Next Generation Risk Analysis for Oil & Gas Capex Planning

By Dr. Dan Patterson dpatterson@pmfocus.com

Introduction

The science of project planning has somewhat of a tenuous reputation at best. How often do large oil and gas Capital Expenditure (Capex) projects really come in as per the plan? Almost never. Even during this era of digital transformation, project schedule and cost overruns are still more the norm than they are the exception.

Arguably, the reason for this is less about poor execution and more about the fact, that as an industry, we still struggle with accurately forecasting how long these complex capital expenditure projects will actually take to complete. The root cause being less to do with the likes of CPM-based techniques not being fit for purpose but instead simply due to inaccurate data being fed into such plans. Feed in overly optimistic durations into a CPM schedule and guess what – the forecasted completion date for the project will in turn be overly optimistic and rarely achievable.

To improve our forecasting capability, we need to do a better job of defining how long work **really** takes. This can be inherently challenging when building a construction schedule as the scope of work, quantities and specific deliverables are often not 100% defined during the time at which the plan is developed.

In recent years, initiatives such as cost/schedule risk workshops (CSRAs) have helped drive realism into capex forecasts but these measures have typically been reactive (simply applying contingency to a forecast) rather than actually establishing a more achievable and realistic forecast up front as part of the planning process itself.

With the advent of technologies such as Artificial Intelligence and the simple realization that it takes the expertise of a specialist team to build a plan, rather than a planner working in a silo, the tide is finally turning with regards to more accurate project forecasting.

CPM Planning in the Oil & Gas Industry

Owner oil and gas organizations and Engineering Procurement Construction (EPC) contractors have long relied on Critical Path Method (CPM) plans to help forecast completion of their investment before project completion/start of the operating asset lifecycle.

CPM is based on a very simple premise: break down the scope of a project into activities; estimate how long these activities will take; link these into a sequence and

from this we can calculate the total duration of all work leading to project completion.

Of course, there are some additional layers of complexity involved such as working calendars, critical and non-critical path(s) and associated float etc., but at the end of the day, the CPM-forecasted project completion is entirely driven by **sequence of work** and **how long this work will take**.

Getting owners and EPC contractors to agree on these sequences and durations, however, is a real challenge. What is needed is a more collaborative approach to owner/EPC contractor information sharing to help alignment.

Determining Sequence of Work

In a CPM schedule, sequence of work is modeled using four different types of what are known as precedence logic types (Finish to Start, Start to Start, Finish to Finish and the dubious Start to Finish). These logic links define hard rules as to the sequence of work e.g. "we can't lay the decking before we have completed the underlying structure". In many ways, defining such sequence is easier than determining durations as it is a simple logical definition of the order in which things can be built. Knowledge of such sequencing typically resides with the expertise of the field execution team through their experience on prior projects. Historically, modeling sequence has not been the biggest bottleneck in planning – that falls under "Forecasting Durations".

Accurately Forecasting How Long Work Will Take (Durations)

Accurately forecasting activity durations is just plain difficult – period. Why? Well, the problem lies with the fact there are multiple influencers on duration:

- Productivity rates
- Number of personnel/crews working
- How much work is there to do & what are the quantities involved?
- External factors such as weather or availability of materials
- Differing perspectives from both the owner and EPC Contractor

All of these drive uncertainty and variability of duration. It's no wonder CPM plans suffer from poor accuracy. It's easier for us to forecast by **not** taking into account these variables and simply assume everything will work out OK. The downside to this though is that we then end up with a **best-case** forecast rather than a **most-likely** forecast. If we march our project to a best-case target, we are much more likely to fail as we are unfairly benchmarking against a highly unlikely outcome.

How Risk Analysis Helps

In the past decade, risk analysis, specifically in the form of Monte Carlo simulation has become widely accepted as a means of moving from 'best-case' planning to

'most-likely'. In simple terms, the Monte Carlo analysis simulates a very high number of potential project outcomes accounting for the huge number of possible variations in activity durations. The mathematics behind Monte Carlo is simple and defendable. What has been an ongoing challenge though is how best to capture and model the inputs needed for a Monte Carlo simulation.

In each simulation iteration, a given duration is selected from a range of values and applied to the CPM schedule. This range is typically defined using what is known as a 3-point estimate comprising a minimum, most likely and maximum value. Again, while this is mathematically sound, getting a team member or discipline lead to define such a range in the form of say a 3-point triangular or 2-point uniform distribution quickly leads to you being marched out of the room under a cloud of ridicule!

