

# Preface of February 2010

- Since this presentation was delivered, many audiences expressed their concerns and asked questions how the wave model of project activities may be explained in conventional terminology of risk assessment.
- Our current web site explains what was missed and is now added to the conventional risk model: analytical description of project execution by mutual compensation of task variations (approach widely used in Project Management practice but never formalized)
- Remarkably, this new understanding has not changed the algorithm and does not affect the following presentation

# Excessive Project Cost – Where It Comes From: The Quantum Perspective

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**2009 ISPA / SCEA Professional Development and Training Workshop**

# UnderEstimating Project Costs: *Error or Lie?*

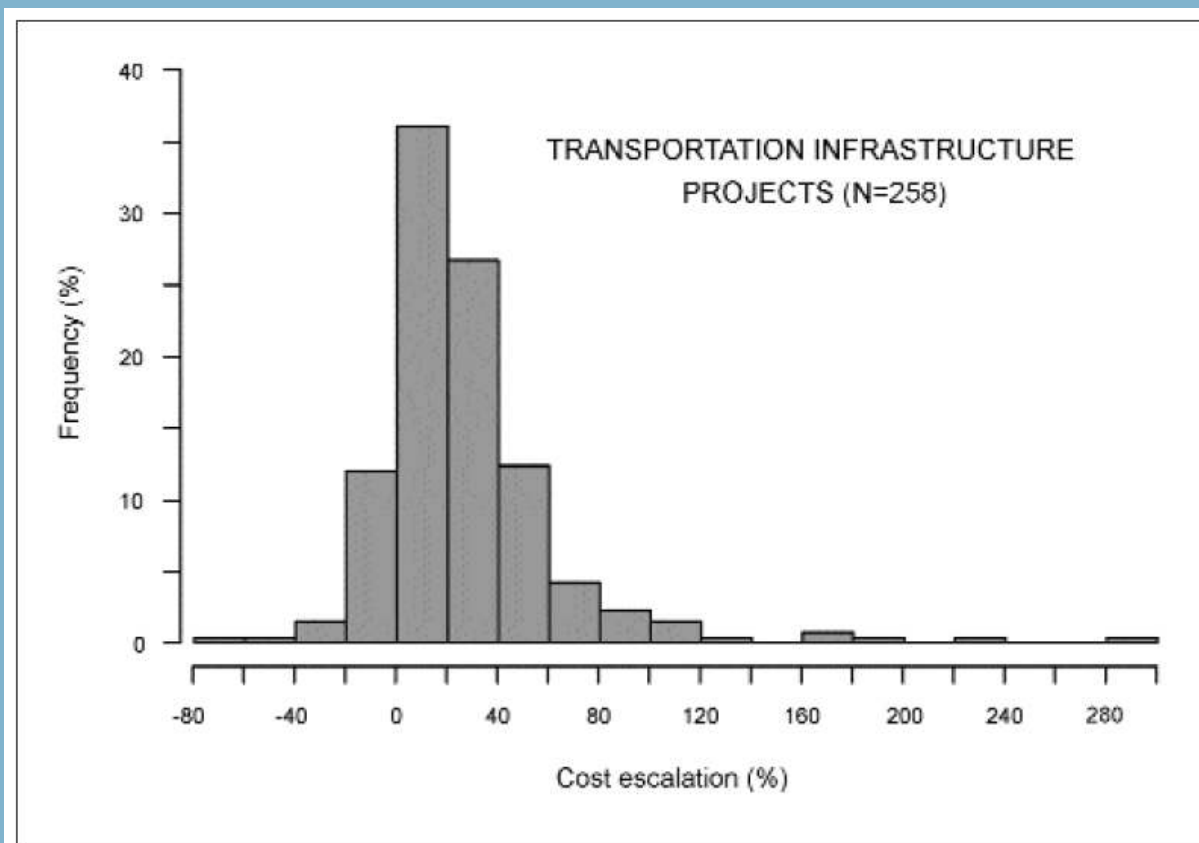


FIGURE 1. Inaccuracy of cost estimates in 258 transportation infrastructure projects (fixed prices).

