// A Fresh Take on Project Forensics

Enhanced Schedule Delay Forensics through Project Metrics and Ribbon Analysis

Dr. Dan Patterson, PMP

CEO & President, Acumen

October 2010

ACUMEN

Proven Project Analytics

+1 512 291 6261 // info@projectacumen.com

www.projectacumen.com

Table of Contents

Introduction

The business of schedule claims is both an art and a science. This paper discusses how an analytical approach to schedule forensics using metric analysis results in a highly effective means of determining the root cause and resultant damaging impact as part of the project claims process. The technique can be used by owners or contractors alike during arbitration and litigation cases.

In a perfect scenario, the need for either owner or contactor-driven claims arguably wouldn't arise. If the baseline or "as-planned" schedule was both highly accurate in its execution forecast and then precisely adhered to during execution, without interference or change, then post-execution disputes would be moot.[1]

However, in reality, this is rarely the case. This paper introduces a technique that helps with determining root cause of project delays resulting in claims.

Types of Claims

Claims typically arise from several project events including:

- Delays
- Disruption
- Acceleration
- Change in scope
- Differing site conditions
- Termination

While these types of project claims are well defined and documented, the means by which the root cause of the effect of such claims is resolved is often source for much dispute and interpretation. This paper focuses on how metric analysis can assist with the first four types of claim (delays, disruption, acceleration and change in scope). The modeling of all four of these is heavily dependent on CPM scheduling techniques.

"As-planned" and "As-built" Scenarios

Schedules can be generally classified as either "as-planned" or "as-built".
The "as-planned" or baseline schedule needs to comply with contract requirements; accurately represent the agreed upon scope of work depict the contractor's plan and represent a plan that is constructible with a reasonable critical path[2].

---

[1] See "Improving Project Plans using a Schedule Maturity Framework" at www.projectacumen.com/resources/whitepapers to learn more about how to build sound project schedules during the planning phase of a project

[2] Construction Delays 2nd Edition, Theodore Trauner, ISBN 1856176770

The "as-built" schedule needs to accurately reflect any changes and/or status updates made as a result of execution of work. During a project lifecycle, there may be several as-built or statused schedules reflective of multiple points in time.

The key to successful claims analysis and the accurate determination of cause is to have a sound basis of schedule for both the "as-planned" as well as multiple "as-built" scenarios depicting changes over time. With such a detailed history of how the schedule evolves during the project comes the ability to essentially walk back through time, and determine where, when and why deviation from the "as planned" scenario occurred. Drivers of these changes can be determined using various techniques that focus on variances between these scenarios.

Delay Analysis

Delay analysis can be categorized as follows:

Foresight Methods:

Focus on 'as-planned scenarios' and compare the 'impacted as-planned', which includes only owner-caused delays, with the 'adjusted as-planned', which includes only contractor caused delays. Foresight methods ignore as-built history and therefore has little basis on as-built reality.

Hindsight Methods:

Focus on 'as-built' scenarios and compare the as-built delayed schedule to that of the collapsed as-built (equivalent as-built schedule with delays removed). Hindsight methods don't account for variations from the original baseline plan.

Contemporaneous Methods:

Focus on updated and statused snapshots of the schedule. Typically this includes the original as-planned schedule and then a succession of updated 'as-builts' over time. The key to a contemporaneous schedule is that it reflects both scope changes (reflected in changes to activities, durations, sequence of work etc.) as well as status updates (reflection of contractor performance). By capturing both scope change and performance, the relative impact of both can be ascertained. The Contemporaneous method can be executed using what is known as a Time Impact Analysis (TIA) or a Window Analysis.

Time Impact Analysis is based on a single snapshot of a statused or updated schedule. By updating activities to reflect actual durations and/or adding activities to reflect delay periods, the knock-on effect to the critical path and other downstream activities in the schedule can be determined. Delays due to either scope change or under performance are then determined by comparing back to the "as planned or baseline".

Window Analysis on the other hand, utilizes snapshots of a schedule captured throughout the project lifecycle through to the point of the contentious delay. By comparing the critical path between these snapshots, the point at which the path changes can be determined.

Additional techniques including Half Step, Impacted as Planned and Collapsed As Built all drive towards the same objective: to pinpoint where and when variances from an agreed upon plan occur, and from this determine why these variances came about. In short, the various modeling techniques, through additive or subtractive updates to a given scenario, all provide a comparison against which the cause and ownership of delay can be better understood.