To date, the problem hasn't been in the mathematical modeling – instead it has been due to software tool vendors not making the risk and uncertainty capturing process more meaningful to the project team.

Next Generation Risk Analysis

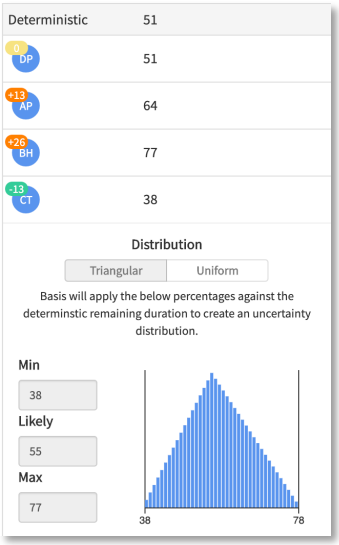
To help address the challenge of developing a meaningful risk model, a more team-centric and collaborative means of capturing risk and uncertainty inputs has been developed along with more easily consumable and actionable risk reports.

Let the Software Compile the Uncertainty Ranges for You

Rather than force team members down the "describe the range of outcomes as a distribution approach", instead why not capture such expert opinion through a simple scorecard? Simply ask team members to either buy-in or push back on the proposed durations.

As multiple team members provide similar or even differing opinions, each of these inputs can be combined to automatically generate the uncertainty distribution. This distribution can then be fed into the Monte Carlo model for analysis.

Team Member "Buy-In Scorecard"



Computer Generated Uncertainty Range

This approach carries the massive benefit of making the expert opinion and knowledge capture process very fast and easy for contributors while still retaining the underlying modeling methodology. This approach also better ensures that the total consensus of the team is accounted for in the risk model rather than being 'the voice of one'.

Relating back to the challenge of owner/EPC contractor alignment, this concept of consensus-based planning hugely helps drive alignment which in turn drives buy-in and ultimately drives the project's chances of on-time completion. As more projects start to adopt the highly collaborative contracting model known as Integrated Project Delivery (IPD), the differing opinions from multiple project stakeholders are being better captured and represented.

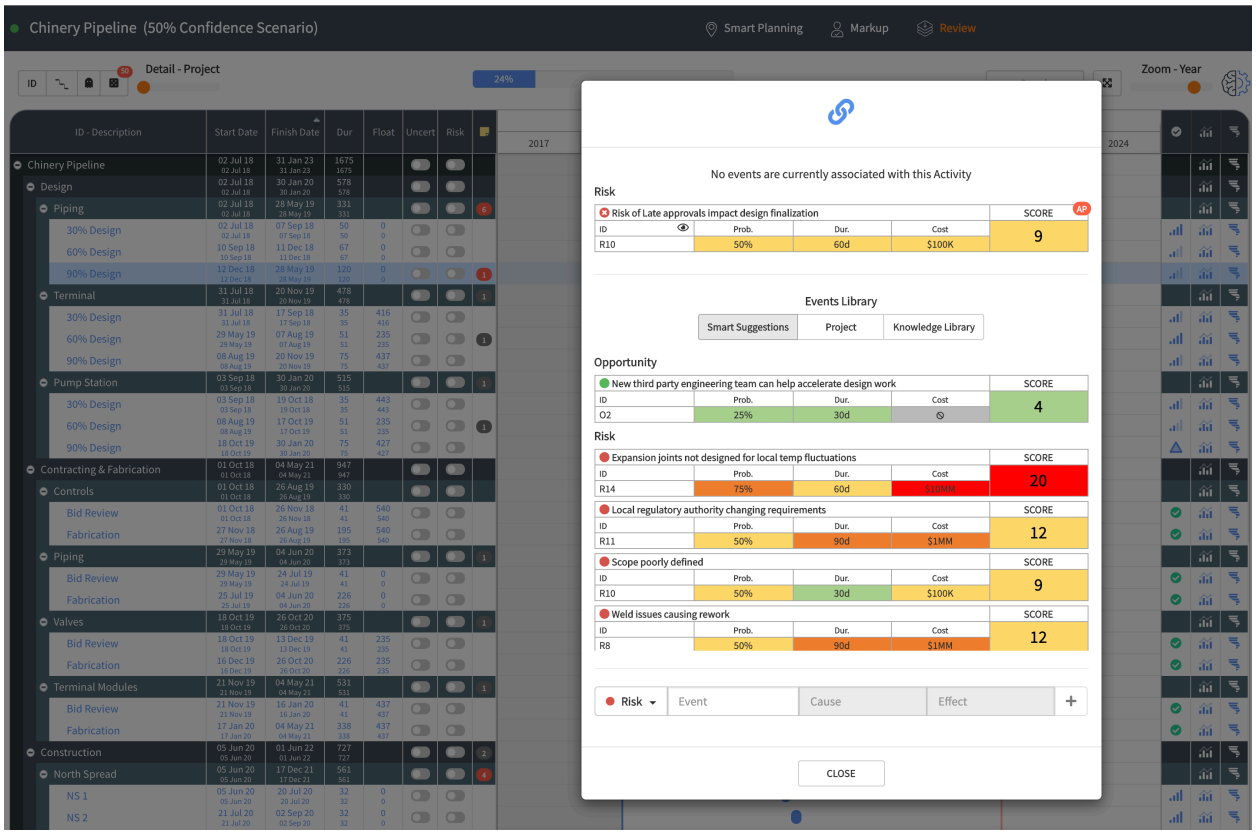
Use Artificial Intelligence (AI) to Help Establish Your Risk Register

