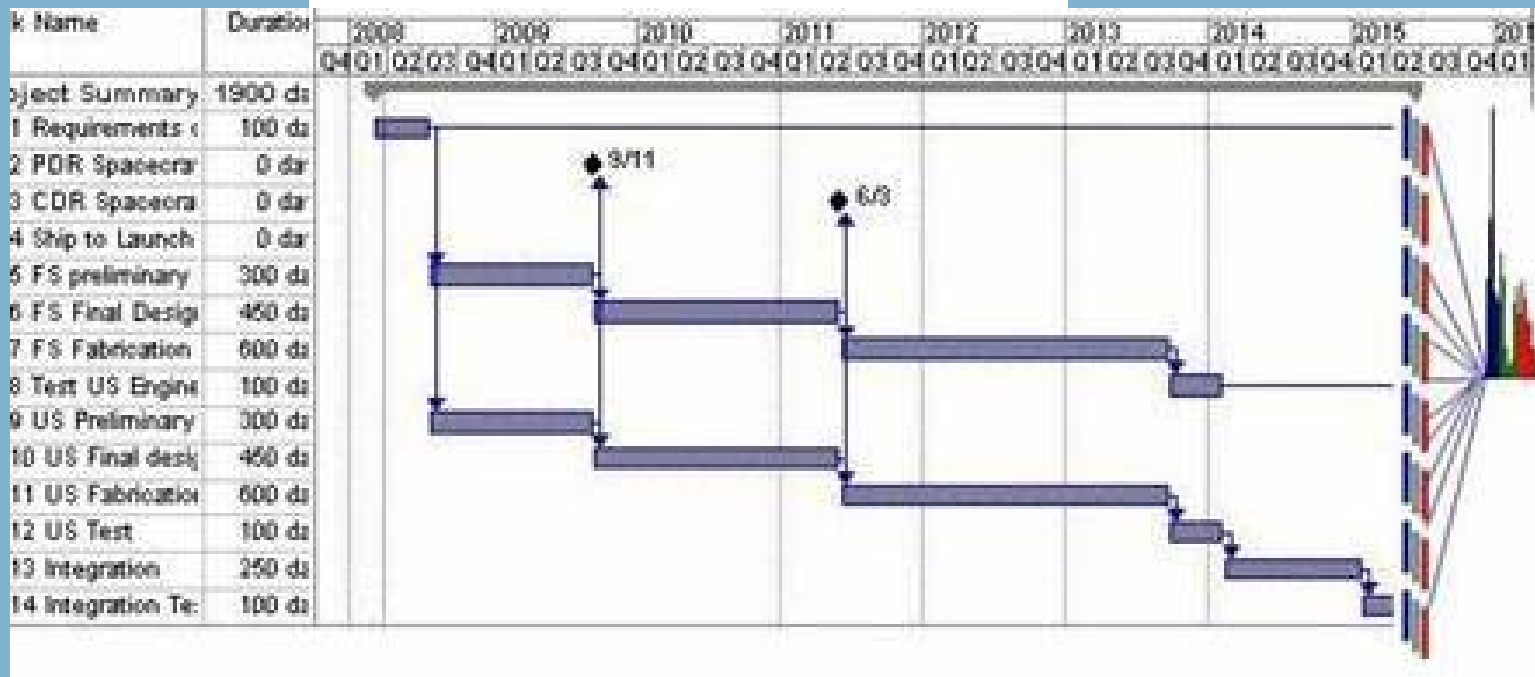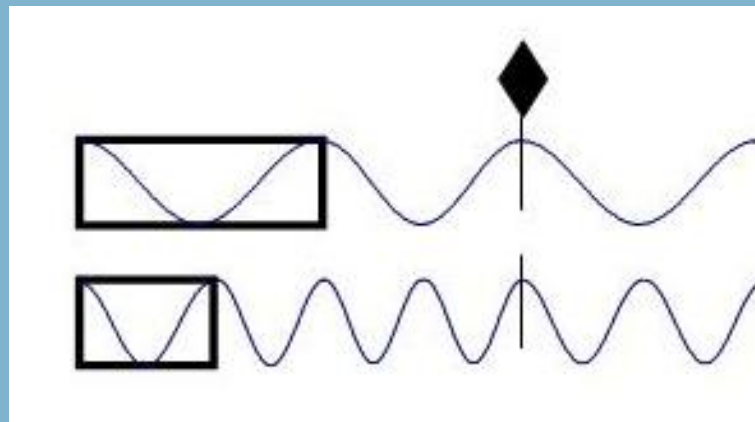
What Theory Should Do

