33-WTR Construction Law. 6

Construction Lawyer
Winter, 2013

Scheduling

WHAT IS A SCHEDULE GOOD FOR? A STUDY OF ISSUES POSED BY SCHEDULES ON COMPLEX PROJECTS

Robert M. D'Onofrio, P.E., Anthony L. Meagher[a1]

Construction lawyers and scheduling consultants have long grappled with the various methods of analyzing schedule delays. Recently, efforts have been made to establish common nomenclature and consensus as to preferred methods. This article will further explore those efforts, make suggestions as to the application of preferred methods, and discuss related considerations in drafting contract schedule provisions.

Schedule Delay Analysis Methods

Various methods for analyzing schedule delay have existed since the implementation of critical path method (CPM) scheduling. Time impact analysis originated in the early 1960s as a prospective method for isolating and identifying delay in a project schedule and its relationship to past or current delays.[1] Although time impact analysis has long been the preferred method for identifying and quantifying delay impacts to a construction schedule,[2] a variety of different methods are frequently referred to as time impact analyses, regardless of whether they incorporate the contemporaneous updates or the principles of schedule delay analysis. In *Neal & Company v. United States,* for example, the contractor's expert called the schedule delay analysis method a "time-impact analysis," but the court determined the analysis was actually an "as-built analysis" and did not find it persuasive.[3] In *ADT Construction Group, Inc.*, the Board noted that the name of the method was not as important as how the delays are evaluated in the schedule.[4]

Different delay analysis methods are sometimes categorized in groups based on their impact, such as hindsight, foresight, or contemporaneous methods. Although the name given to a particular method is not important, a lack of standardized terminology has led to confusion.

The construction industry generally recognizes 14 distinct methods of schedule delay analysis. Those methods can be separated into five basic categories, each of which is explained briefly below.

Time Impact Analysis (TIA)

Properly Adjusted TIA Method. Delays are analyzed in slices of time just before and just after the period of the delay. Each slice of time is a schedule updated to incorporate as-built data, including all delays and any excusable time extensions through that slice of time. The change to the float values and the projected completion date in the schedule reflects the gain or loss of time between each slice of time.

Unadjusted TIA (Windows) Method. The Windows method is a type of TIA that uses "windows" to look at the slices of time in the project. The only difference between this method and the Properly Adjusted TIA is that the Windows method typically uses the schedule updates as they were submitted, and does not adjust the required contract completion date to reflect excusable delay as it occurs. Consequently, users of this method typically only acknowledge delay that falls on the longest path as opposed to any critical path.

Prospective TIA Method. The Prospective TIA method analyzes the project at a slice in time and projects the delay forward in the schedule. Often, these projections are based on estimates of delay in lieu of the actual delay duration during the project. In a forensic context, the actual delay duration is often used. This differs from the Properly Adjusted TIA because projecting delays (even if the actual delay duration is used) forward of the data date may produce a different result from keeping as-built delay durations to the left of the data date in the as-built portion of the schedule. A Prospective TIA is a way to adjust a schedule contemporaneously during contract performance if both parties can agree to the estimated delay impact and duration before the impact occurs.

Windows (Wide Periods) Method. This method is similar to the Windows method explained above. In this version, only select schedule updates are used in the analysis resulting in wider periods.

Collapsed As-Built Method

All methods in the Collapsed As-Built category utilize the as-built schedule and "collapse" it by removing delays to ***7** determine whether this will shorten the duration of the as-built schedule knowing what happened after the fact. This category is sometimes referred to as the "but-for" method, in that ""but for" one party's delay, the contractor would have finished at an earlier date. There are generally four distinct implementations of Collapsed As-Built. The four types of Collapsed As-Built methods vary by the manner in which the delays are removed and which party's delays are removed.

Category	**Method**
A. Time Impact Analysis (TIA)	1. Properly Adjusted TIA
	2. Unadjusted TIA (Windows)
	3. Prospective TIA
	4. Windows (Wide Periods)
B. Collapsed As-Built	5. Multiple Period Using Updates
	6. Collapsed Stepped Removal
	7. Remove Owner Delays
	8. Remove Contractor Delays
C. As-Built Critical Path	9. Critical Path Using Updates
	10. As-Built Path
D. Impacted As-Planned	11. Stepped Insertion
	12. Global Insertion
	13. Compare Owner/Contractor
E. Total Time	14. As-Planned vs. As-Built

Multiple Period Using Updates Method. This variation of the Collapsed As-Built category takes into account the schedule updates and measures the change in projected completion date after each collapse between schedule updates.[5]

Collapsed Stepped Removal Method. This version of the Collapsed As-Built category takes the as-built schedule with all the delays identified and removes each delay one at a time. The net effect on the end date of the shortened schedule after each delay removal is the impact of each delay. Both owner and contractor delays are removed in this version.

Remove Owner Delays Method. This version of the Collapsed As-Built category removes all the owner delays simultaneously to show when the project would have finished "but-for" the owner delays.

Remove Contractor Delays Method. This version of the Collapsed As-Built category removes all the contractor delays simultaneously to show when the project would have finished "but-for" the contractor delays.

As-Built Critical Path

Methods in the As-Built Critical Path category trace the critical path and duration of delays through the entire as-built schedule.

Critical Path Using Updates Method. This variation of the As-Built Critical Path category uses the schedule updates to identify the contemporaneous longest path, then adds up the as-built durations of delay along this path.

As-Built Path Method. The As-Built Path method uses the as-built schedule to identify the longest path through the project after the fact. Only delays that fall on the longest continuous path of as-built activities are considered to have impacted the project.

Impacted As-Planned

Methods in the Impacted As-Planned category utilize the baseline schedule and insert all the delays to show where the project would have finished had all the delays been known at the start of the project. There are generally four distinctly different implementations of Impacted As-Planned. The four methods of Impacted As-Planned vary by how the delays are inserted and which party's delays are inserted.

Stepped Insertion Method. In this version of the Impacted As-Planned category, the delays are inserted one at a time in chronological order. After each delay is inserted, the change to the projected completion date is measured and constitutes the impact attributable to that delay.

Global Insertion Method. This version of the Impacted As-Planned category inserts all delays simultaneously to see where the schedule would have finished had all delays been known at the start of the schedule.