In addition to more efficiently capturing duration ranges through the approach described above, the second step in the risk model building process is to capture and quantify risk events.

Traditionally, risk events have been tracked in what is known as a project risk register. Risk registers themselves are fundamentally sound and well proven in the field. Where the modeling challenge arises is in the linking those identified risks from the risk register into the schedule risk model. Without overstating – this process is treacherous at best and one that causes huge challenges in project risk workshops.

So instead of identifying risks in isolation of the schedule and then trying to embed them back in, why not provide an environment where risks are both identified and scored directly in context of the schedule itself?

Taking this a step further, by leveraging AI, team members can take also advantage of the computer making suggestions as to common risks and their historical impact on similar scopes of work.



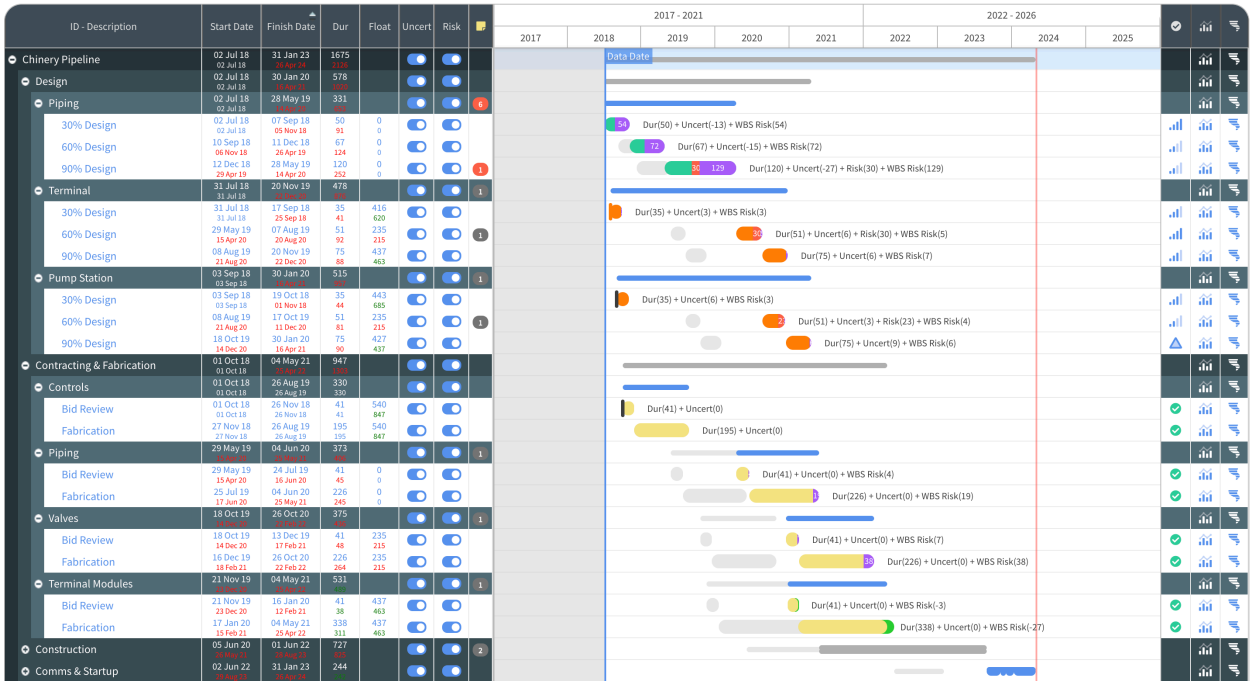
AI-Driven Guidance on Risk Event Identification