Liability of Delay

Delays and resultant claims can be identified as either owned by the contractor or the owner of the project. Figure 1 shows the different scenarios that lead to either scenario for the contractor or owner.

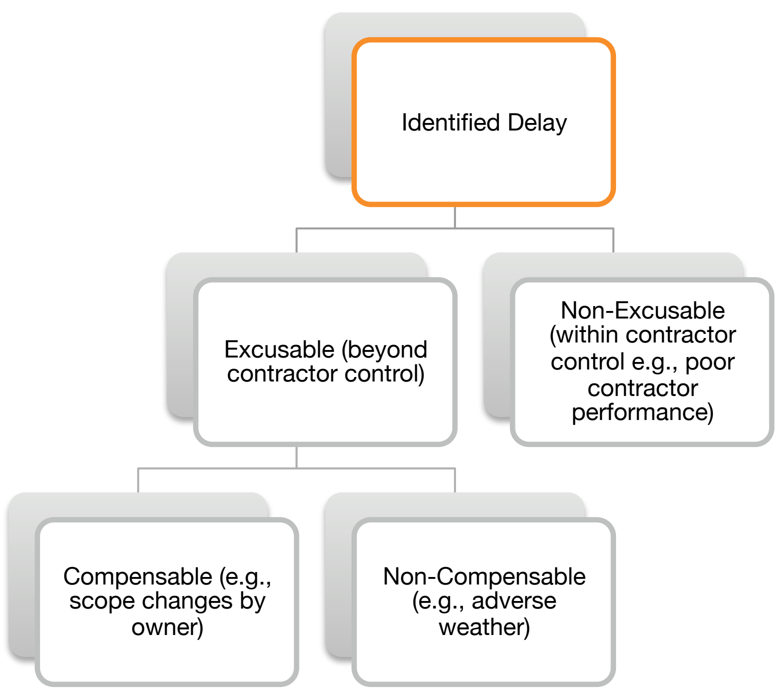

Figure 1 – Ownership of Delays

Once the driving delay activity(s) within a schedule are determined, causation analysis can be conducted to determine who is responsible for the delay. Such causation analysis typically relies heavily on researching of project documents, review of communication threads, expert witness testimonials etc.

Why are Delay Claims so Complex?

Delay claims tend to be complex; however it is not necessarily because of actual determination of cause (i.e., ownership). More often delay claim complexity is due to the complex process of determining where and when (i.e., which activities) in the project actually caused the delay. In other words, determining what starting activity in the overall sequence of work actually caused a knock-on delay effect through the schedule and therefore caused an overall project delay.

How Can Metric Analysis and Ribbon Visualization Help?

The previously described techniques all strive to pinpoint variances between scenarios (e.g., as planned and as-built). A combination of metric analysis and a visualization technique called Project Ribbons can provide a quick, easy and yet highly accurate and insightful means of achieving this goal.

A white paper titled "Project Simplification Through Metric Analysis" published in 2009 [3] introduced the concept of applying project metrics to 'ribbons' or groupings of project data. In summary, ribbons are a means of rotating long, vertical, multi-page Gantt charts into more horizontal groupings of activities (based on a given criteria) so as to better visualize sequence of work throughout a project.

Figure 2 – Example of Schedule Quality Forensic Analysis4

Figure 2 shows an example of a schedule quality assessment conducted against a single project. Slicing the project into phases allows for viewing the likes of total float by

[3] Project Simplification Though Metric Analysis" White Paper authored by Dr Dan Patterson, October 2009, www.projectacumen.com/resources/whitepapers

[4] Screenshot of Acumen Fuse®, a metric analysis and visualization tool. www.projectacumen.com/fuse

phase and pinpointing specific schedule shortcomings. An overall quality score can be achieved through the use of a quality scorecard.

Taking this a step further, and ribbonizing by, for example, “critical” and “non-critical” activities and subsequently applying performance-based metrics such as “delayed”, “accelerated”, “on-time”, analysts have the ability to slice and dice projects and pinpoint bottlenecks and starting points for delay. Further, by slicing ribbons by time periods, additional pinpointing of issues with respect to time can also be achieved. So not only can delay-associated characteristics be determined for groupings of activities or scenario comparisons as a whole but now delays can also be pinpointed within a specific time period or phase of a project.