- Risk analysis should start with *symmetric* task distributions (directly or indirectly implied by planners),
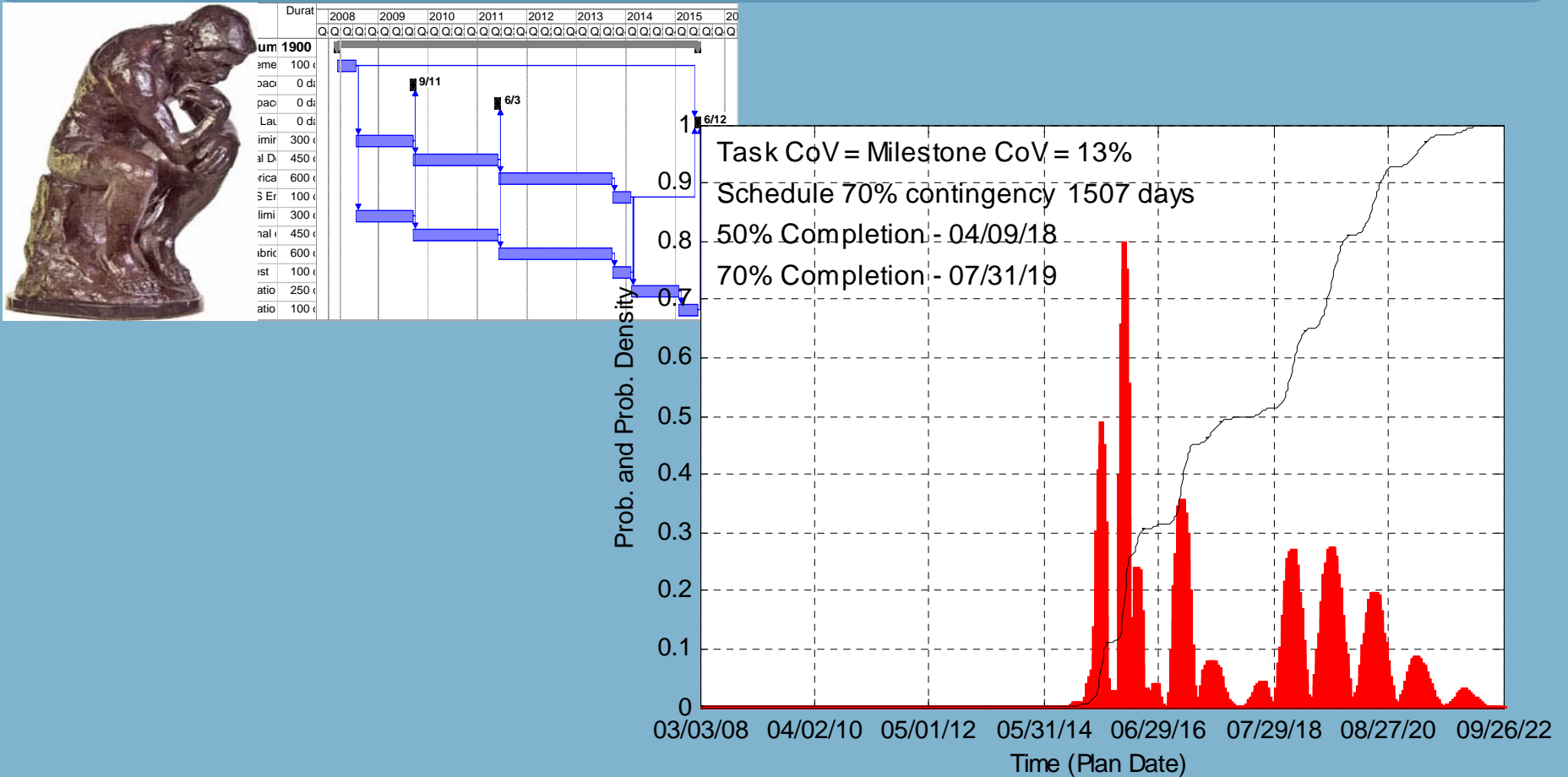
and

