NAC Executive Insights

Assumption, Risk Driver and Constraint Tracking

Key Points

- Assumption migration is identified as a key risk driver in large scale, long duration projects.
- The full potential of risk drivers may not be understood without an understanding of the dynamic nature of the program execution.
- Programmatic impacts resulting from constraint-coupled projects and activities can have significant performance results, and, as such, constraints, both first order and second order, should be routinely identified and tracked.

Assumption, Risk Driver, and Constraint Tracking

As we have seen, large, long duration engineering and construction programs are susceptible to assumption migration, changing risk drivers over time, and the impacts of second tier constraints, which may emerge or disappear throughout the program's lifetime. Let's look at each of these in turn.

Assumption Migration

Assumptions are an inherent part of risk assessment and contingency planning in the engineering and construction industry. In short duration projects, these assumptions are usually considered to have some reasonably well-defined mean value and a standard deviation or uncertainty over the short term that is both able to be modeled and is manageable. The situation in longer duration programs, however, is very different as assumptions inherent in the program have a longer time frame over which to change. Standard deviations, for example on real labor or commodity annualized cost changes based on short- or longer-term time series, may be valid for assessing uncertainty over a short duration project yet can be misleading in longer duration programs.

The program manager must be concerned not with the annualized cost change but rather with the total cost change over the extended program time horizon. Using standard deviation as a measure of uncertainty, we see the standard deviation of cost increases with the time horizon because of the effects of compounding. While the standard deviation of the annualized cost change rate decreases (in proportion to the square root of the program duration) as program length increases, the standard deviation of the total compounded cost actually increases (in proportion to the square root of the program duration). This means that a 16-year program is four times as uncertain as a one-year project if we measure uncertainty as the standard deviation of the continuously compounded total cost.

Similarly, assumption migration can be driven by regulatory, technology, and other factors.

The key is not alternative risk modeling, although a multiplicity of techniques may help to better understand the impacts of key assumptions. Rather, it is about tracking in a systematic way the assumptions that underpin a program's execution plan and risk model and establishing acceptable bandwidths before risk and program reevaluation is undertaken. This point applies equally to the tracking of changing risk drivers and constraints discussed in the next sections.

Changing Risk Drivers

Identification of top risks is a typical project-level risk assessment output that has been carried over into a program environment. The complexity and duration of major engineering and construction programs, however, require a deeper understanding of those risk drivers that have the potential to become significant influencers of program outcomes. This is a different question than the one currently answered in the industry today.

Large, complex, long duration engineering and construction programs must recognize the dynamic nature of the program environment and realize that different risk drivers will gain prominence at different points in a program's lifetime. Additionally, the potential of these discrete risk drivers may change as program execution strategies and results evolve and other constraints or assumptions similarly change.

Finally, the full potential of risk drivers may not be understood without an understanding of the dynamic nature of the program execution model we have built through our program planning efforts.

In order to address these concerns, we need to increase our focus on three areas:

1. Gaining a more comprehensive identification and understanding of risk drivers and their potential impacts in the extremes.
2. Tracking these risk drivers through the program until the point where their potentially extreme impacts can no longer come into play.
3. Scanning for new candidate risk drivers that may emerge over the program's life.

More comprehensive identification and understanding can be developed through the combination of several risk assessment strategies. Scenario analysis helps identify significant risk drivers that may have low probabilities but potentially extreme impacts. Complexity analysis can aid in identification of those areas of a program where complexity is increasing throughout the life of the program. Failure Mode and Effects Analysis (FMEA) also bubbles up a number of extreme impact risks, assigning higher risk priority numbers for risks harder to detect.

In some instances, systems dynamic modeling may be appropriate in order to better understand how policies, decisions, structures, and delays impact a program's overall risk level and, by extension, its outcome.