Figure 3 shows a second example project ribbonized by critical and non-critical activities with sample delay-based metrics applied (comparison between the “as-planned”/baseline dates and the “as-built”/statused schedule). From the analysis, it can be seen that only two activities were completed delayed (specifically in 2009) but more importantly, those two activities (Feasibility Study and Peer Review) were both critical and hence had an impact on the downstream activities in the schedule (hence impacting the completion date).

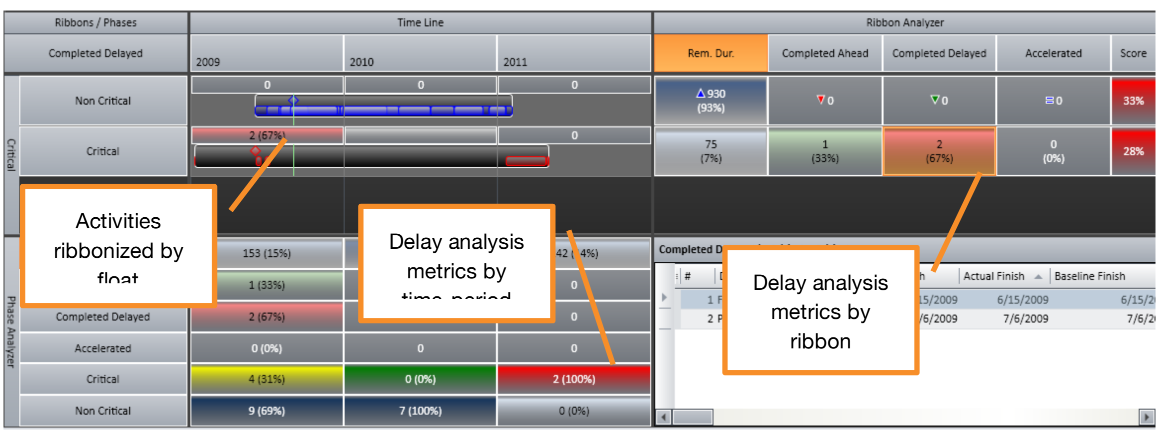

Figure 3 – Example Ribbon Analysis

Using Ribbon Metric Analysis to Compare Project Scenarios

The true value of ribbon metric analysis comes with the ability to compare multiple instances, snapshots, or scenarios of a project such as comparing “As-planned” with “Impacted As-planned”. Consider an example whereby a contractor and owner are in dispute over a delayed and over-budget project. The contractor is claiming that the delays were a result of scope changes made by the owner; the owner is claiming the scope changes had no bearing on the delays and instead the delays were caused by poor execution of critical path work.

Firstly, consider the contractors claim of scope change: a comparison between the contractually agreed upon "as planned" schedule was compared to a mutually agreed "as planned update reflecting the scope changes". Figures 4a, b and c show lists of the changes made to the schedule including changed durations, an added activity ("remedial") and modified logic.

ID	Description	As-Planned.plan	As-Planned-new-scope.plan
8140	Engineering	35	32
8150	FEED	15	20
8160	Detailed Design	25	
8170	Procurement	60	
8180	Early Long Lead	60	
8190	Other	30	
8200	Construction	75	
8220	Civils	45	
8250	Commissioning	30	
8260	Phase I	20	
8270	Phase II	10	
8290	TOTAL Project	170	
8300	Remedial		

Increases and decreases to specific activity durations

Newly added activity

Figure 4a – Changed Durations

Id	Predecessor	Id	Successor	As-Planned.plan	As-Planned-new-sco...
8130	Project Start	8160	Detailed Design	FinishToStart (0.02)	FinishToStart (0.03)
8160	Detailed Design	8190	Other	FinishToStart (0)	FinishToStart (0.01)
8220	Civils	8300	Remedial		
8300	Remedial	8260	Phase I		

Changes to logic

Figure 4b – Modified Logic

ID	Description	Maximum Lag	As-Planned.plan	As-Planned-new-sco...
8130	Project Start	10	10	
8160	Detailed Design	0	0	
8220	Civils	0	0	
8300	Remedial	0		

Lags added to links

Figure 4c – Modified Lags

Figure 5 shows the impact of these scope changes to the planned schedule reflected using ribbons and metrics including:

- Increase to overall duration from 270 days to 302 days
- Forecasted project completion slipped from 18 June 2008 to 17 July 2008
- Number of critical activities – newly added "remedial" activity actually fell on the critical path
- Forecasted cost increased from $460K to $497K

- Average float for the entire project decreased – an indication of a more compressed and aggressive schedule
- Delayed activities – 9 activities experienced a delay relative to the original “as-planned”

Focusing on the delayed activities metric, the analysis revealed that a total of nine activities experienced a delay as a result of the scope changes. Further drilling down into the sequence of work showed that a newly introduced regulatory design review period driving the need for a lag to be added to the link between “FEED” and “detailed design” was the root cause of this knock-on effect for delay. Thus, even prior to the start of execution, the “as planned” schedule was unrealistic because it didn’t reflect the changes to scope added by the owner.

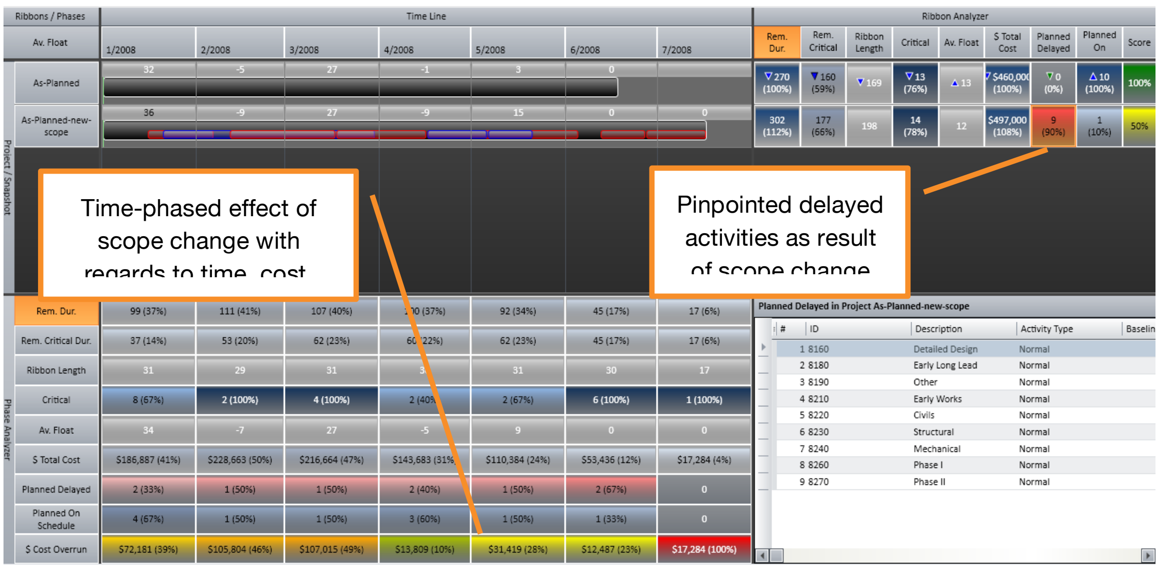

Figure 5 – Comparison between Original and Changed Scope Scenarios

Next consider the owners claim of poor performance: compare the “as-built” against both the original “as-planned” as well as the “updated plan reflecting the scope changes”.

As seen in Figure 6, comparison ribbon analysis showed the “As-Built” project completed on 10 July 2008 compared to the “As Planned” completion date of 18 June compared to the scope-adjusted “as planned” completion date of 17 July 2008.

Further analysis (figure 6) showed that while 4 activities experienced completion delays, only 2 of these were caused by poor performance (“Structural” and “mechanical”). The key to the analysis here was then to reveal that neither of these two under-performing activities were actually on the critical path. The first critical delaying activity was “Commissioning - Phase I” which was driven by the newly added “Remedial” activity (as determined by the scope variance analysis).

From this analysis, it was clear that while the “As-built” project completion did indeed come in later than the “As planned” forecast, the root cause of this was not the under-performing structural or mechanical activities but instead due to the change in scope with regards to the required remedial work. This insight resulted in the contractor not being liable for damages to the owner and instead the contractor being able to claim damages for the impact on their additional workload for the increase in scope.