- *Predict* milestone distributions skewed to longer times and higher budgets
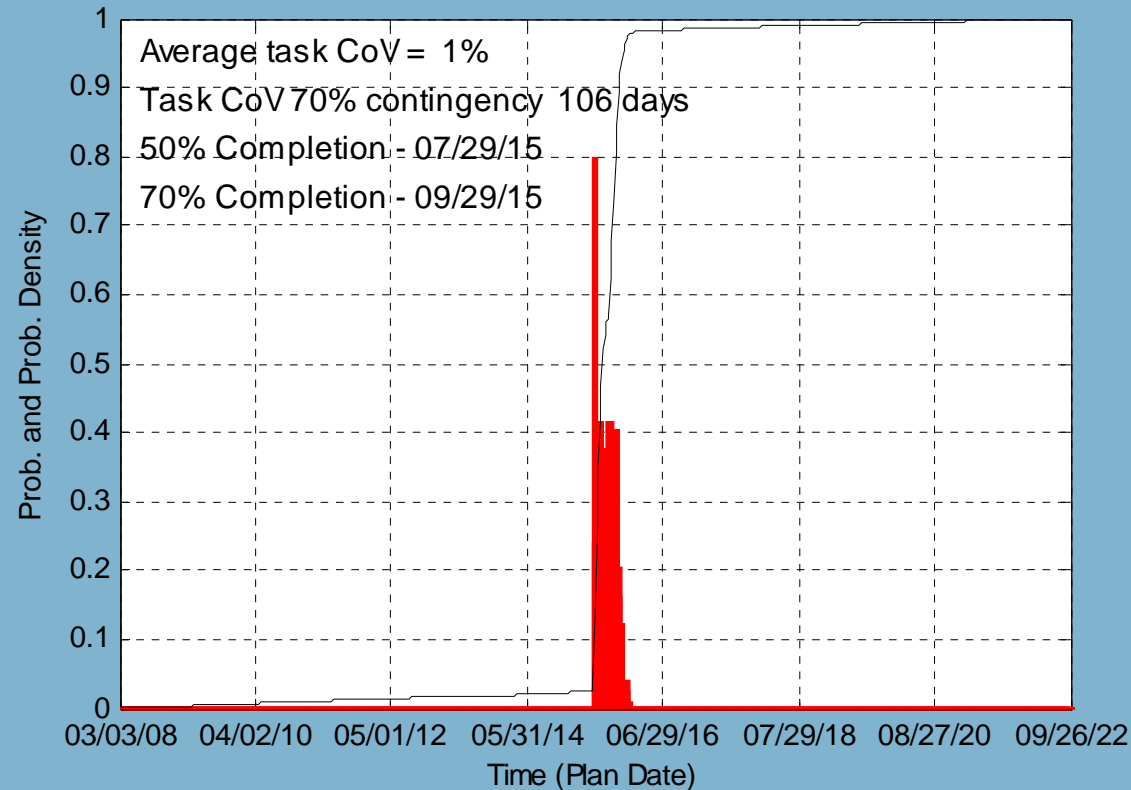
Quantum Model and Milestone Image

Schedule Risk (No Input)

Task CoV = Milestone CoV = 13%
Schedule 70% contingency 1507 days
50% Completion - 04/09/18
70% Completion - 07/31/19