Constraint Coupling

At both a project as well as a program level, good managers seek out and identify constraints that will directly affect their respective efforts. That search is typically:

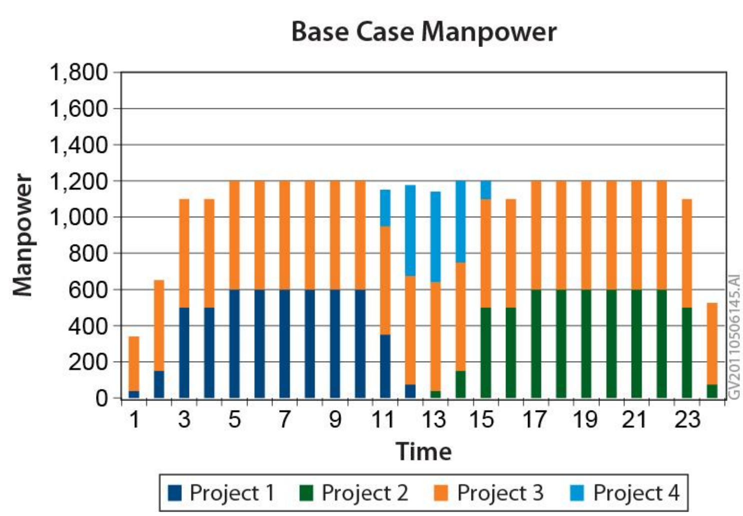
- Based on the original program or project execution plan.
- Rarely, routinely updated, as the day-to-day demands of the program or project take attention off a continuous planning cycle.

Original program execution plans may change, however, and even impacts off the critical path can have significant impacts on overall program performance because of constraint coupling.

Let's look again at the simple example of a four-project program to illustrate the point:

- Project 1 is an enabling project, not on the critical path. It has a twelve-month duration and, because of sequencing constraints, does not lend itself to acceleration.
- Project 2 is interdependent with Project 1 and cannot be initiated until Project 1 is substantively complete. The baseline plan showed it as not starting until after Project 1 is complete, but it could have been started two months earlier since Project 1 is substantively complete.
- Project 3 represents the critical path efforts, and project labor on this project element is constrained at 600 as a condition of permitting.
- Project 4 is seasonal related work that cannot be rescheduled but is generally independent of other project linkages—except constraints related to overall labor availability.
- Total labor available to all project programs in any period is capped at 1,200 as labor is in short supply and multi-owner labor agreements have been executed to eliminate poaching and an uncontrolled wage spiral.

The planned manpower loading is as shown.



Subsequent to program initiation, a change is identified in Project 1 that will cause a suspension in construction and other related activities at the end of month four. This hiatus will last for two months, but Project 1 is not on the critical path. The project manager has indicated he can control costs, so there is no cost increase and no increased labor requirement, although the project schedule will be two months longer.

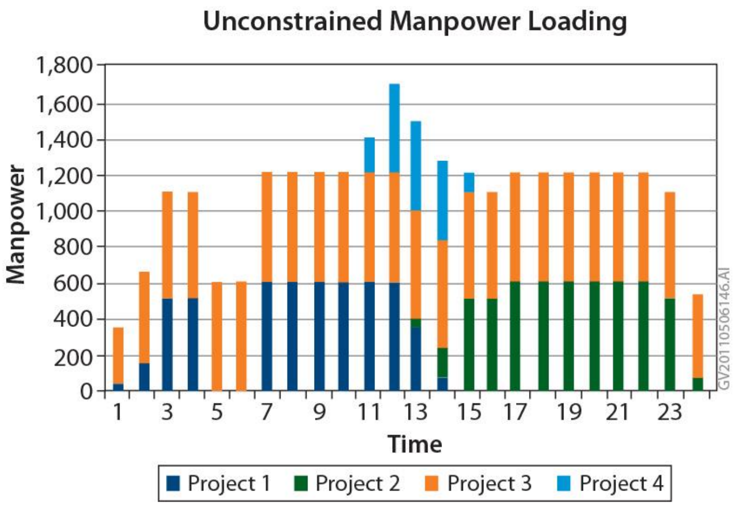
The project manager for Project 2 is consulted and indicates that he could accommodate a two-month slippage in

Project 1 since the precedent work he requires would be completed in time for him to begin. From a "direct" project interface perspective, neither Projects 3 nor 4 were dependent on Project 1.

The various program management elements need to look deeper than just "direct" interfaces and to some of the constraints that exist in the "white space" between projects or at a program level.

