International Experts in Claims Analysis, Dispute Resolution, and Project Management for Process, Oil & Gas, Pipeline, Power, Industrial, Infrastructure, and Building Construction Projects

LONG INTERNATIONAL

Risk and Uncertainty Analysis Services

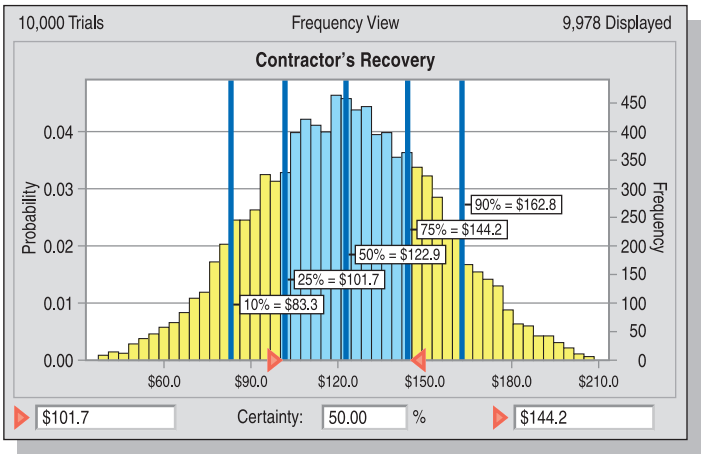
OVERVIEW

To analyze risk and uncertainty, we prepare sophisticated cost and schedule models that, with our client's input, forecast a range and probabilities of outcomes to better define the uncertainties of claim values and project completion dates. Instead of preparing a static cost spreadsheet or schedule model that provides one result, or a group of models with contrasting results, Monte Carlo simulations allow us to define variable cost and date ranges and distributions and conduct thousands of trials within a given model. We can then assess the probability of events such as meeting a budget or a completion date or a contractor prevailing on various components of its claimed damages. We can also isolate and adjust the most sensitive variables in any cost or schedule model and then take action to address these variables. We use Crystal Ball® and other software to help owners, contractors, and insurers better manage their risks.

Common Uses

- Contingency development for capital cost estimates
- Project feasibility assessments comparing capital and operating costs with projected revenues (production quantities and market prices)
- High-level claim evaluations *(see Example 1)*
- High-level schedule and completion date evaluations *(see Example 2)*
- Workforce, materials, and equipment management and optimization
- Cost forecasting

Claim Recovery/Probability Chart



Example 1: Claim Evaluation

Monte Carlo simulations are very effective in evaluating construction and insurance claims at a high level. The table below presents a typical static model in which a contractor's $254.5 million construction claim and an owner's $47 million counterclaim are evaluated to assess the relative strengths and weaknesses of each claim component.

The static model helps determine the total of the contractor and owner's most likely claim and counterclaim recovery values, $114.5 million, but does not establish a reasonable range based on the uncertainties associated with legal and technical entitlement, adequacy of documentation, and proof of damages. The Claim Recovery/Probability chart above illustrates the results of a Monte Carlo simulation using similar data, plus assumptions related to ranges of claim recovery and probability distributions for each claim component.

Based on various assumptions regarding the relative strength of the contractor's claim and the owner's counterclaim elements, the 10,000 trials showed the following results:

- The most likely recovery for the contractor is $122.9 million.
- The most likely range of recovery, where 50 percent of all trials fell, is between $101.7 million and $144.2 million.
- While the contractor's claim totals $254.5 million, 90 percent of all trials fell below a recovery of $162.8 million.
- Similarly, while the owner's lowest assessed exposure was $3.0 million, 90 percent of all trials showed an exposure greater than $83.3 million.

Depending on client needs, these simulated recovery values provide an owner or contractor invaluable information in settling a claim by assessing an owner's potential exposure or a contractor's most likely recovery in arbitration or litigation.

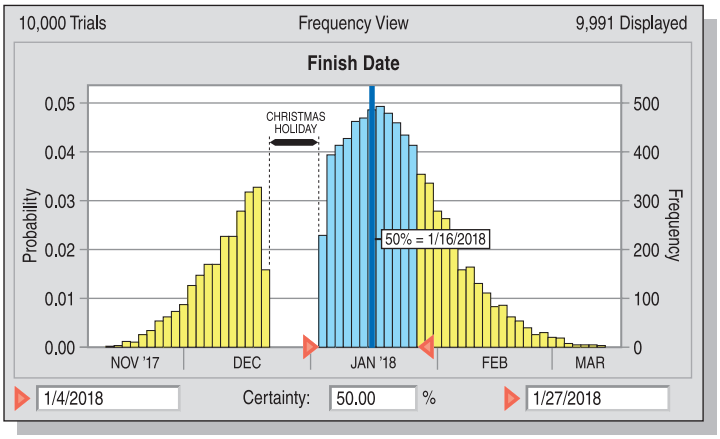
Static Model of Contractor's Claims and Owner's Counterclaims and Distribution Criteria