- Task distributions are normal with CoV = 13%, milestone probability density is asymmetric an predicts ~ 4 years contingency
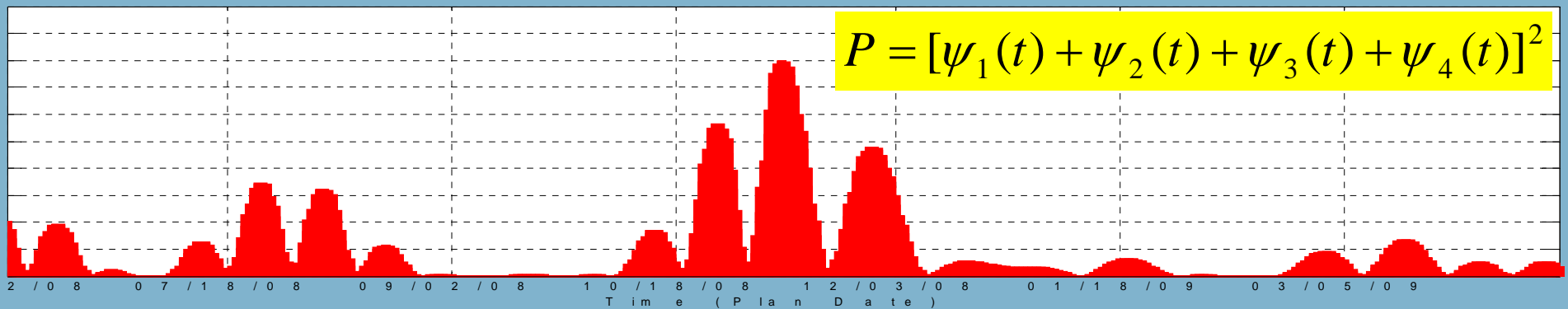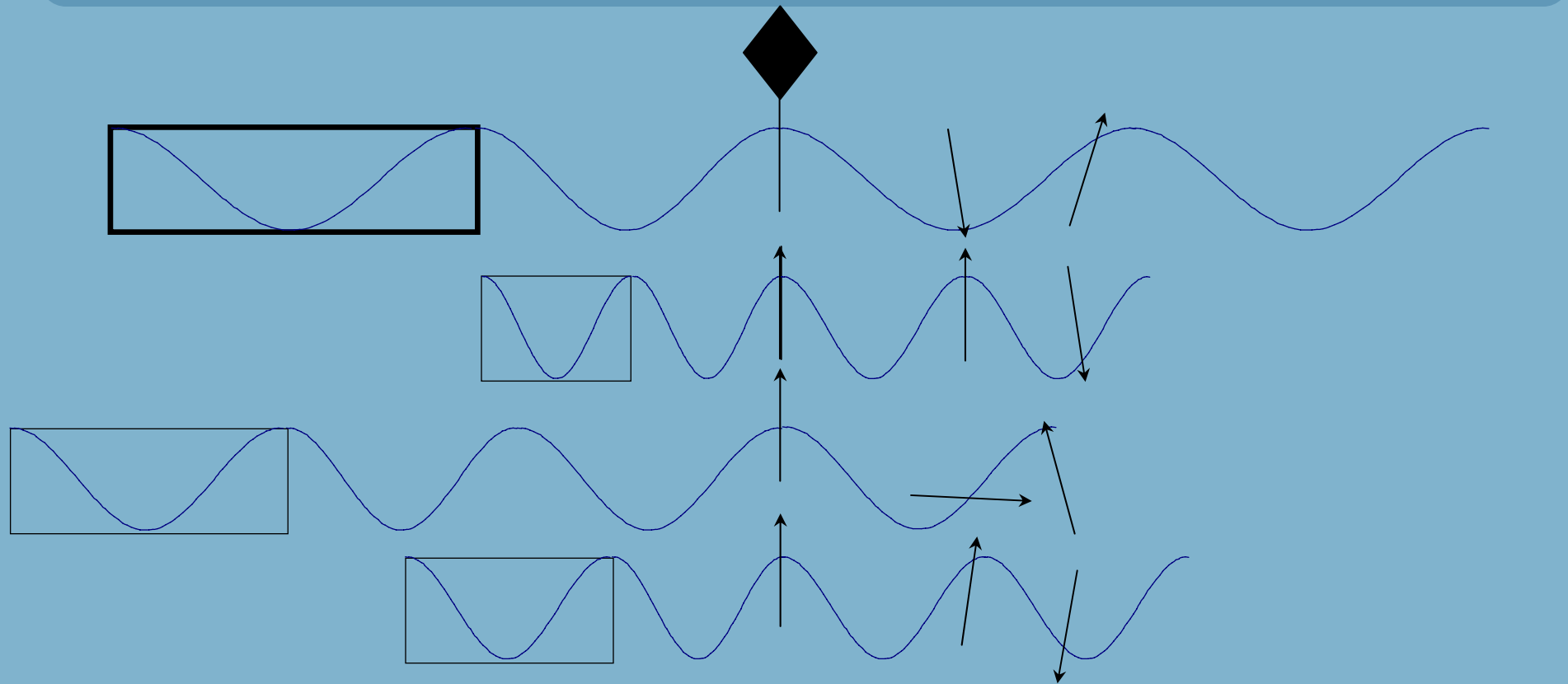
"Internal" Input: Reduced Task CoV