“... 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*

# Project Statistics and Central Limit Theorem

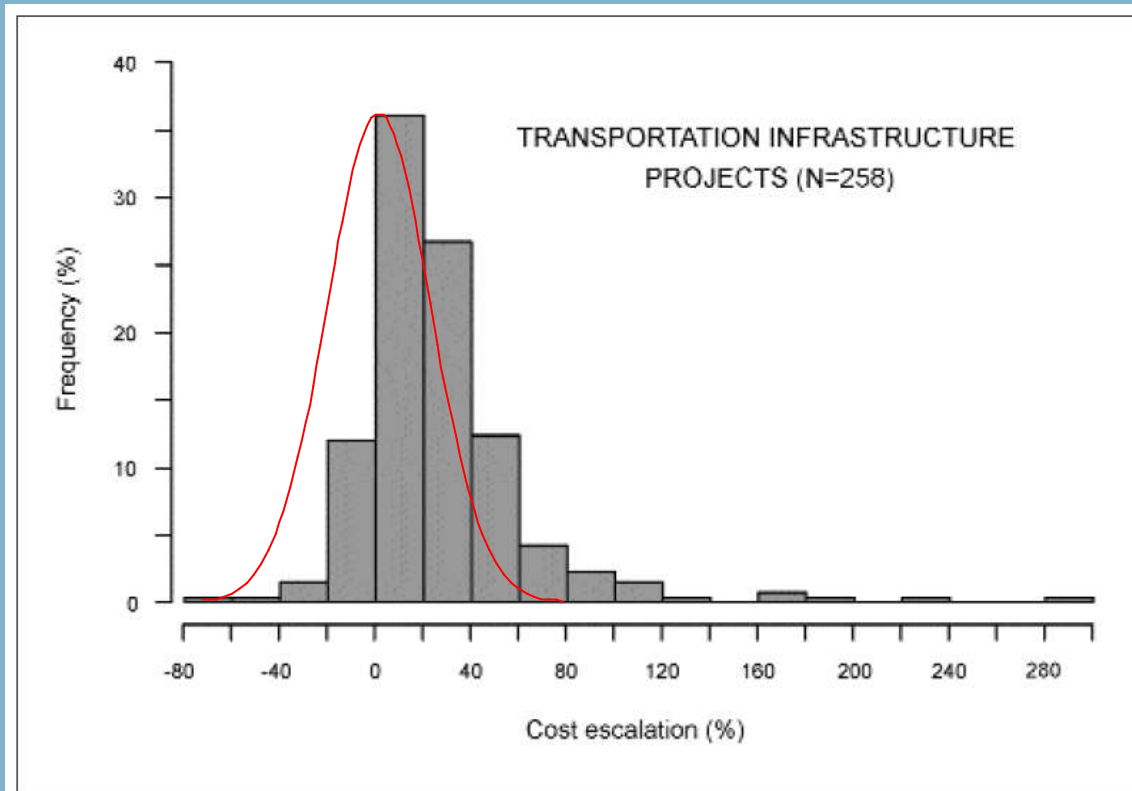
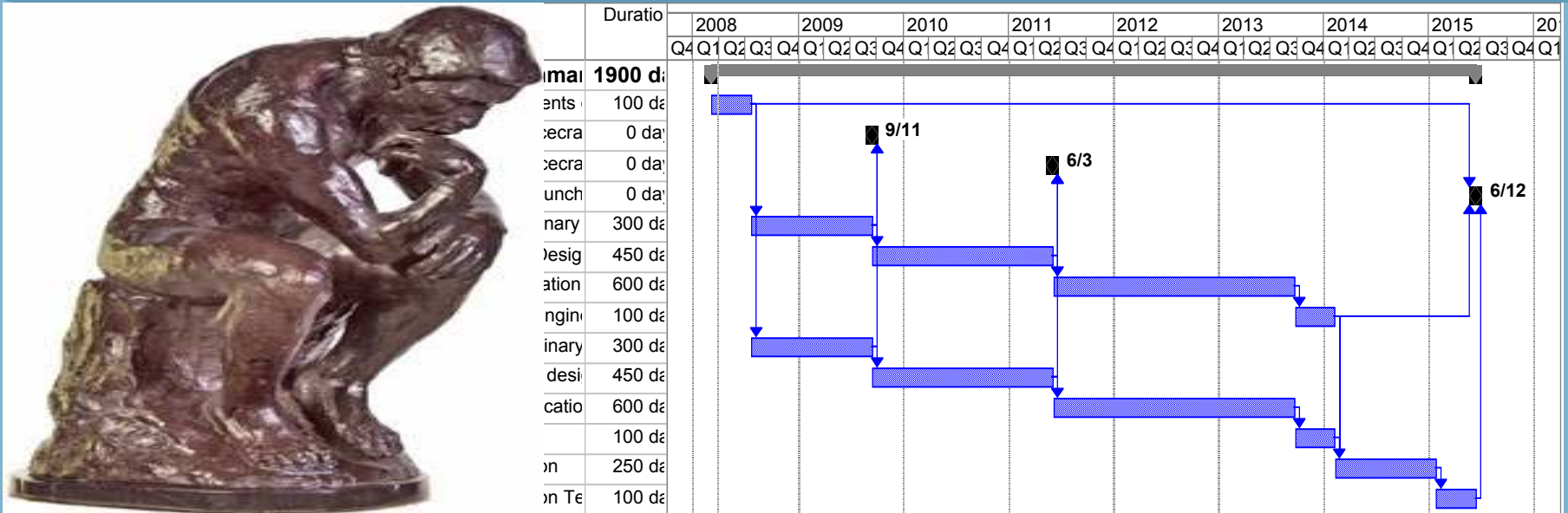


FIGURE 1. Inaccuracy of cost estimates in 258 transportation infrastructure projects (fixed prices).

## 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

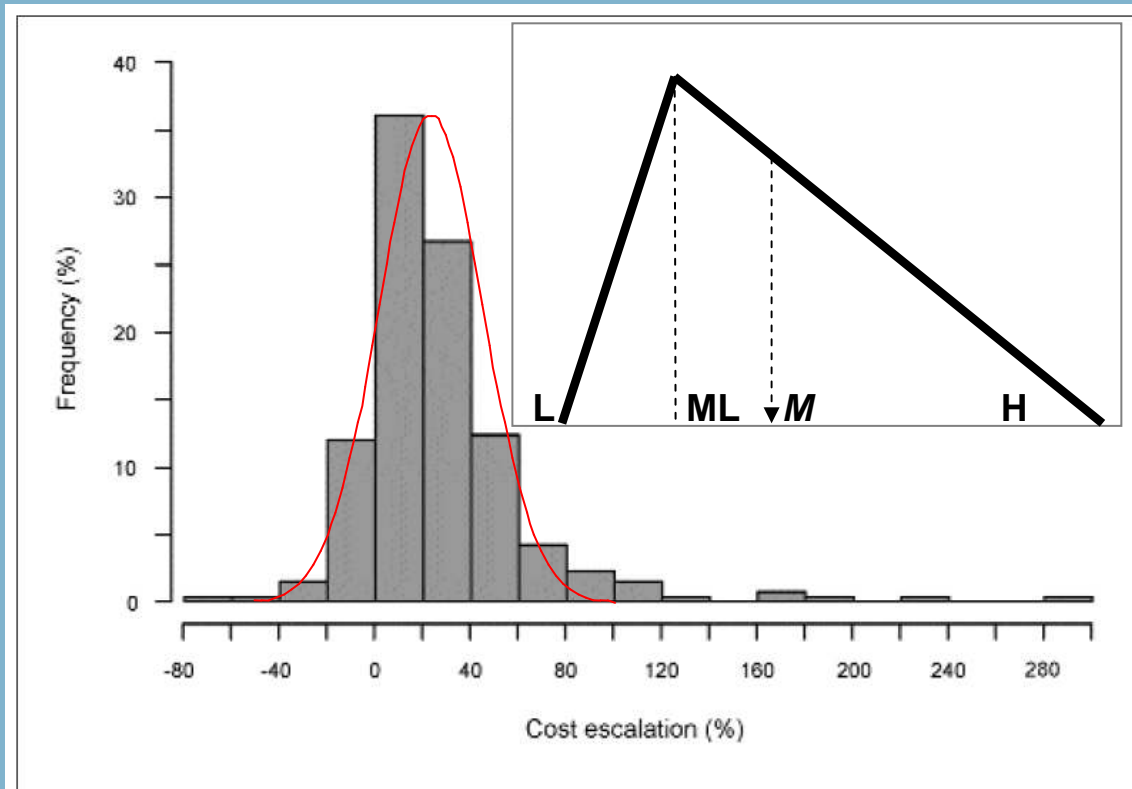


FIGURE 1. Inaccuracy of cost estimates in 258 transportation infrastructure projects (fixed prices).