Compare Owner I Contractor Method. In this version of the Impacted As-Planned category, two different baseline schedules are used. All owner delays are inserted into one schedule, and all contractor delays are inserted into the ***8** other schedule. The differences between the two independent projections are compared.

Total Time

As-Planned vs. As-Built Method. The Total Time, or As-Planned versus As-Built, method compares the as-planned schedule with the as-built schedule, and the total number of owner-caused delays occurring anywhere on the as-built schedule are claimed as excusable, compensable delay. Often, the entire difference between the as-planned and as-built schedules is attributed to the owner.

One area of significant concern about the 14 different methods of evaluating delay is that when the 14 methods are compared using the same set of facts, they all produce different results.[6] This is because the methods treat basic scheduling concepts differently. This is true even when the following variables are all fixed:

• as-planned schedule, as-built schedule, contemporaneous updates, all logic, durations, sequence, and activities in the schedule

• the duration, sequence, and responsibility for each delay

Other studies have reached the same conclusion when comparing different methods to a variety of scenarios.[7] The fact that these methods all produce different results leads to only two logical conclusions: either (a) no method is acceptable, or (b) only one method is acceptable.[8] The authors believe the latter is more likely because most methods fail to adhere to basic scheduling principles.

Some methods are clearly better than others from a purely technical perspective. Other methods are little more than junk science.[9] Because all methods are not equal, determination of preferred methods and a method ranking is necessary for guidance on schedule delay. What follows is a discussion of a preferred standard for schedule delay analysis.

Guidelines for Schedule and Delay Analysis

The following eight guidelines, which are discussed in more detail below, provide the foundation for accurate and reliable schedule and delay analysis and are consistent with applicable law. These guidelines are based on how a project is scheduled in construction, legal decisions in the United States, and a sense of fairness and accuracy. These guidelines also represent best practices in any schedule delay analysis, whether during or after the project.[10]

1. Compare the plan to perform the remaining work before each delay with the plan to perform the remaining work after that delay.

2. Identify critical delays.

3. Evaluate all delays in a chronological and cumulative manner.

4. Adjust the contract completion date to reflect excusable delay as it occurs.

5. Include accurate as-built information in the analysis.

6. Minimize projected future delays.

7. Correct any necessary logic flaws, but carefully document and explain any changes to the contemporaneous schedules.

8. Tie causation to each delay in accordance with the principles of schedule delay.

Guideline #1: Compare the Plan to Perform the Remaining Work Before Each Delay With the Plan to Perform the Remaining Work After the Delay

The primary purpose of a CPM schedule is to be a forecasting tool that, at any point in time, reflects the current plan to perform the remaining work in the schedule. Almost all construction projects require CPM schedules. In fact, CPM schedules are so important to construction projects that one court noted "some required documents, such as preconstruction schedules, are of such importance that refusal to comply with contractual requirements regarding submission constitutes a material breach of the contract."[11] Contemporaneous schedule updates are logic driven and incorporate the impact of progress, including any delays, through each update. The schedule impact resulting from a delay can be shorter or longer than the duration of the delay that caused the impact. For example, if a delay absorbs float in the schedule, the schedule impact of the delay to the projected completion date will be shorter than the delay duration. Schedule resequencing also may mitigate the impact of a delay. Schedule impact can be longer than the delay duration should the performance of the work extend into periods with schedule constraints, such as a period during which certain work cannot be performed.[12] For example, if relocation of a trout stream cannot occur during a federally mandated spawning period, then a 10-day delay that pushes the stream transfer activity into the prohibited period may result in a projected schedule impact much greater than 10 days.[13] Determining the actual impact is only possible if the delay is inserted into an accurate, updated schedule.

Best practice requires comparison of the CPM schedule just before and just after the particular delay.[14] As the Court of Federal Claims noted in *George Sollitt,* "[b]ecause the critical path changes over time, critical path schedule updates are needed to analyze delays."[15] As such, the schedule update after the delay will incorporate the impact of that delay and reflect the revised plan ***9** to complete the work. Quantifying delays in this manner will prevent overestimation of delay before it is incorporated into the project schedules.[16]

Likewise, any schedule delay analysis that ignores the contemporaneous schedule updates is inherently flawed. Such methods include the "total time" and "as-planned versus as-built" methods.[17] Likewise, any schedule delay analysis method that ignores the projected CPM schedule logic also fails, even if it utilizes as-built data from the contemporaneous updates. Methods with this flaw include variations in the "as-built critical path" and ""collapsed as-built" methods. These methods ignore the CPM calculations that use logic to determine the relationships between activities. Further, these methods do not reflect the required completion date, making it impossible to determine float and which activities were critical at any given time. Absent the logic-driven calculations of CPM schedules, the information in an accurate as-built schedule is of limited use for delay analysis. The Board of Contract Appeals in *Santa Fe Engineers* explained:

> Appellant's expert's as-built schedule is a graphical, day to day, history of what occurred on the project based upon the project documentation of both parties .... In the absence of a schedule or other standard for performance, the as-built does not depict a critical path, float, or critical delay. It does not depict how much work was done only that some was done on the date entered. It does not depict the contract completion date. It does not list the original contract schedule, the revised contract schedule, or any dates upon which work was planned in the CPM schedules.[18]

This statement applies to the as-built critical path, collapsed as-built, and any other delay methods that ignore the updated CPM schedules.

Guideline #2: Identify Critical Delays

Delay must be critical to warrant a time extension, that is, the delay must be to activities that have no float available.[19] Float is the amount of slack time on an activity before that activity would delay the contract completion date.[20] Float exists in the schedule, is absorbed by delays, and is created by excusable time extensions. Determining the critical path is central to every schedule delay analysis. Traditionally, the critical path is defined as the longest path of work through project completion--a path where all activities had no float.[21] The traditional definition applies to schedules without constraints.[22] Although this definition of the ""critical path" may be generally accurate, in modern schedules the so-called critical path often contains activities that have float.[23] A more accurate definition of a critical activity is any activity that has no float available in a properly adjusted schedule. With modern schedule constraints, particularly calendar constraints, activities with float commonly fall on the longest path through project completion.[24] Delay of an activity with float merely absorbs float.[25] In order to delay the project, however, the delay must delay project completion.[26] Likewise, activities not on the longest path may have no float, and a delay to these activities would also delay project completion.[27]