Description	Claim Amount	Most Likely Value	Low Value	High Value	Monte Carlo Simulation Distribution
Contractor's Claims	**$254.5**	**$138.0**	**$50.0**	**$254.5**	
Loss of Productivity	$151.0	$102.0	$40.0	$151.0	Triangular
Delay Damages	$37.0	$16.0	$0.0	$37.0	Triangular - Delay Dependent Variable
CO 4 - Design Changes	$26.5	$0.0	$0.0	$26.5	70% No Recovery / 30% Full Recovery
Unapproved Change Orders	$40.0	$20.0	$10.0	$40.0	Triangular
Owner's Counterclaims	**$47.0**	**$23.5**	**$47.0**	**$0.0**	
Liquidated Damages	$32.0	$16.0	$32.0	$0.0	Triangular - Delay Dependent Variable
Completion Costs	$15.0	$7.5	$15.0	$0.0	Triangular
Total	**$207.5**	**$114.5**	**$3.0**	**$254.5**	

Example 2: Project Completion Date

Monte Carlo simulations are valuable for project planning. In Example 2, a contractor wants to estimate the likely project completion date given estimated man-hours but using variable manpower, labor productivity, and percentage of scope growth.

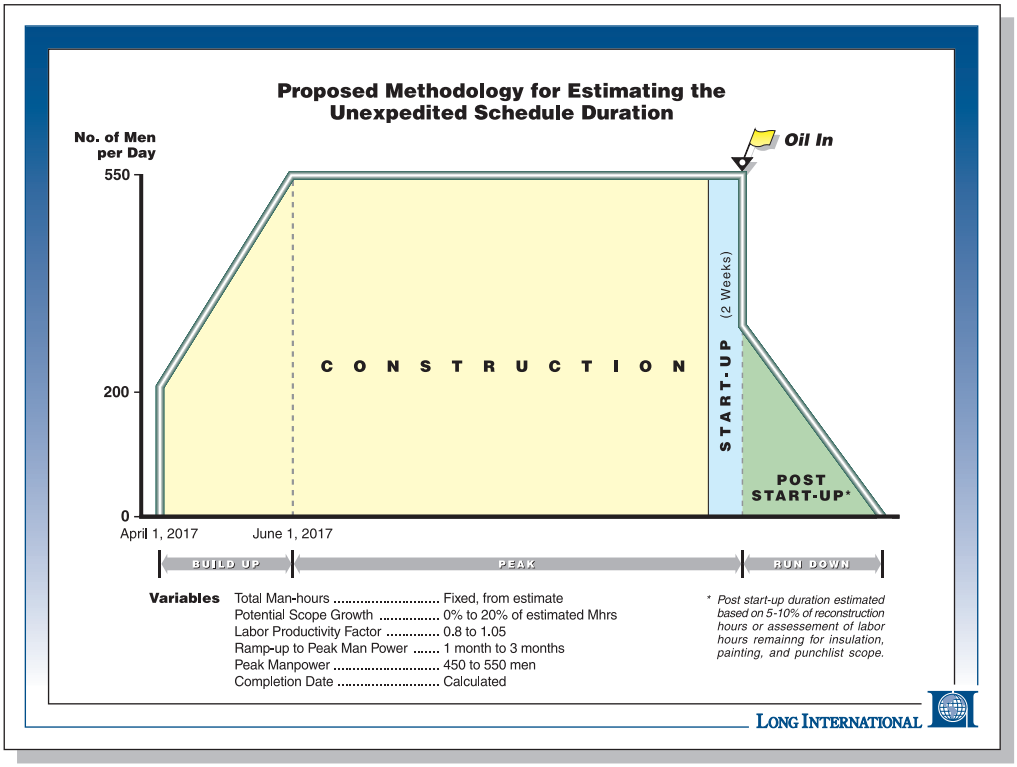
Completion Date/Probability Chart



To evaluate the effect of manpower utilization, we develop a simple model of construction manpower, from mobilization through post startup. Given user-defined ranges of manpower utilization during the build-up, peak, and run-down periods of construction and start-up, the Monte Carlo simulation, run with 10,000 trials, provides the project completion date distribution shown in the Completion Date/Probability chart.

The simulation found that the most likely project completion date was 16 January 2018, and 50 percent of all trials fell between 4 January 2018 and 27 January 2018. If, for example, the contractual completion date was before Christmas, the contractor may have to adjust its manpower assumptions or incur liquidated damages. Monte Carlo simulations allow easy answers to "what if" scenarios. In this case, when the peak manpower was fixed at 550 men, with all other variables remaining the same, most trials ended in December 2017.

We can use similar schedule-related models to forecast completion dates based on variables such as delays, manpower availability, productivity, equipment and material delivery date uncertainties, and other schedule-related issues.



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