## What Theory Should Do

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

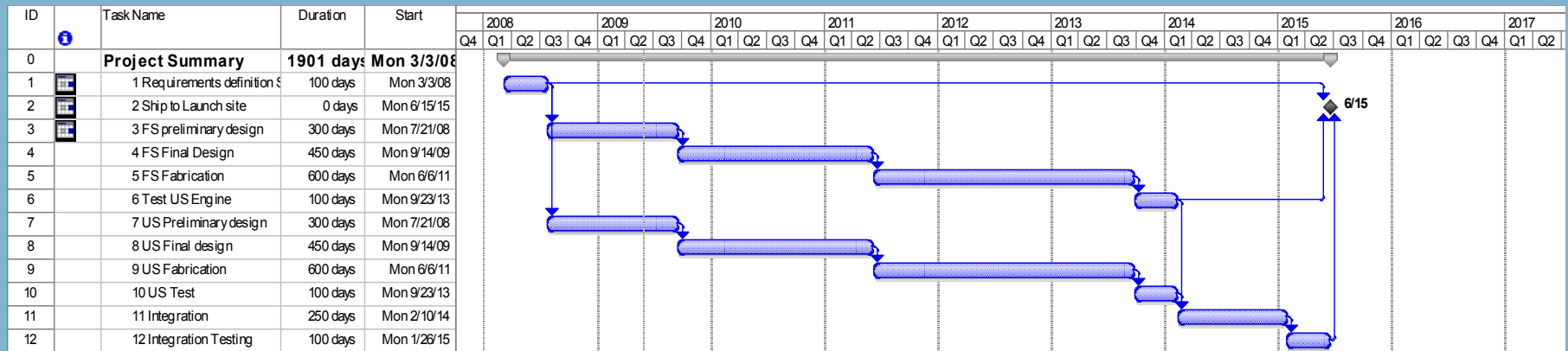
and

- *Predict* milestone distributions skewed to longer times and higher budgets

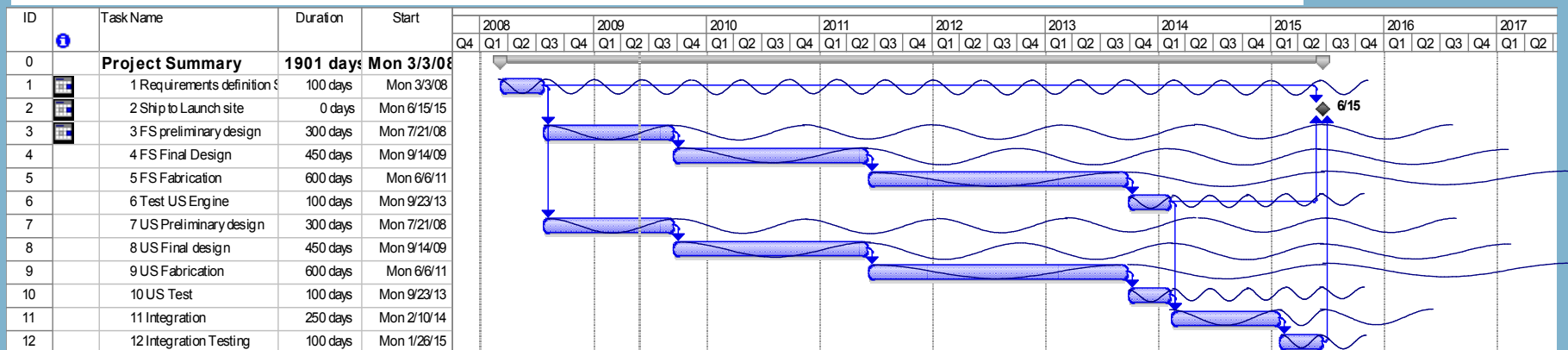


# Classical and Quantum Gantt Chart

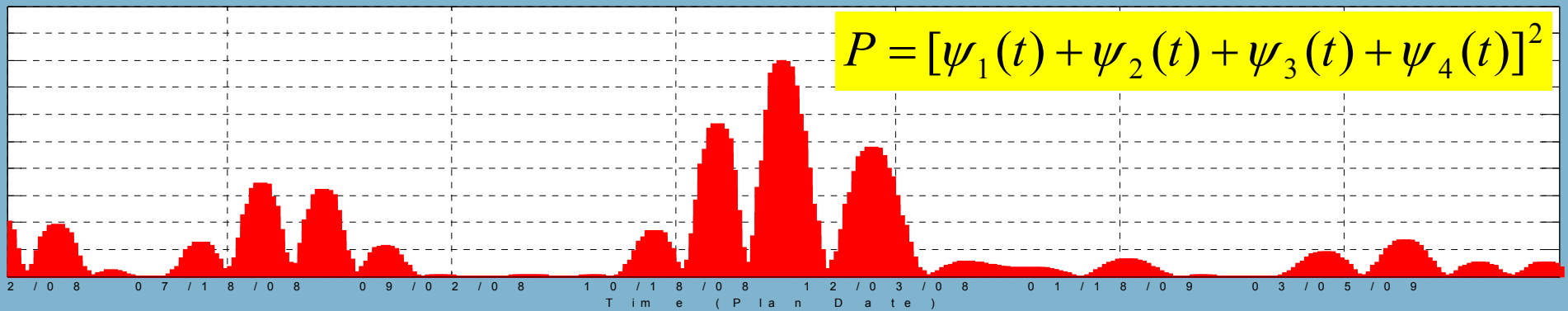
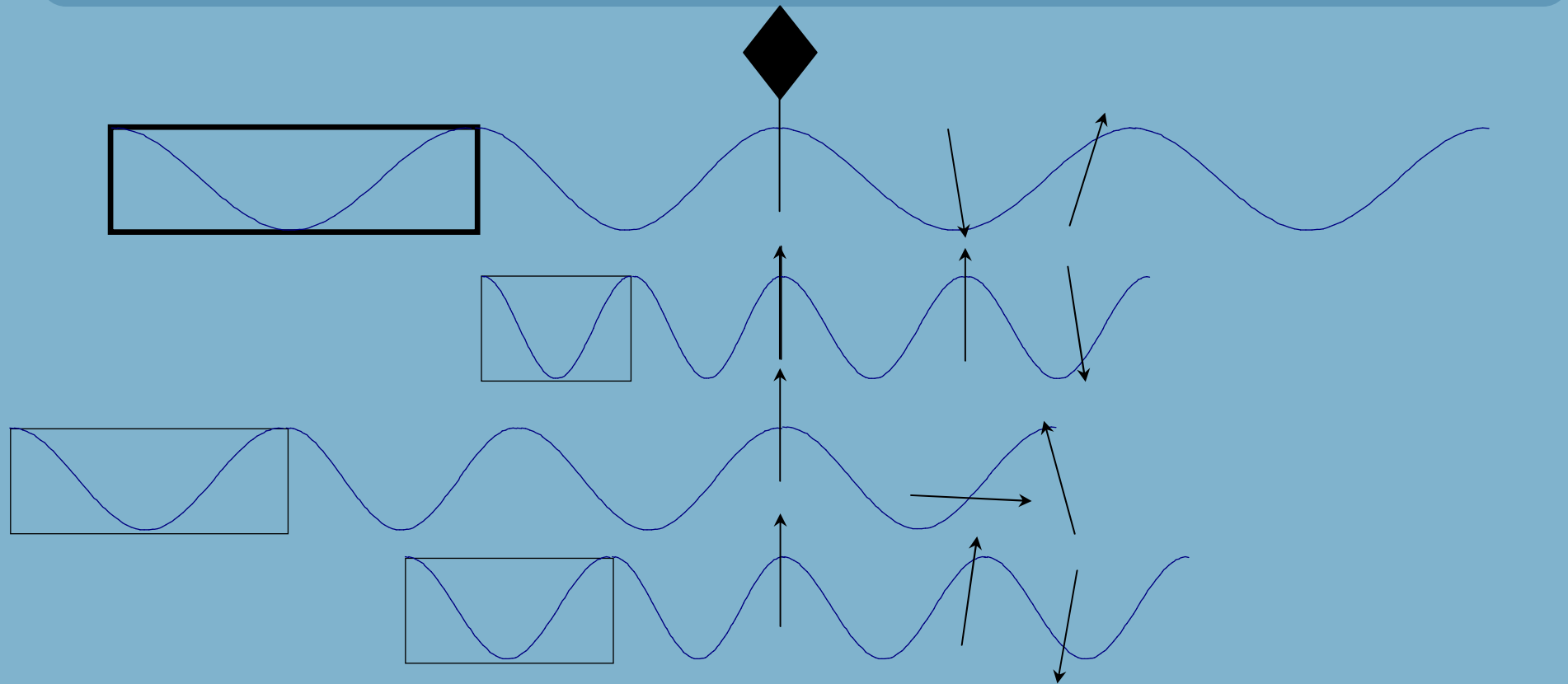
Milestone is defined by distribution function tails of several most sensitive tasks