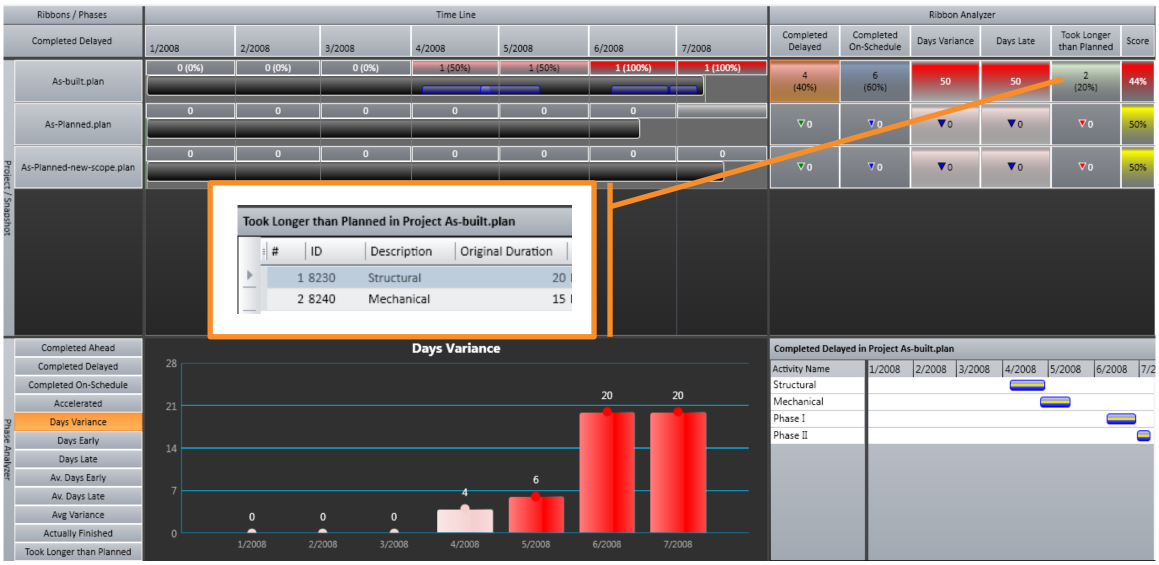

Figure 6 – Ribbon Analysis Pinpointing Delay Drivers

Cause and Effect Metrics

One of the benefits of a ribbon-based analysis is that the analysis can incorporate an unlimited number of variance and quality-based critiques. These critiques can then be used for pinpointing cause of delay as well as rolled up through the use of scorecards to give an overall big-picture into the effect/impact of the delay. Being able to hone in on specific individual metrics to determine root cause of variance as well as rolling up the combined effect of multiple delays into total scores for scenarios or even specific network paths within a project is hugely valuable.

While too numerous to list individually in this paper, metrics that help determine cause of delay for a ribbon analysis include:

- Quality of schedule: appropriate use of logic types, constraints and appropriate estimates.
- Changes to scope: determination of additions, deletions, or changes to activities, resource assignments, calendars etc. Compare these changes to variance in forecasted performance to determine impact of the scope changes.

- Changes to sequence of work: through path analysis determine which paths within a schedule changed and, more importantly, determine the impact of these changes with regards to available float. This provides a means of determining whether a changed sequence of work was truly a driver of the delay in question.
- Continuous Path Durations: determination of changes to the actual length of work or duration within given paths (e.g. the critical path may not change in scope or direction but the length of the continuation of work may have increased as a result of a change to scope).
- Variance of Near-critical Paths: While the critical path is the focus in a CPM schedule, insight into how many other near-critical paths and how these change as a results of delays help correlate cause and effect as a result of a delay.
- Questionable Logic: in addition to suffering from insufficient logic (in the form of missing logic), schedules can also fall foul of having overly complex and redundant logic. Identifying such redundant logic helps determine, for example, whether an "as planned" schedule has been artificially constructed thus not truly representing the sequence of work to be executed.
- Execution Performance: Being able to pinpoint trending and patterns of poor performance, for example, by a specific sub-contractor, is a powerful means of assigning cause across multiple delaying activities across multiple critical/non critical paths.

Conclusions

The science behind effective schedule delay analysis is heavily based upon CPM scheduling techniques resulting in comparisons and variances between multiple interpretations of planned and executed schedules.

Comparing such scenarios through the use of project ribbons and subsequently applying schedule quality, performance and delay-related metrics to these ribbons provides a unique means of truly understanding not only the effect of delay but more importantly, accurately pinpointing the root cause of such.