Float is calculated in the schedule through the required project completion date. Accordingly, any activity without available float (a negative float activity) is critical because delay to that activity would delay the required completion date. This includes not just the longest path (when behind schedule the lowest or most negative float path), but all other lesser negative float paths.[28]

As the schedule is revised to reflect delays and as-built progress, however, the float values will go negative unless excusable delays are incorporated into the schedule. Without adjusting for excusable delays, more activities will artificially show up as critical than are critical in reality. Consequently, schedules must be updated to reflect excusable delays as they occur in order to keep the completion date properly adjusted and to enable identification of the actual critical path.[29] Once a schedule has been delayed, any activity with negative float is critical, but only if the schedule is updated to reflect all appropriate time extensions.[30]

Guideline #3: Evaluate All Delays in a Chronological and Cumulative Manner

Any schedule delay analysis should progress chronologically through the CPM schedule, incorporating accurate as-built information, including all delays as they occur and the updated plan for the remaining work.[31] A schedule delay analysis is not credible if it only includes one side of the story.[32] Any schedule delay analysis needs to include delays caused by all parties.[33]

The float values of schedule activities at any point in time are dependent on the impact of prior delays. If delays do not occur at the same time, then they are sequential and should be evaluated one at a time in the order they occur so that their actual impact on particular activities can be evaluated accordingly.[34]

For example, in a simple, two-activity or two-path scenario where both paths are critical, an owner delay that occurs first creates float on the alternate path of work that a subsequent contractor delay of equal duration can absorb, making the entire delay excusable and compensable.[35] In the reverse situation, however, if the contractor ***10** delay occurs first, it does not create float on the alternate path of work.[36] A subsequent owner-caused delay results in an excusable but noncompensable delay for the same duration.[37]

Guideline #4: Adjust the Contract Completion Date to Reflect Excusable Delay as It Occurs

As stated above, as the work progresses, the completion date should be updated to reflect all excusable delays.[38] This will adjust the float values on all remaining work as of that point in time.[39] Likewise, all contemporaneously granted time extensions need to be reflected in a schedule delay analysis--i.e., when considering a contractor claim for delay, that portion of the delay acknowledged by the owner, if any, must be included in the schedule.

If there are multiple paths of work in the schedule, excusable delay on one path of work creates float on the alternate paths of work. This float later can be absorbed by a subsequent delay (as opposed to being a critical path delay to the project completion date) that otherwise would have been critical had the prior excusable delay not been incorporated into the schedule. Float values always are calculated through the required contractual completion date. Therefore, failure to extend the project completion date will inaccurately show lower float values on subsequent work, making more activities appear to be critical than actually are critical at that point in time.[40] Determining whether a delay absorbs float, is excusable and compensable, or is excusable and noncompensable is impossible to do accurately unless the schedule is updated to reflect already-incurred excusable delay.[41]

All contemporaneous time extensions must be incorporated into any after-the-fact schedule delay analysis as well. When both parties agree to a time extension during the course of the project, it is inappropriate to claim after the fact that the time extension was not appropriate.[42] For example, the Board in *In re Perini Corp.* criticized this action as follows:

> In 2001 [Government's Expert] analyzed the activities that impacted the critical path to contract completion and opined that ... the evaluation and granting of the 278-day extension of the contract completion date in Modification Nos. 10, 11, 15, 22, 23, 34 and 37 were "incorrect" (ex. G-l at 23, 171). *This analysis fails to acknowledge admitted government and excusable delays, clearly established by the record, and is not credible*. (Emphasis added.)[43]

During contract performance, it is important to maintain a properly updated and adjusted schedule on any project.[44] Making decisions based on an out-of-date schedule creates hazards and generates disputes that could be minimized if both parties have an accurate schedule.

Failure to properly adjust the completion date required by the contract for excusable delay may create additional liabilities for an owner. An owner continuing to make changes and accepting a contractor's performance after the expiration of contract time may constitute a waiver of the completion date[45] or waiver of the time is of the essence clause of the contract.[46] Unless the owner terminates within a reasonable time period after the expiration of contract time, an owner generally waives its right to terminate for delays until a new completion date is reset.[47] Likewise, waiver of the time is of the essence clause in the contract may revert the contract to requiring performance "within a reasonable time period" and prevent the owner from assessing liquidated damages.[48]

Guideline #5: Include Accurate As-Built Information in the Analysis

Any delay analysis must take into account what actually happened on the project. An analysis that only looks at the planned schedule and ignores actual as-built progress on the project is unreliable.[49] Schedule delay analysis methods that ignore the as-built schedule have repeatedly been rejected.[50] Generally, all versions of the "impacted as-planned" and "plan plus impacts" methods ignore the as-built information.[51] For example, in *Titan Pacific* the court noted that

Analyses made after project completion, however, that *make adjustments to attain new and revised projected scheduling depend on theoretical contingencies. They are of limited value*.

...

Plaintiff's calculations in application of its "like-time" theory disregard the facts found by the Board as to the sequence of

work, the quality of work, and the effects of weather on the Phase III work in the years 1977, 1978 and 1979. *The calculations reflect a theoretical application to a CPM as-planned schedule that was not intended to be followed. The calculations disregard the facts that actually existed in on-site operations*. (Emphasis added.)[52]
Likewise, any schedule delay analysis method should incorporate accurate as-built data in order to be considered credible.

11 *Guideline #6: Minimize Projected Future Delays

Several potential problems arise when a projected delay is inserted into a schedule, including:

• overestimating the duration of a delay

• projecting durations of long delay, skewing the critical path ahead of when it would normally adjust for that delay

• projecting delay before it is included in the contemporaneous schedules or actually occurs, which could improperly mask concurrent delays

• projecting delay before it occurs, which can ignore mitigation efforts after the delay was incorporated into the schedule

As a result, it is important to minimize the duration of the delays projected in the schedule. On a construction project, when an excusable delay is identified in the schedule, such as a changed condition, typically the contractor is required to request a time extension with the amount of time the contractor estimates the delay will last and insert that duration into the schedule. The new activities or set of activities inserted into the schedule to reflect the change is often referred to as a *fragnet*, short for fragmentary network. Once the fragnet is logically tied into the schedule, the delay to the project completion date represents the time extension for the changed work. Ideally, both the owner and contractor would agree on the duration of an appropriate time extension that incorporates the changed condition. At that point, the contractor is free to work toward this new schedule the way it would on a new project. If the parties cannot agree on the impact of the delay, they can agree to wait until after the delay is finished and use the actual impact on the schedule in lieu of an estimate. Waiting until the actual schedule impact is known, however, takes away some of the risk and reward. The contractor does not have the benefit of beating the estimated delay, but also is not responsible if the estimate proves too short.