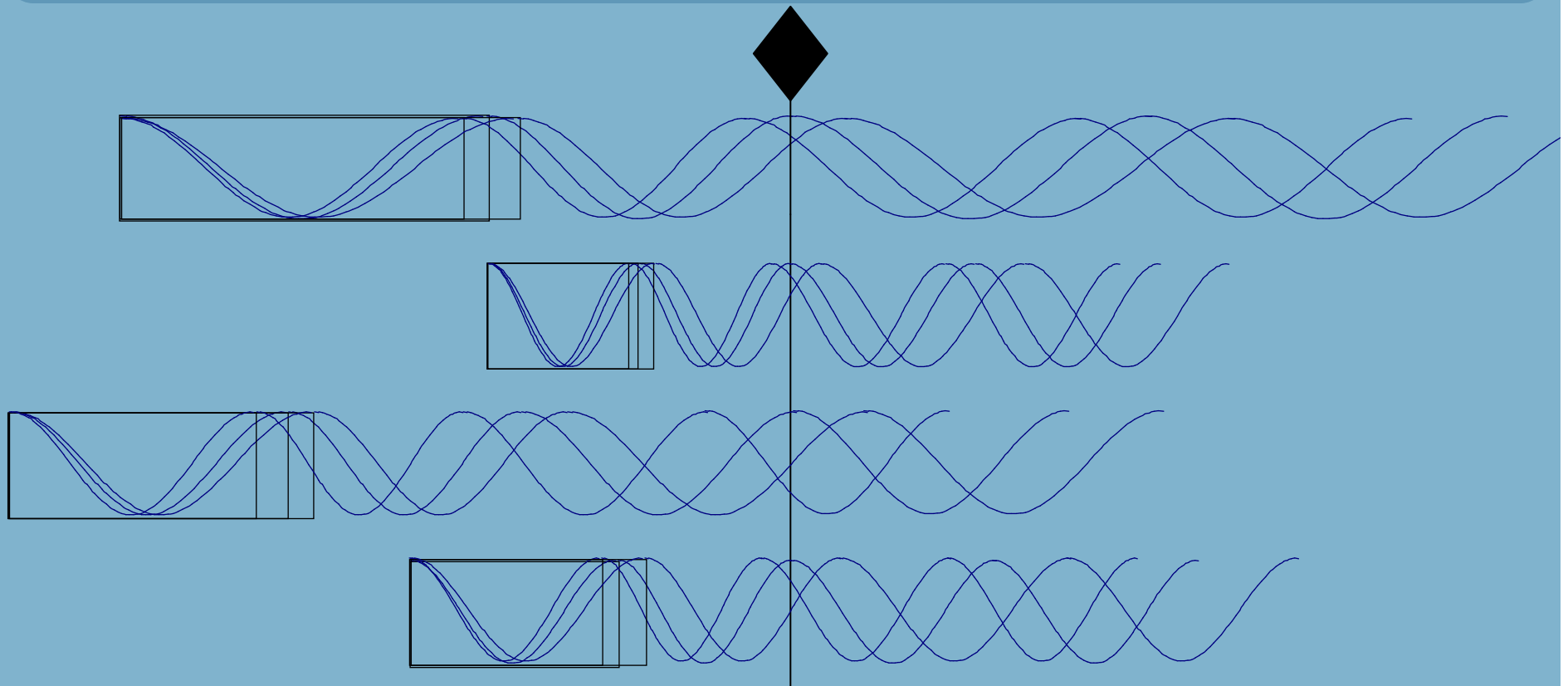
Milestone is defined as superposition of wave functions of all fluctuating tasks