Average task CoV = 1%
Task CoV 70% contingency 106 days
50% Completion - 07/29/15
70% Completion - 09/29/15

- Task distributions are normal with CoV = 1%, milestone probability density is asymmetric an predicts ~ 100 days contingency
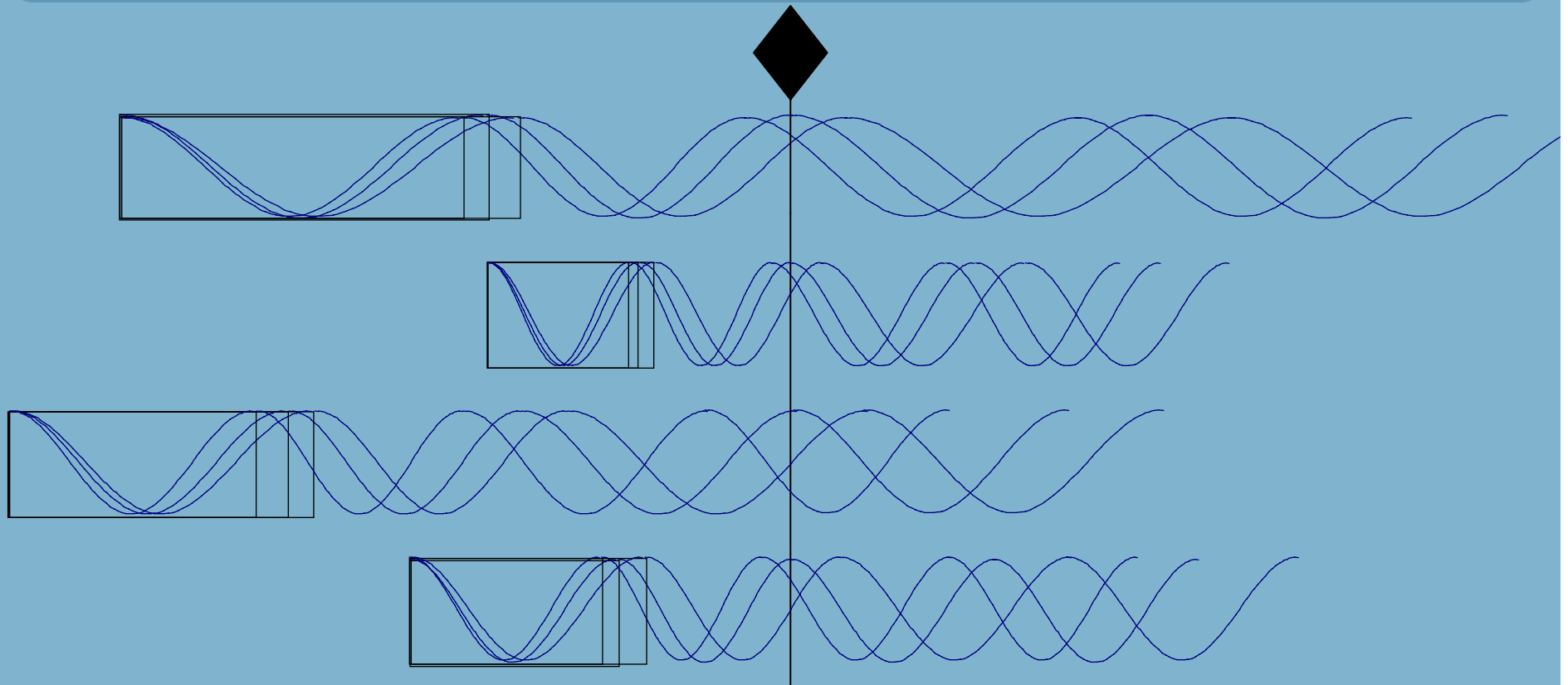
"External" Input: Very Low Risk
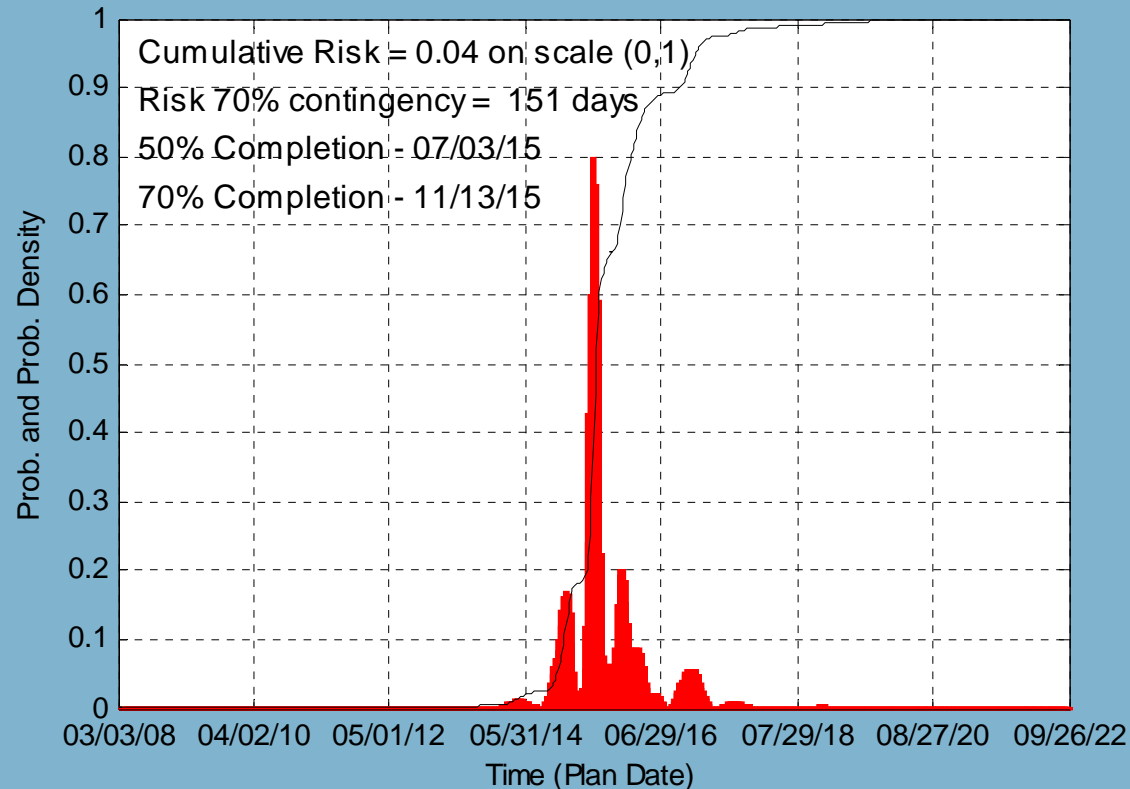
- Task distributions are normal with CoV = 13%,
- Risk is very small,
- Milestone probability is almost symmetric with ~ 150 days contingency.