In the United States, if no agreement is reached prior to completion of the schedule delay, the standard is to use the period of actual delay, instead of the parties' estimates. Other countries use a different approach. For example, in the United Kingdom, even after the full delay impact is known, the standard is still to rely on what a reasonable estimate would have been at the start of the delay.[53] The reasoning behind this is to facilitate an early resolution of disputes.[54] An expedited resolution is more likely when both parties know that no additional benefit will be gained by waiting until after the delay is completed to determine the schedule impact.[55] Meanwhile, failure to adjust the schedule to reflect excusable delay can create many future schedule problems, as mentioned above, from difficulty determining critical activities to potential waiver of a "time is of the essence" clause.

When doing a schedule delay analysis after the delay has occurred, projecting delays forward of the data date should be avoided where possible.[56] The preference in a schedule delay analysis is to compare the contemporaneous schedule update just prior to the delay with the schedule update after the delay. The difference between the two will incorporate the impact of any delay. Some delay events, such as long lead times on material fabrication and delivery, may be required to be inserted in the schedule forward of the data date. This should be performed with discretion because inserting actual delay events forward of the data date may alter the schedule's critical path. This effect can be magnified the further from the data date the delay is inserted. A similar shift of the critical path often occurs when future delay events are constrained to the date they actually occur. Setting actual dates forward of the data date should be avoided, as the true delay impact will already be incorporated into the schedule update after the delay. That schedule would also incorporate any mitigation efforts taken to minimize the delay.

Guideline #7: Correct Any Necessary Logic Flaws, but Carefully Document and Explain Any Changes to the Contemporaneous Schedules

Schedules can be modified in an after-the-fact delay analysis, but such modifications should be limited. In some cases, courts and boards have rejected schedule analyses that were not modified at all to reflect missing logic ties that made the schedule unrealistic.[57] However, if changes are made to the schedules used on the project, they should be carefully documented.[58]

A rebuttable presumption exists that contemporaneous CPM schedules are correct.[59] As the board noted in *Santa Fe:*
We do not find that the November revisions were necessary to "correct" the October CPM. Rather, the November CPM merely reflected a different plan for further prosecution of the work which differed from the previous plan. However, the adoption of an alternate method of performance in the later CPM does not, of itself, contradict the existence of a delay as shown in the preceding CPM. *There is a rebuttable presumption of correctness attached to CPM's upon which the parties have previously mutually agreed*. In the absence of probative evidence, not present in this appeal, that the delay shown was not in fact sustained we will rely on the October CPM for the period it was in effect, i.e., through the end of November 1981. For the subsequent period, we will rely on the November CPM. *To put it another way. in the absence of compelling evidence of actual errors in the CPM's, we will let the parties " "live or die" by the CPM applicable to the relevant timeframes*. (Emphasis added.)[60]
This is not to say courts will reject appropriate corrections. In *States Roofing Corp.,* minor corrections to logic errors in the schedule corrected after the fact were considered to be "in keeping with good scheduling practices."[61] Another departure was accepted in *Hensel Phelps,* where the Board determined that the contemporaneous CPM ***12** schedules developed and updated by the contractor were unreliable because they hid work that would not have been completed in the allowable time period.[62]

There are generally three types of logic ties and constraints in a schedule:

Physical constraints. Physical constraints are those that are absolutely a physical necessity in the sequence of construction of the project.[63] For example, in a high-rise building, steel cannot be erected for the fourth floor until the third floor steel has been erected. Therefore, the schedule must have a finish-to-start logic relationship between the finish of the activity for erecting third-floor steel and the start of the activity for erecting fourth-floor steel. Because construction cannot possibly take place without it, this connection in the schedule would be considered a physical constraint.[64]

Contractual constraints. Contractual constraints are those required by the contract.[65] For example, if the contract specifications in a road construction project do not allow asphalt paving during winter months, scheduling paving activities outside those months constitutes a contractual constraint. Other common contractual constraints include
• site access restrictions[66]

• federally mandated nonwork periods such as endangered species breeding nonwork periods

• noise or vibration control at different times of the day

• required settlement compaction or other waiting periods

Preferential constraints. Preferential constraints reflect the contractor's discretionary plan to perform the work. These constraints typically include crew sequencing and nonwork periods where the contractor could work but elects not to, such as weekends (because of labor costs) or harsh winter months because it would require temporary heating and other weather-related measures.[67] Excessive preferential sequencing minimizes the float available on noncritical path work and may even unnecessarily extend the completion date. Preferential sequencing is identified in the baseline schedule. Once accepted, the contractor may have a limited ability to add additional preferential logic ties, whether in schedule updates or after project conclusion in a forensic delay analysis.

For schedule delay analysis, CPM schedules generally only should be modified after the fact to correct errors in physical constraints or contractual constraints where the project could not have possibly been constructed as planned in the original CPM schedules.[68] The contractor's preferential sequencing also generally should not be changed after the fact.[69] However, in some cases, corrections to preferential sequencing have been deemed appropriate after-the-fact changes to the project CPM schedules.[70]

Some other common scheduling practices should be addressed if possible but may not be appropriate for modification after the fact. Leads[71] and lags[72] in a schedule generally should be avoided;[73] a better method is to break the activities up into smaller segments and use finish-to-start[74] relationships. For example, if two concrete pours are scheduled in sequence in the same location, a lag may be used to give the first pour time to cure before starting the next pour. A better way to schedule the project is to break up the concrete pour activity into separate pour and cure activities, with the cure activity on a seven-day calendar. Similarly, in highway construction, the paving operation may follow the grading operation by 10 days in order to allow it to continue to proceed as soon as grading is complete along the roadway. Rather than using a 10-day lag between the activities, it is preferable to break the activities up into smaller segments of roadway, then have each paving segment follow the corresponding grading segment. Excessive leads and lags can obfuscate a logic-driven critical path and may not properly reflect the logic relationships during progress if the schedule is not performed exactly as planned.[75] In *Donohoe Constr. Co.*, leads and lags were improperly used in the schedule, artificially shortening the critical path, leading to rejection of the contractor's CPM analysis.[76]

Similarly, mandatory start and finish dates should be avoided in a schedule where possible, as should options that mandate a float value for an activity. Both of these constraints affect the CPM calculations for that path of work and limit the functionality of a CPM schedule.