# How It Works -1 Project Sample



# 300 Monte Carlo Simulated Project Samples

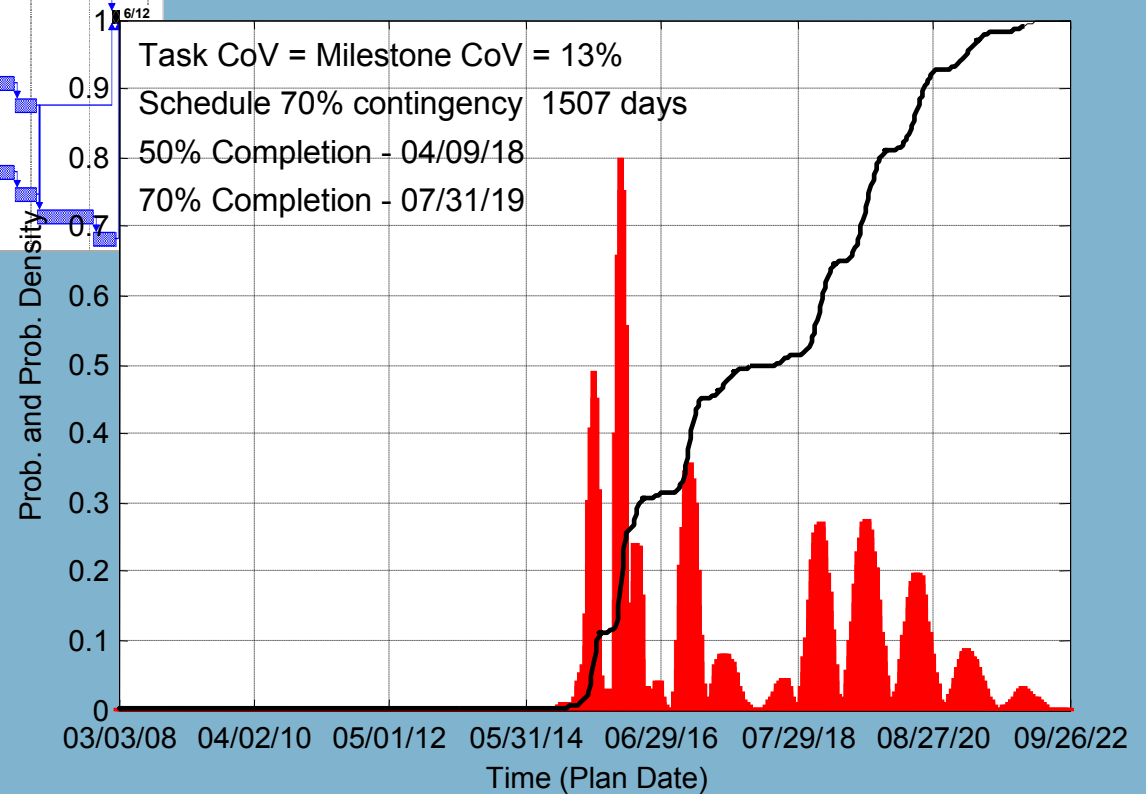
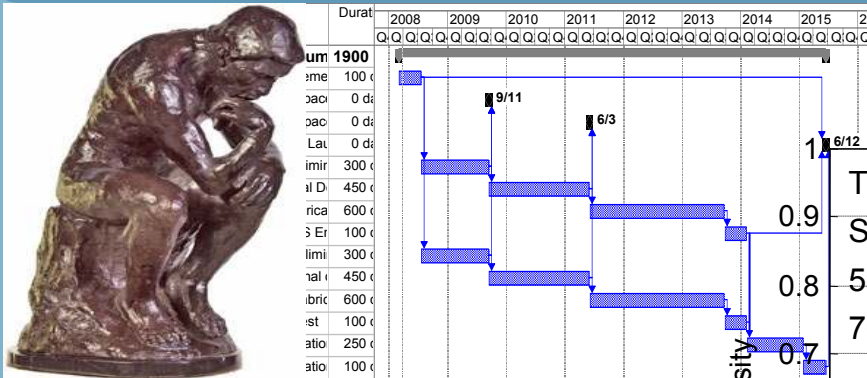


Mean of milestone image is shifted  
to *later date*

$$P = \sum_{\tau} [\psi_1(t, \tau) + \psi_2(t, \tau) + \psi_3(t, \tau) + \psi_4(t, \tau)]^2$$

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

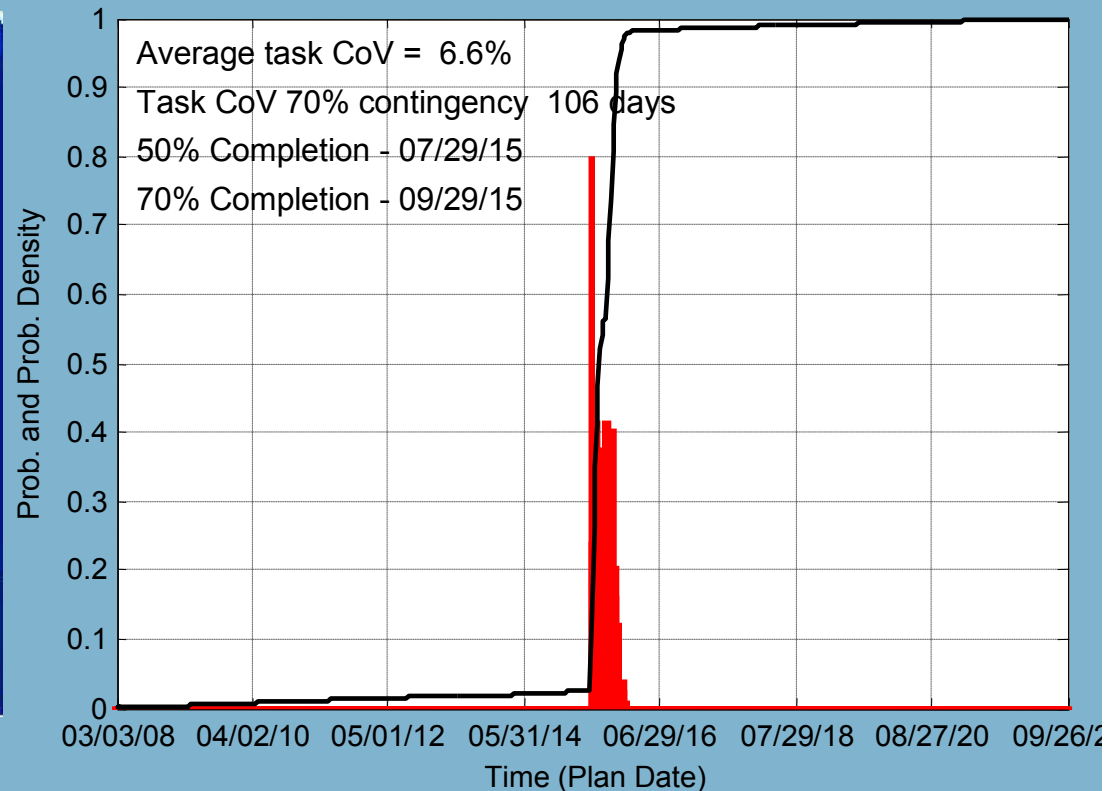
# Schedule Risk (No Input)



- Task distributions are normal with CoV = 13%, milestone probability density is asymmetric and predicts ~ 4 years contingency