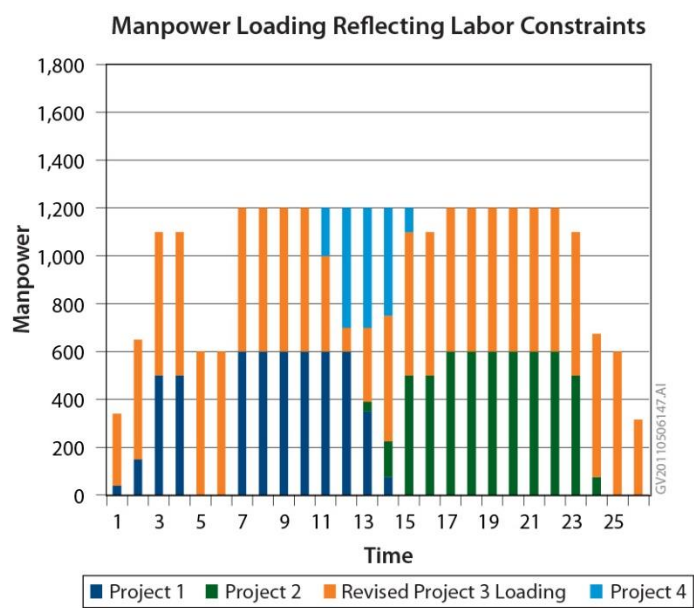
As a first step in that direction, the revised manpower loading in an unconstrained scenario is identified.

This initial look shows the overall critical path end date being maintained, but only with manpower loading in excess of the overall 1,200 constraint placed on the program. Without such a programmatic viewpoint, it may not be self-evident that the change proposed for Project 1 would cause the program to violate one of its constraints.



Attention now turns to executing the changed program while still meeting both the overall program 1,200-person constraint and Project 3's 600-person constraint. This loading shows that program completion is delayed by two months despite the fact that Project 1 is not on the critical path.

The example is simple, but the point is not. Programmatic impacts resulting from constraint-coupled projects and activities can have significant performance results, and as such, constraints, both first order and second order, should be routinely identified and tracked. Potential constraints affecting international scale engineering and construction programs today include:



- **Common global demand drivers for natural resources and primary materials –** Large, rapidly growing, developing countries represent emerging market shifting drivers for the materials of construction.
- **Energy security –** Potential threats to energy security from both state and non-state actors. Energy flows through the Straits of Hormuz and Malacca are growing (over half of all seaborne oil) and are increasingly vulnerable to disruption from terrorists, piracy, or accidental events.

- **Shortage of heavy marine transport –** New construction strategies of prefabrication and modularization as well as the reconfiguration of the world's heavy industrial base carry a requirement for specialized heavy marine transport. Increasingly, therefore, a megaproject today needs to understand the logistics risks of movement of materials of supply from source to use and actively manage risks that are many times unseen and hidden away in often ignored shipping schedules.
- **Supply disruption from natural events in major areas of supply –** Many areas that represent critical raw, intermediate, or final supply sources are vulnerable to the disruptive effects of natural events or disasters. For example, consider each of the following potential scenarios and the impact they would have on major construction programs globally:
  - Major cyclone causes extensive damage to iron ore exporting facilities in Western Australia.
  - Category 5 hurricane destroys refinery capacity on a scale comparable to or in excess of that experienced after Hurricane Katrina.
  - Major earthquake causes destructive damage to copper exporting ports in Chile and Peru.
- **Flawed industry financing model –** Today we are sensitive to the fact that insurance does not change underlying risks, but rather reallocates them. Key however is the ability of the risk assuming party to actually absorb these risks when they materialize. Systemic events, or said differently, highly correlated industry financial risks, actually limit the effectiveness of such risk transfer.
- **Supply chain "friction" from global events of scale –** In the last decades, we have witnessed the impacts SARs, bird flu, and the increased security regimes that flowed from the 9/11 attacks have had on the efficient movement of people and goods. We live in an increasingly networked world, and the events in one part can affect the supply chain both globally and permanently. The global economy is becoming increasingly networked and as such the risks associated with such "frictional" events is only likely to increase in frequency and severity.
- **General disruption of major supply chains –** In the past, we worried about labor strife or political expropriation principally at our construction sites. Today, disruptions can occur globally, including in areas other than our sources of supply or sites of construction. The impacts can be as severe as the risks are unobvious. A strike in a shipyard in Korea might delay a specialized marine vessel required for delivery of modules fabricated in China for use in a project in Australia. Changed visa requirements may limit the third-country labor supply necessary to complete fabrication of components for a major project supplier.

These and other constraints related to labor, material, energy, and financial and informational flows must be considered in order to understand how they may effectively "couple" various program activities.

Reference

The GIGA Factor; Program Management in the Engineering & Construction Industry; CMAA; ISBN 978-1-938014-99-4; 2011

About the Author

Bob Prieto was elected to the National Academy of Construction in 2011. He is a senior executive who is effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering, and construction industries.