Schedule programs such as Oracle's Primavera often include the option to use retained logic[77] or progress override.[78] The purpose of these options is to deal with activities that take place out of the sequence dictated by the schedule. The preferred method for dealing with these activities is to use retained logic, and break and correct any flawed logic relationships as required. If necessary, this process may include breaking activities down to a greater level of detail. For example, if "pour the concrete floor slab" is a predecessor activity to "construct the wall framing" in a house, the two activities are represented in the schedule by a wall framing activity logically tied to start after the completion of floor activity finishes. If the floor slab takes place in multiple pours, the wall framing on one side may be able to start before the entire floor activity is finished. If this occurs, then the preferred way for dealing with it in the schedule is to break both the floor and wall activities up into smaller sections with smaller durations, and use appropriate logic ties (as opposed to using a lag to start the wall activity with a delay after the start of the floor activity).

Fixing constraints and out-of-sequence work in the schedule is necessary in order to achieve a logic-driven critical path that reflects the way work actually proceeds on the project. Failure to fix the actual sequence of work will often result in an inaccurate critical path and an inaccurate estimate of the projected completion date. In other words, the impact of a delay will be distorted due to flaws in the CPM schedule logic.

13 *Guideline #8: Tie Causation to Each Delay in Accordance With the Principles of Schedule Delay Nonexcusable Delay

Nonexcusable delay is delay that is the responsibility of the contractor and, accordingly, does not result in an extension of the required project completion date. This includes delays that do not fall on the critical path (delays that absorb float), contractor-caused delays, and any voluntary acceleration or resequencing that the contractor undertakes to adjust the schedule for reasons not constituting excusable delay. After the expiration of contract time, the owner may assess either liquidated damages (if the contract provides for them) or actual damages (where the contract does not provide for liquidated damages) in order to recover the owner's time-related costs resulting from late performance.

Delay absorbing float. When delay absorbs float in the schedule, the delay is not critical to project completion. Such delay, regardless of responsible party or cause, is not excusable and does not extend the project completion date. As explained above, even activities on the longest path of work can have float because of calendar and other constraints in the schedule.[79] Thus, it is important to determine the float value of all activities, regardless of whether or not they are on the longest path of work.

Contractor delay. Contractor-caused delay is nonexcusable delay that often extends the scheduled completion date later than contractually required. By definition, such delays create negative float on the longest path. Should the project finish later than the properly adjusted completion date, the owner may be able to recover its delay costs from the contractor as described above.

Contractor acceleration/resequencing of the schedule. The contractor has the right to make up its own lost time on the project or complete the work more quickly than planned. Because liquidated damages are not charged until after the expiration of contract time, negative float in the schedule only becomes a breach of contract if not mitigated. The contractor may accelerate its own work to make up time in the schedule, or resequence the work to make up time. The contractor typically has a duty to mitigate delay if possible, regardless of cause, often through resequencing the schedule where possible. However, the contractor may incur additional costs as a result of resequencing, depending on the availability of labor, material, and equipment that can make the resequencing a type of acceleration.

Excusable Compensable Delay (Owner Delay)

Excusable compensable delay results in a time extension and entitles the contractor to recover delay costs. For excusable compensable delay, the contractor must show that the delay was on the longest path of work in the schedule, not just any critical path, and extends the completion date for the project. The delay must also be caused by the owner or someone for whom the owner is responsible. Such delays can result, for example, from owner-initiated changes in the scope of work, design errors, or active interference by the owner or its agents or other contractors performing work on the project under contract with the owner.

Excusable Noncompensable Delay

Excusable noncompensable delay results in a time extension but does not entitle the contractor to recover additional costs. For excusable noncompensable delay, the burden of proof is not as high as it is for compensable delay.[80] Excusable noncompensable delay does not necessarily have to be on the longest path to project completion, as long as it delays any critical activity that has no float.[81] Excusable delay requires owner-caused delay for compensability, but any critical delay outside the control of the contractor typically will entitle a contractor to an excusable noncompensable time extension (in other words, to offset liquidated damages).[82] Excusable noncompensable delay is also the result of several special situations:

Concurrent delay. Concurrent delay occurs when delays caused by the owner and the contractor (or those for whom each is responsible) both lie on separate critical paths to the project, are independent of each other, and occur at or around the same time period.[83] Moreover, a delay to either path of work would have independently caused a delay for project completion.[84] Concurrent delay is typically excusable but noncompensable, and each party is responsible for its own time-related costs.[85]

Offsetting delay. Offsetting delay is a derivation of concurrent delay in that it offsets or nullifies contractor delay for any owner delay that would have independently caused a delay to the contract completion date but for a more critical path.[86] Offsetting delay is delay to work that is critical but not on the longest path to completion of the work. For example, an owner delay to a critical path of work that has no available float, and subsequently would project delay past the properly adjusted contract completion date, may entitle the contractor to a time extension that can offset liquidated damages for the period of delay.[87] By comparison, when unique contractual language in the contract specifications prevents the end date from being constrained (therefore preventing negative float), even a contractor delay creates float on an alternate path of work that owner delays can later absorb.[88] The inverse situation, where an owner delay occurs first, chronologically followed by a contractor caused delay on an alternate path of work, does not result in offsetting delay because ***14** the owner delay creates float the contractor delay can absorb; in other words, the contractor is not required to hurry up and wait.[89]

Force majeure delay. Force majeure is the legal term for “acts of God,” typically unanticipated events outside the control of either party.[90] Force majeure events are typically unforeseeable and absent the control, fault, or negligence of the contractor. When a force majeure event extends overall contract completion, the contractor is typically entitled to a noncompensable extension of time.