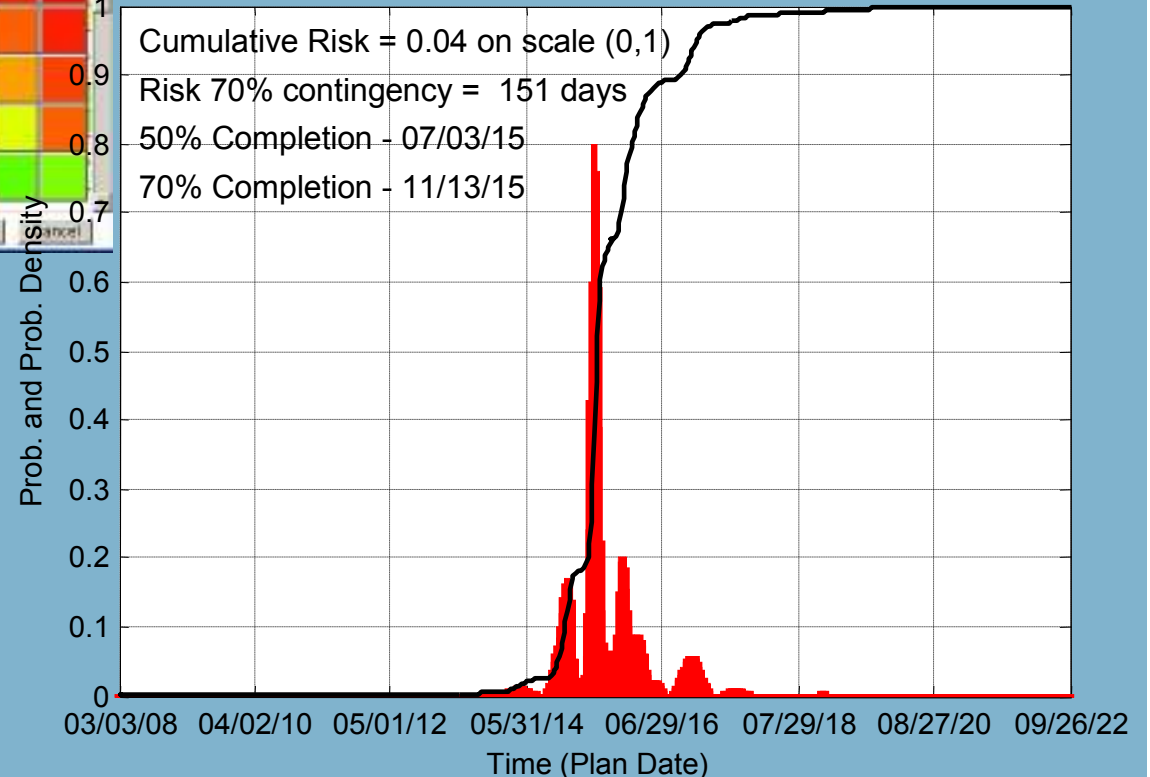
# Task CoV Input

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 distributions are normal, milestone probability density is asymmetric and predicts ~ 100 days contingency