How It Works -1 Project Sample

$$P = [\psi_1(t) + \psi_2(t) + \psi_3(t) + \psi_4(t)]^2$$

2 / 0 8   0 7 / 1 8 / 0 8   0 9 / 0 2 / 0 8   1 0 / 1 8 / 0 8   1 2 / 0 3 / 0 8   0 1 / 1 8 / 0 9   0 3 / 0 5 / 0 9
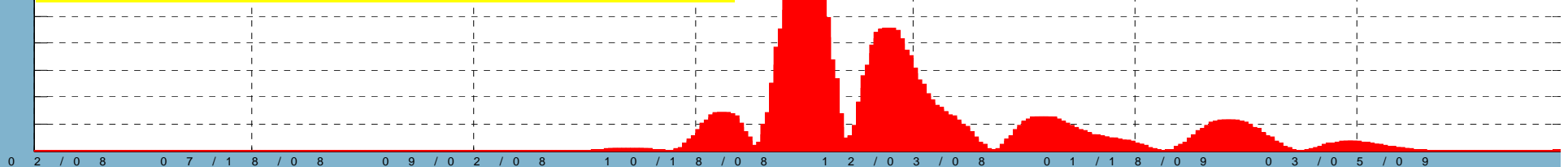
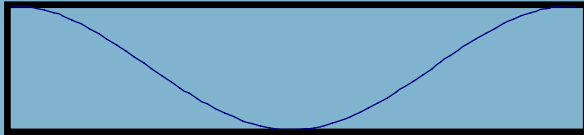T i m e   (P l a n   D a t e)