Rather than team members having to brainstorm from a blank sheet of paper, they can take into account previously realized risks and opportunities from similar historical projects. Not only that, but as new risks are identified, they can be automatically added to the enterprise risk register ready for subsequent consumption the next time around. This self-perpetuating risk management loop is an entirely new and more effective way for an organization to become more risk mature.

Meaningful Risk Exposure Insight

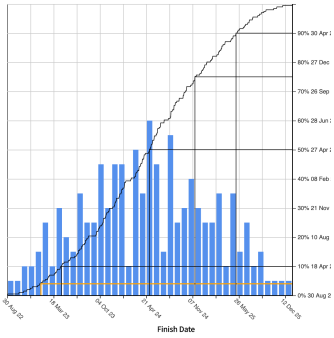
Overcoming the complexity of the risk data capture process has been addressed above. Once analysis is complete, reporting the meaning of the results is key. Traditional risk reports have tended to be statistical in nature referring back to the likes of probabilities and correlations – all very interesting but in reality, how

useful? Wouldn't it be more useful to simply understand "what is our risk exposure on this project?", "what is causing this exposure?" and "what can be done to mitigate and reduce this?"

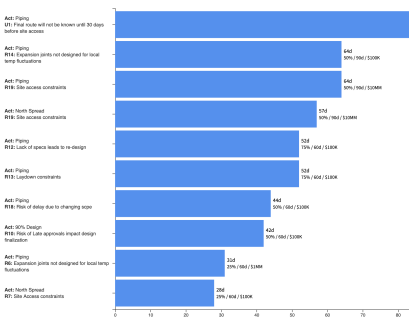


Example of a Risk-Adjusted Schedule Accounting for Uncertainty & Identified Risk Events

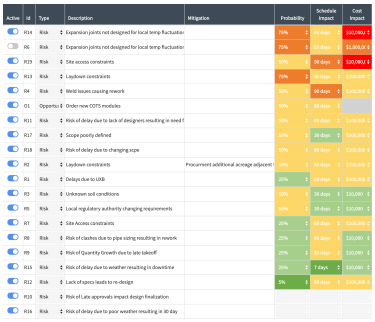
One of the biggest drawbacks of traditional project risk management has been that risk analysis has been conducted not only as a separate exercise to the planning process, but worse, it is conducted in a separate software tool. This makes little sense. Instead, the processes of building a CPM schedule and risk analysis should be combined into one. By accounting for risk and uncertainty during the schedule development itself, we start to move towards true risk adjusted forecasting – we can make more informed decisions if we have an up-front understanding of risk hot spots.



What is My Risk Exposure?



What is Driving My Exposure?



Enterprise Risk Register

Elaborating on smarter risk reporting, focusing on required contingency to overcome risk exposure as well as highlighting whether specific risk events or areas of schedule aggressiveness are most driving on-time completion exposure is a much more meaningful way to report risk than has been previously possible.

Risk-Adjusted Forecasting is Applicable to All Project Stakeholders

Historically, project risk analysis has been a luxury available to only the larger project organizations and typically embraced more by owner organizations than EPC contractors. The advent of next-generation risk-adjusted forecasting software is opening up the benefits of risk insight to the masses. By combining the data mining power of AI with a mindset change with regards to incorporating team member expert opinion, risk modeling is making huge strides forward.

Contractor organizations can now benefit from determining applicable contingency along with appropriate margin when developing their commercial bids. In short, contractors can ensure they are more competitive by following this risk adjusted forecasting approach.

Likewise, owners now get more insight into the realism and achievability of contractor schedules and so can react and remediate faster if contingency burn-down starts to accelerate beyond an acceptable tolerance.

In all instances, the benefit of providing a much easier means of capturing risk inputs; applying them to a proven approach using Monte Carlo simulation and then deeper and more meaningful insight through next generation risk reporting is hard to argue against.

The long overdue marriage between CPM project planning and Monte Carlo-based risk analysis is finally becoming a reality. By helping more accurately forecast project schedules as well as drive more on-time project completion, this culmination of proven practices becomes a marriage made in heaven.