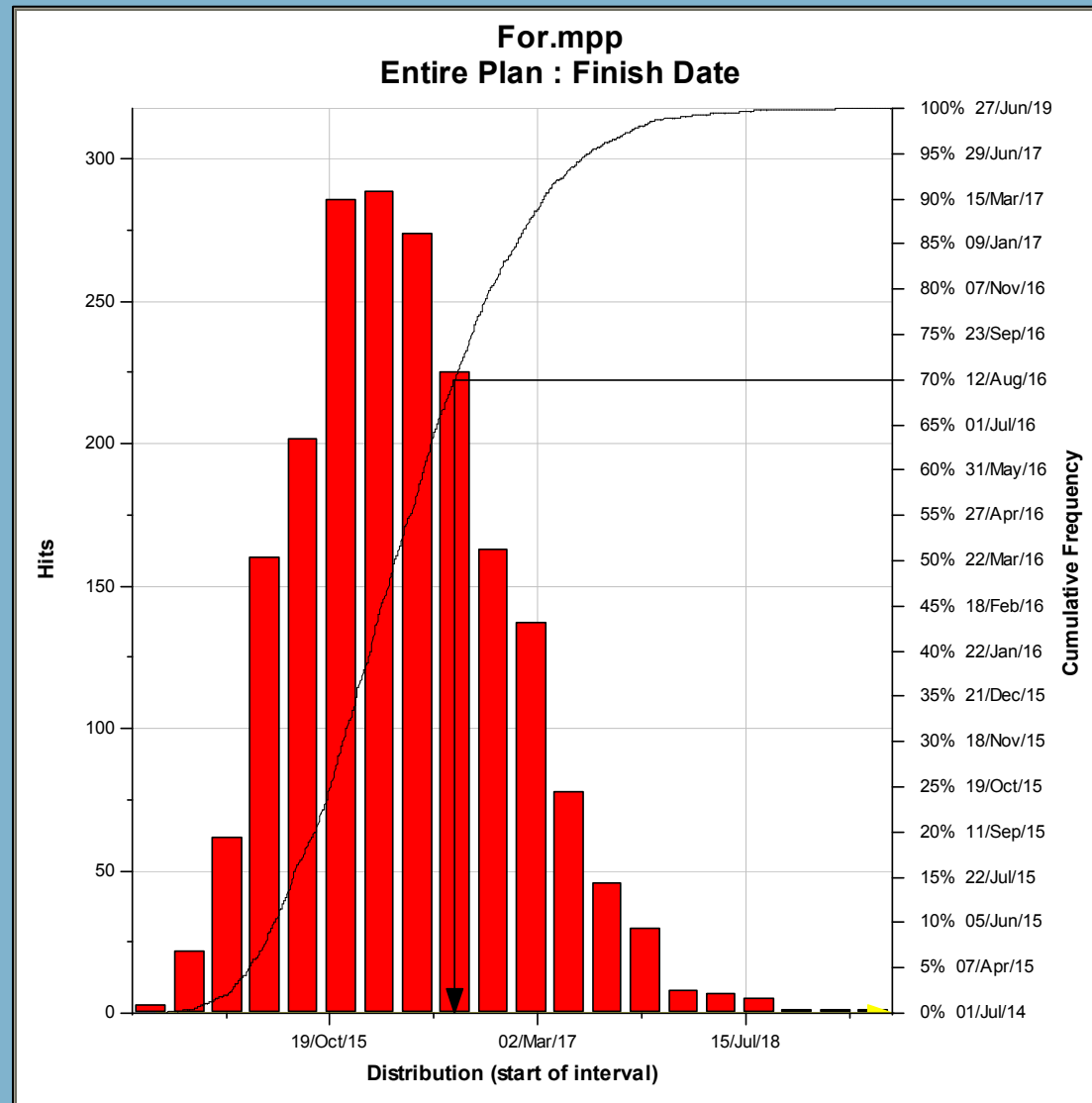
# Risk Register Input



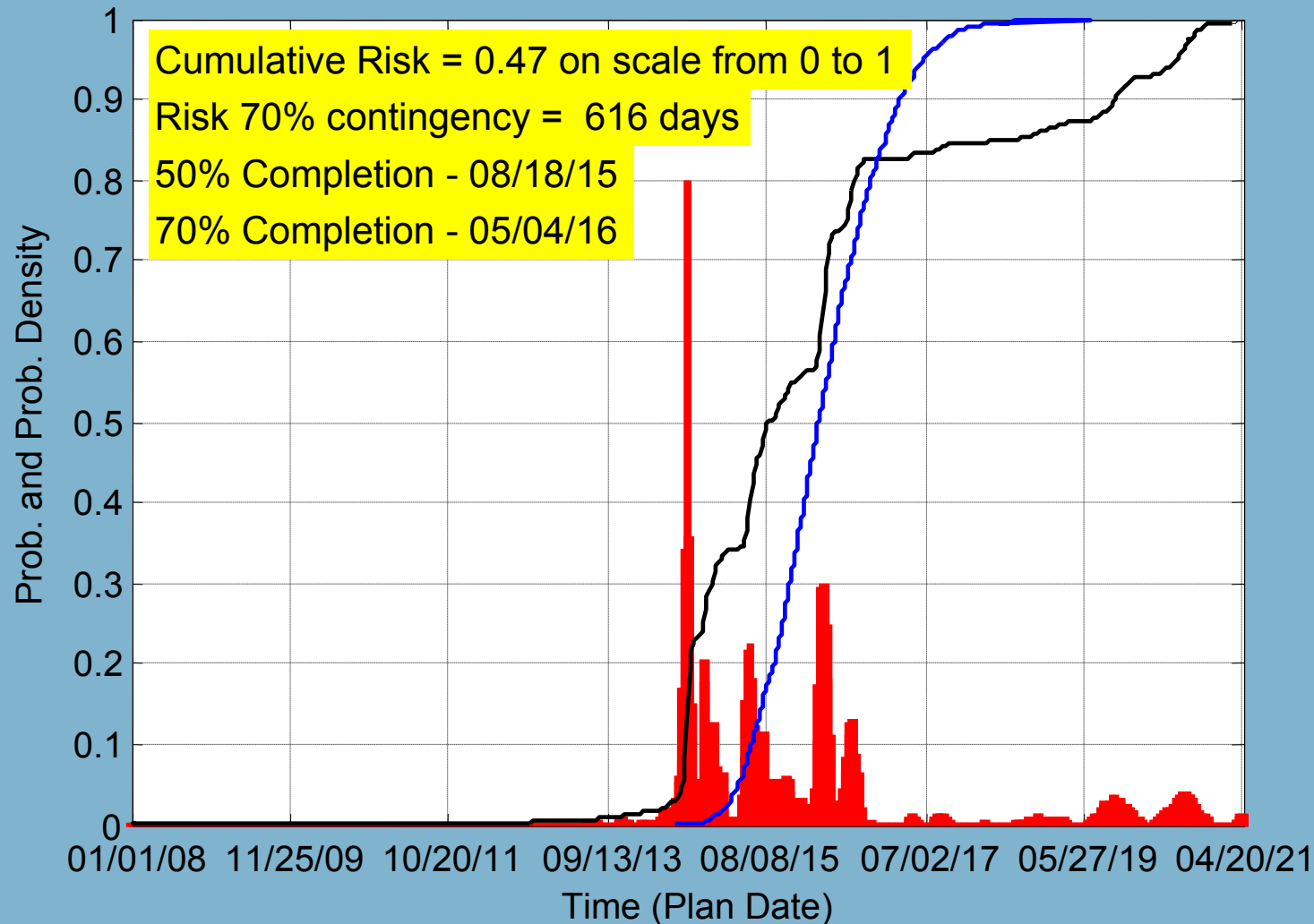
- Task distributions are normal with  $CoV = 13\%$ ,
- Risk is very small,
- Milestone probability is almost symmetric with  $\sim 150$  days contingency.

# NASA Project: Classical Monte Carlo Analysis

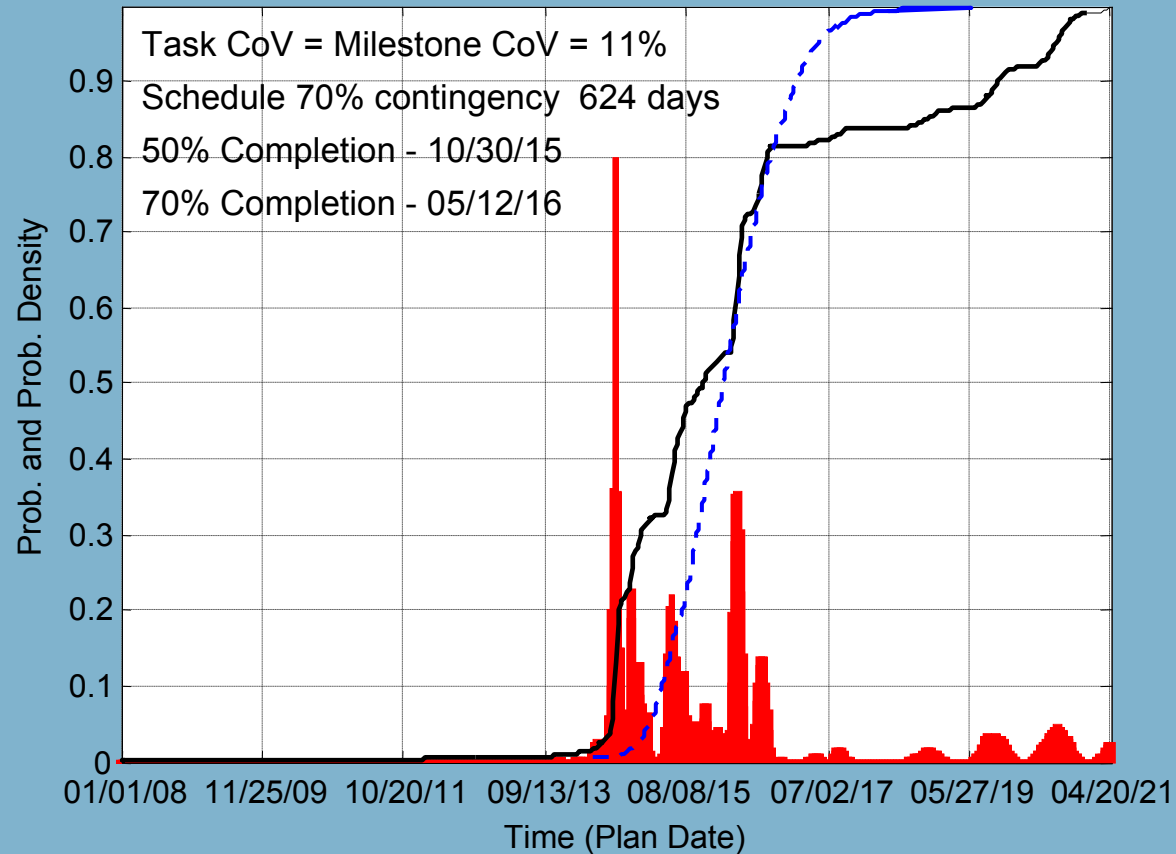
Preliminary indications are that the P-70 target is 2 years delayed to 12 August 2016 from 27 August 2014