Application to Schedule Delay Analysis Methods

When measured against the eight guidelines for any schedule delay analysis described above, most schedule delay analysis methods fail as a result of flaws in the method. For example, every version of collapsed as-built schedule delay analysis fails to (1) incorporate float (guideline #2, identify critical delay), concurrency, the schedule updates, and the change in projected completion date between updates (guideline #1); (2) adjust the contract completion date to reflect excusable delay (guideline #4); and (3) evaluate the delays in a chronological and cumulative manner (guideline #3). Likewise, both versions of the as-built critical path schedule delay analysis also fail to follow the guidelines related to the contemporaneous schedule updates. Each of these flaws is inherent in the method and cannot be corrected without substantially changing the method. As another example, all versions of impacted as-planned schedule analysis ignore as-built information (guideline #5). There is no way to reconcile the as-built information with an impacted as-planned method. If an impacted as-planned method incorporates schedule updates, it becomes a different method.[91]

An as-planned versus as-built schedule analysis, more commonly known as a total time method, fails for the same reasons. By definition, it compares only the as-planned schedule with the as-built schedule (ignoring the contemporaneous schedule updates--guideline #1). If it includes the schedule updates, it no longer can be considered an as-planned versus as-built method.

The remaining versions of time impact analysis require closer evaluation to determine if any follow all of the above guidelines. The only method that follows all eight guidelines is the properly adjusted time impact analysis. As shown herein, the versions of impacted as-planned, collapsed as-built, as-built critical path, and as-planned versus as-built all fail to follow most guidelines. For comparison of the various time impact analysis versions, a more detailed review is necessary to ascertain differences in method.

There always will be some subjectivity in schedule delay analysis because of complexity and limitations in information. As the courts and boards use CPM analysis to shift toward more accurately apportioning concurrent delays,[92] it becomes even more important to use a reliable schedule analysis method. Just because one method is preferred over another does not mean it will be accepted. The method still should comply with the eight guidelines for schedule analysis outlined above. Even so, many methods fail when applied to a complex scenario. As a result, agreement on a standard methodology and implementation will minimize disputes in the industry, focusing the dispute to causation where finders of fact can make a determination if required. To evaluate the subtle differences between Time Impact Analysis (most preferred) and Windows (second most preferred), a closer examination is required to ensure that the guidelines are properly implemented. In particular, guideline #4 (adjust the contract completion date to reflect excusable delay as it occurs) and guideline #7 (correct any necessary logic flaws, but carefully document and explain any changes to the contemporaneous schedules) are most likely to reveal differences between these two methods. Methods that fail application of the guidelines for schedule analysis because of built-in flaws in the method, such as versions of collapsed as-built, as-built critical path, impacted as-planned, and as-planned versus as-built, should be avoided.

Standards for Admissibility of Schedule-Related Expert Testimony

Daubert v. Merrell Dow Pharmaceuticals, Inc.[93] is the seminal decision relating to the admissibility of expert testimony. In *Daubert*, the Court mandated that a trial court apply Rule 702 of the Federal Rules of Evidence to determine admissibility. And, as such, the Court must determine whether the testimony reflects "scientific, technical or other specialized knowledge" that will be of assistance to the fact finder (i.e., whether it will help decide the issues in the case) and whether the scientific knowledge is properly grounded in the methods and procedures of science.[94] In its ""gatekeeper" function, the trial judge must "make a preliminary assessment of whether the reasoning and methodology underlying the expert testimony is scientifically valid and whether such reasoning can be properly applied to the facts at issue." The specific factors to be considered are (a) whether the scientific theory or method can and has been tested, (b) whether it has been subjected to peer review and publication, (c) the potential rate of error, (d) the existence of standards controlling the operation of the technique, ***15** and (e) the extent of "general acceptance" in the relevant scientific community.[95] *Kuhmo Tire Co. v. Carmichael*[96] extended this gatekeeping requirement to all expert testimony, not just scientific testimony.

Although *Daubert* is the standard in federal cases, some states continue to apply the standards articulated in *Frye v. United States*.[97] *Frye's* central question is whether the proffered techniques, when properly performed, generate results generally accepted as reliable within the particular scientific field in which they belong. This standard led the court in *Frye* to reject results from a lie detector test.[98] Given its requirement of "general acceptance," *Frye* is regarded as the less flexible of the two tests.

Under either *Daubert* or *Frye*, schedule analysis methods that fail to adhere to the guidelines discussed above are subject to attack as inadmissible. Because of their frequent use, many of the methods could be argued to be ""generally accepted," but the real question is whether they generate reliable results. Even under the arguably more flexible *Daubert* test, attacking the rate of error that can result from the various methods provides a sound basis for challenge.[99]

Recommendations for Writing Contract Schedule Specification Sections

Construction contracts often have a remarkable dearth of guidance concerning project schedule requirements. Apart from requiring a schedule and requiring that the work be performed by a certain date, many construction contracts provide little guidance on what type of schedule the contractor must employ to manage and execute the work. Prudent contract drafting will include detailed schedule requirements to ensure that the contractor has sufficient tools to manage the work, that the owner has the ability to monitor performance of the work through schedule updates, and that the parties are able to properly analyze schedule-related claims when they arise.

None of the standard forms is sufficient in this regard. The AIA standard form construction contract, document A201 (2007) schedule provisions;[100] the ConcensusDOCS, document ConsensusDOCS-200 (2007);[101] and the EJCDC schedule provisions[102] do not say anything specific about the format of the schedule, nor are they definitive about the update and reporting requirements as the work progresses. A more complete schedule requirement, requiring a CPM schedule, updates at specific intervals during the course of the work, and perhaps monthly progress reports regarding the schedule, is important for any project of significance. The following are some examples.

***Example 1*:**

The Progress Schedule shall be formatted in a detailed precedence-style critical path method, or such other format satisfactory to the Owner and Architect and shall also (a) provide a graphic representation of all activities and events including float values that will affect the critical path of the Work, (b) coordinate all information with each phase of Work, and (c) identify dates that are critical to ensuring the timely and orderly completion of the Work in accordance with the requirements of the Contract Documents, including the dates for Substantial Completion of each respective phase of the Work. The Contractor shall update the schedule at least once a month to reflect progress of the Work and promptly give notice to the Owner and Architect of any actual or potential delays.