300 Monte Carlo Simulated Project Samples

Mean of milestone image is shifted to *later date*

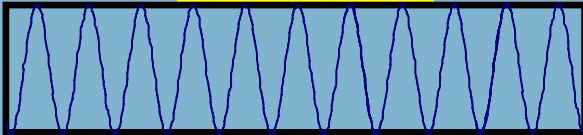$$P = \sum_{\tau} [\psi_1(t,\tau) + \psi_2(t,\tau) + \psi_3(t,\tau) + \psi_4(t,\tau)]^2$$
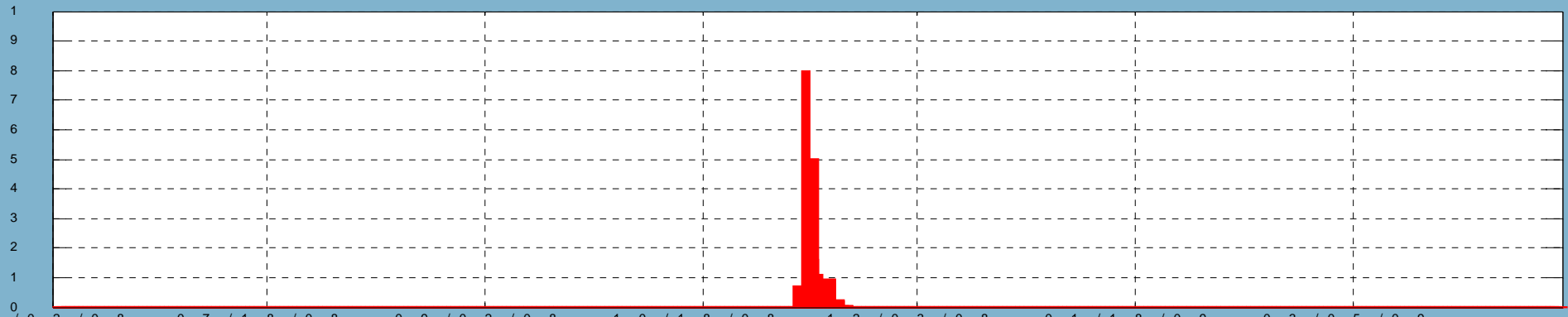
0 2 / 0 8   0 7 / 1 8 / 0 8   0 9 / 0 2 / 0 8   1 0 / 1 8 / 0 8   1 2 / 0 3 / 0 8   0 1 / 1 8 / 0 9   0 3 / 0 5 / 0 9

3000 Project Samples, 1% Task CoV

CoV = 11%

CoV = 1%

TaskID	CoV(%)	TaskName	Duration
1	11	Requirements definition Spacecraft	100
5	11	FS preliminary design	300
6	1	US Preliminary design	450
7	1	FS Final Design	600
8	11	US Final design	100
9	11	FS Fabrication	300
10	1	US Fabrication	450
11	1	Test US Engine	600
12	11	US Test	100
13	11	Integration	250