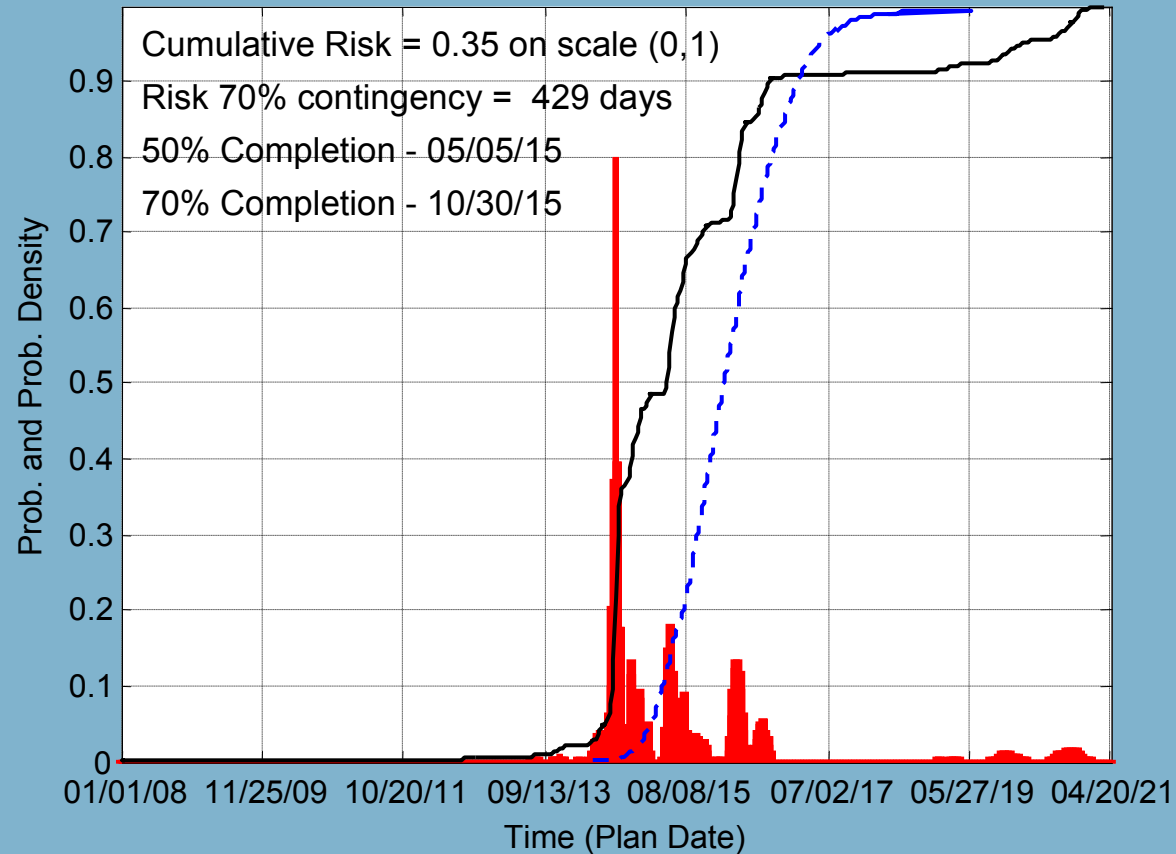
# NASA Project: Quantum Monte Carlo Analysis



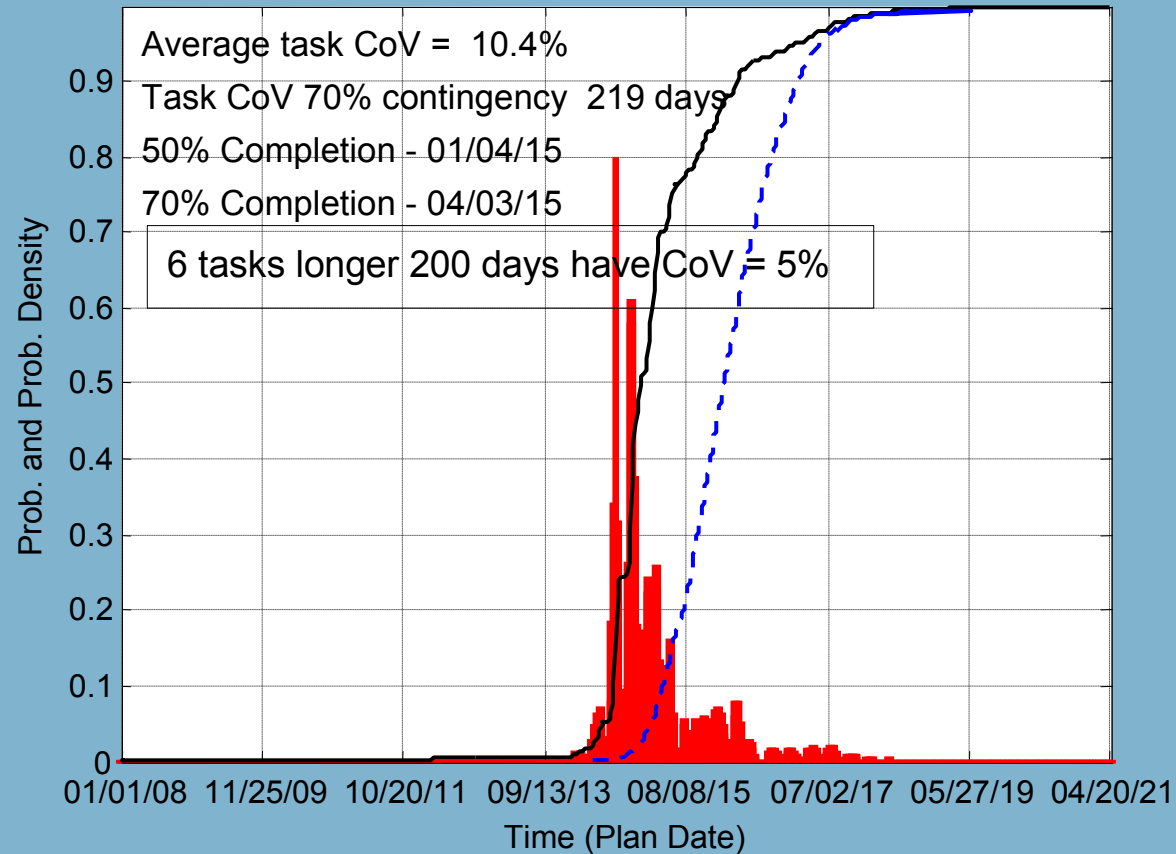
# NASA Project: Quantum Analysis, Risk = 0.5



# NASA Project With Lower Risk



# NASA Project With Better Defined Long Tasks



# Summary

- Quantum model explains project delay and over-cost by currently unknown *details of project tasks and their mutual correlations*;
- Quantum approach delivers results similar to classical method, with much less manual labor required;
- Quantum approach provides project overview without user input.