Example 2:

The construction schedule shall be in a detailed precedence-style critical path method ("CPM")-type format satisfactory to the Owner and the Architect which shall also: (i) provide a graphic representation of all activities and events including float values that will occur during performance of the Work; (ii) identify each phase of construction and occupancy; and (iii) set forth dates that are critical in ensuring the timely and orderly completion of the Work in accordance with the requirements of the Contract Documents (hereinafter referred to as "Milestone Dates"). Upon review and acceptance by the Owner and the Architect of the Milestone Dates, the construction schedule shall be deemed part of the Contract Documents and attached to the Agreement as Exhibit ___. If not accepted, the construction schedule shall be promptly revised by the Contractor in accordance with the recommendations of the Owner and the Architect and resubmitted for acceptance. The Contractor shall monitor the progress of the Work for conformance with the requirements of the construction schedule and shall promptly advise the Owner of any delays or potential delays. The accepted construction schedule shall be updated at least once a month by the Contractor to reflect actual conditions (sometimes referred to in these General Conditions as "progress reports") as set forth in Subparagraph __________ or if requested by either the Owner or the Architect. In the event any progress report indicates any delays, the Contractor shall propose an affirmative plan to correct the delay, including overtime and/or additional labor, and/or resequencing the Work (but without any adjustment to the Contract Time), if necessary. In no event shall any progress report constitute an adjustment in the Contract Time, any Milestone Date or the Contract Sum unless any such adjustment is agreed to by the Owner and authorized pursuant to Change Order.

Conclusion

Although there are 14 different methods for analyzing schedule delays, they all can lead to different conclusions ***16** when applied to the same fact pattern because of differences in the way each method treats delay. Although time impact analysis (TIA) is the most common and perhaps most reliable generally, many different methods bear the TIA name. As a result, the eight guidelines identified above should be followed in performing any schedule delay analysis. These guidelines lead to a consistent implementation of time impact analysis. Methods that fail to comply with these eight guidelines are subject to attack as inadmissible in court for failing to generate reliable results. Likewise, contract provisions relating to schedules should go beyond what appears in the standard form contracts and, at a minimum, require accurate CPM schedules and regular schedule updates during the project. Such information is essential for providing accurate and up-to-date information for use in managing the project and enabling proper implementation of a reliable schedule delay analysis.

Footnotes

a1 *Robert M. D'Onofrio is a licensed professional engineer and project manager at URS Corporation in New York, NY, who focuses on construction scheduling and delay claims. Anthony L. Meagher is a partner and co-chair of the Construction Practice of DLA Piper LLP (US).*

1 Capital Project Mgmt., Inc. v. IMDISI, Inc., 70 U.S.P.Q.2d 1172, Opposition No. 121,819 to application Serial No. 75/474,121, filed on Apr. 24, 1998, 2003 WL 21779687 (P.T.O. July 30, 2003).

2 *See* JOHN M. WICKWIRE, THOMAS J. DRISCOLL, STEPHEN B. HURLBUT &. MARK J. GROFF, CONSTRUCTION SCHEDULING: PREPARATION, LIABILITY, AND CLAIMS (Aspen Publishers, 3d ed. 2010); *see also* BARRY B. BRAMBLE &. MICHAEL T. CALLAHAN, CONSTRUCTION DELAY CLAIMS § 11.08 (Aspen Publishers, 4th ed., 2011) ("Traditionally, the most favored method for measuring delay is the Time Impact Analysis. The TIA has collected by far the most recommendations and endorsements from courts and industry commentators. It appears the choice of delay measurement method should be TIA, unless other circumstances prevent its implementation.").

3 36 Fed. Cl. 600 (1996).

4 A.S.B.C.A. No. 55307 (2009).

5 It should be noted that this version of the multiple-period collapsed as-built is different than the multiple-period collapsed as-built (version 3.9) identified in AACEI RP 29R-03. While RP 29R-03 method 3.9 uses the schedule updates, it only uses the as-built portion of each schedule update. Because the as-built information remains unchanged with each subsequent schedule update, the RP 29R-03 method is identical to the collapsed as-built method identified as method 3.8 in RP 29R-03. The collapsed as-built multiple-period method identified in RP 29R-03 as method 3.9 is already covered here as method #6 Collapsed As-Built: Collapsed Stepped Removal. Method #5 Collapsed As-Built: Multiple Period Using Updates is different in that it does incorporate the change in projected completion in each schedule update.

6 For detailed implementation of each method and comparison of results, see *Mastering Schedule and Delay Analysis,* Federal Publications Seminars, Thomson Reuters (2011).

7 *See* Abdulaziz A. Bubshait & Michael Cunningham, *Comparison of Delay Analysis Methodologies,* J. CONSTR. ENG. & MGMT. - ASCE, July/August 1998, at 315; Michael F. D'Onofrio & Kenji P. Hoshino, *AACE Recommended Practice for Forensic Schedule Analysis,* presented at the 2010 ABA Forum on the Construction Industry Annual Meeting (The Age of Turbulence: Managing Money Issues in Construction); W. Stephen Dale & Robert M. D'Onofrio, *Reconciling Concurrency in Schedule Delay*

and Constructive Acceleration, 39 PUB. CONT. L.J. at 161-229; Mark C Sanders, *Forensic Schedule Analysis: Example Implementation. Part 2,* 2011 AACE INT'L TRANSACTIONS CDR. 493.

8 While there may be a very basic, one-delay schedule scenario where all methods produce the same result, this is the exception as opposed to the norm.

9 *See, e.g.,* Morganti Nat'l, Inc. v. United States, 49 Fed. Cl. 100 (2001), *aff'd,* 36 F. App'x 452 (Fed. Cir. 2002):
analysis is in essence a *"total time" approach, which is of virtually no value*. [Contractor's expert] "simply takes the original and extended completion dates, computes therefrom the intervening time or overrun, points to a host of individual delay incidents for which defendant was allegedly responsible and which 'contributed' to the overall extended time, and then leaps to the conclusion that the entire overrun time was attributable to defendant." Law v. United States. 195 Ct. Cl. 370, 382 (1971). *It is well settled that this "total time" theory of proving delay is insufficient* to meet the contractor's burden to prove that government-caused delay actually delayed the overall completion of the project. (Emphasis added.)

10 Schedule delay analysis should be approached the same way whether it occurs during the project just after the delay event or after the project in a forensic context. This is akin to the same way economic models should be the same whether applied on a micro or macro level, and as a result, complexity economics has recently replaced the traditionalist economic theories of micro-and macroeconomics. *See, e.g.,* ERIC D. BEINHOCKER, THE ORIGIN OF WEALTH: EVOLUTION, COMPLEXITY, AND THE RADICAL REMAKING OF ECONOMICS (Harvard Business School Press 2006).