Task CoVs

OK   Cancel

Conformity to Classical Monte Carlo Analysis

Task CoV = Milestone CoV = 13%
Schedule 70% contingency 1507 days
50% Completion - 04/09/18
70% Completion - 07/31/19
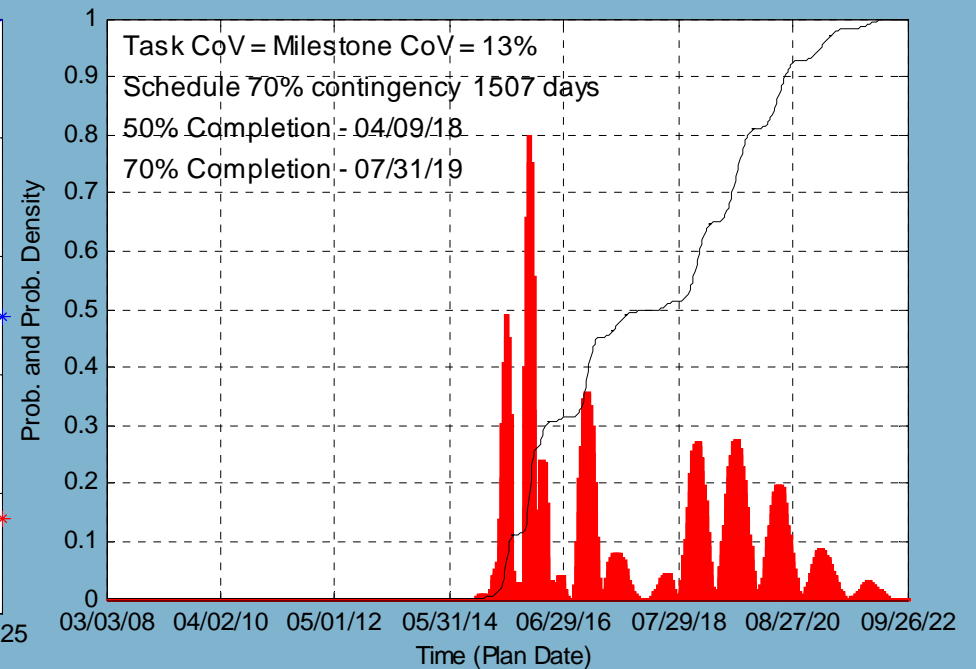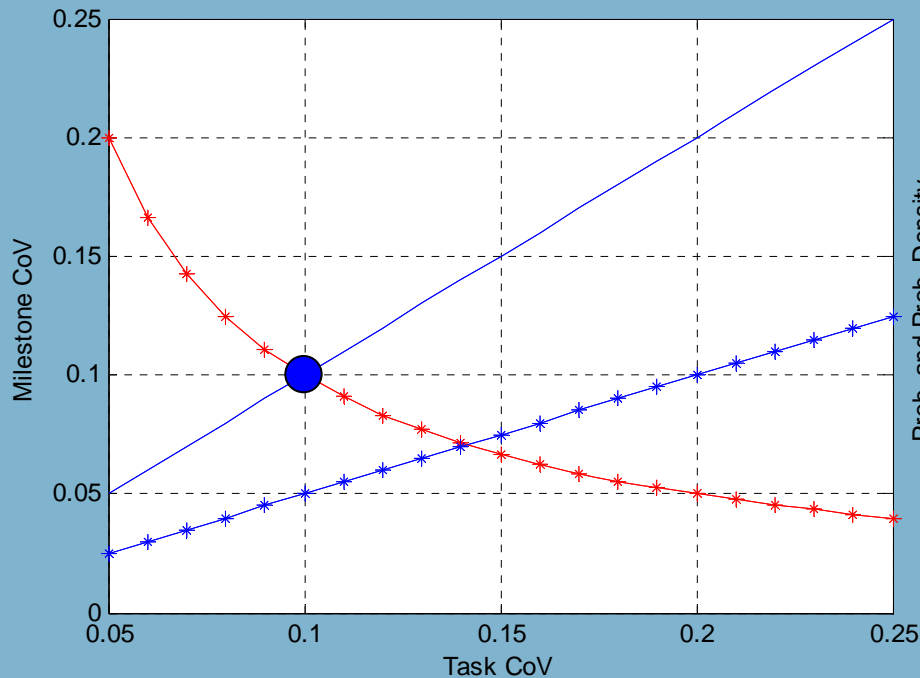
Milestone quantum image is calibrated against classical Monte Carlo simulations: task and milestone CoVs are equal

Conformity to Classical Monte Carlo Analysis

All risks corresponding to
$CoV_{task} = CoV_{milestone}$
are considered "average"

Maximum risks correspond to task $CoVs = 0.25$ (system parameter)

Summary

- Projects are delayed and costs are overrun by currently unknown *details of project tasks and their mutual correlations*

- These details and correlations are modeled by *interference* of quantum mechanical wave functions

- Wave function interference pattern is milestone probability density

- Monte Carlo simulated milestone probability distribution is *naturally asymmetric*

- Fully symmetric task *uncertainties* are converted into milestone *risk*.