11 White Buffalo Constr., Inc. v. United States, No. 99-961C, 2011 WL 4402355 (Fed. Cl. Sept. 22, 2011) *(citing* Takota Corp. v. United States, 90 Fed. Cl. 11, 21 (2009) and Universal Fiberglass Corp., 210 Ct. Cl. at 211-13).

12 *See* Fireman's Fund Ins. Co. v. United States, No. 04-1692C, 2010 WL 2197532 (Fed. Cl. May 26, 2010):
Weather delays are compensable to the extent that construction activities that were scheduled for periods of favorable weather are pushed into periods of unfavorable weather due to government-caused delay. *See* J.D. Hedin Constr. Co. v. United States, 171 Ct. Cl. 70, 347 F.2d 235, 256 (1965) (awarding costs for snow removal labor and "additional temporary heating" when these costs "would not have been incurred but for the original government-caused delays"), *overruled on other grounds by Wilner,* 24 F.3d 1397. "The court may deny an equitable adjustment, however, if the contractor fails to prove that, but for the government delay, the contractor work would have been completed before the onset of the [unfavorable] weather." George Sollitt Constr., 64 Fed. Cl. at 239 *(citing* Kit-San-Azusa, J.V. v. United States, 32 Fed. Cl. 647, 656 (1995)). (Emphasis added.)
See also Witzig Constr. Co., I.B.C.A. 92, 60-2 B.C.A. ¶ 270.

13 *Id.*

14 Blinderman Constr. Co. v. United States, 39 Fed. Cl. 529, 585(1997).

15 George Sollitt Constr. Co. v. United States, 64 Fed. Cl. 229 (2005) ("The critical path of construction activities may change as a project is actually built, and 'activities that were not on the original critical path subsequently may be added.' *Sterling Millwrights, Inc. v. United States,* 26 Cl. Ct. 49, 75 (1992). Accurate CPM schedule updates are required during the course of construction to reflect delays and shifts in the critical path. "[I]f the CPM is to be used to evaluate delay on the project, it must be kept current and must reflect delays as they occur." *Fortec Constructors v. United States,* 8 Cl. Ct. 490, 505 (1985), *aff'd,* 804 F.2d 141 (Fed. Cir. 1986). Accurate CPM schedule updates produced during actual construction are better evidence of the critical path than the baseline CPM schedule provided at the beginning of the project. As this court acknowledged in Blinderman Constr. Co. v. United States. 39 Fed. Cl. 529 (1997), 'accurate, informed assessments of the effect of delays upon critical path activities are possible only if up-to-date CPM schedules are faithfully maintained throughout the course of construction.' *Id.* at 585.").

16 *See. e.g.,* implementation of different methods in Dale& D'Onofrio, *supra* note 7.

17 For a detailed description of implementation of the different schedule delay analysis methods, see *id.*

18 Santa Fe Eng's, Inc., 94-2 B.C.A. ¶ 26,872.

19 *See, e.g.*, Appeals of Harrison W. Corp., E.N.G.B.C.A. No. 5576, 93-1 B.C.A. (CCH) ¶ 25,382 (Aug. 31, 1992). *But see* instances where a subcontractor incurred its own additional time-related costs because of owner caused delay, even though the subcontractor's work had float included in the general contractor's schedule, e.g., ER Mitchell v. Danzig 175 F.3d 1369 (Fed. Cir. 1999) (owner was found liable for the subcontractor's unabsorbed home office overhead costs resulting from an owner-caused delay even though the delayed work was never critical to project completion); Fischbach & Moore Int'l Corp., A.S.B.C.A. No. 18146,77-1 B.C.A. (CCH) ¶ 12,300 (Dec. 13, 1976) (where the site work subcontractor's work was not on the critical path of construction of radio towers that were delayed, but because the subcontractor had to be on site longer, the board allowed recovery of delay damages for the subcontractor); Stephen A. Hess, *Who Should Own the Float?,* 4 J. AM. C. CONSTR. LAW. 1, 5 (2010) (arguing that in some instances delays to an activity with float may nonetheless create additional costs for a contractor and as such should be compensable).

20 *See* Marion Constr. Co., Inc., G.S.B.C.A. No. 13625, 98-1 B.C.A. (CCH) ¶ 29,685 (Apr. 7, 1998).
Total float is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, of any activity in the project schedule. And is further defined as the amount of time any given activity or path of activities may be delayed before it will affect the project completion time. Total float is not time for the exclusive use or benefit of either the Government or the Contractor, but must be used in the best interest of completing the project on time. Extensions of time for performance required under the General Conditions pertaining to equitable time adjustment will be granted only to the extent that the equitable time adjustment exceeds total float in the activity or path of activities affected at the time notice to proceed was issued for the change. The government shall not be responsible for any delays or for the contractor's extended overhead if such delay time can be absorbed in total float. Nor shall the government be responsible for payment for any delays or for contractor's extended overhead which exceed total float unless the delay is government caused. The government shall only be responsible for government caused delays to the extent they exceed total float without the presence of any concurrent non-government caused delay.

21 Ace Constructors, Inc. v. United States, 70 Fed. Cl. 253, 294 (2006) ("The 'critical path' is the longest path through a project and thus defines the total duration of the project.").

22 Robert M. D'Onofrio, *Can There Be Float on the Critical Path?* UNDER CONSTR., Aug. 2009, at 1.

23 *Id.*

24 *Id.*

25 See the section on delay absorbing float below.

26 Fru-Con Constr. Corp. v. United States, 44 Fed. Cl. 298, 314 (1999) ("It is not sufficient to establish that some work was prevented; the work prevented must be work that will delay the overall completion of the job.") (Internal quotation marks omitted.)

27 *See* Sauer Inc. v. Danzig, 224 F.3d 1340, 1345 (Fed. Cir. 2000) ("In addition, the unforeseeable cause must delay the overall contract completion; i.e., it must affect the critical path of performance."); *see also* Contel Advanced Sys., Inc., A.S.B.C.A. No. 49075, 04-2 B.C.A. (CCH) ¶ 32,664, at 161,680 (requiring that the entire project must be delayed in order for the contractor to recover on owner-caused delay of one project segment).

28 *See* Framlau Corp. A.S.B.C.A. No. 14479, 71-2 B.C.A. (CCH) ¶ 9082, at 42,106 (even if an owner delay is not on the longest path, if it would be during a period of liquidated damages such as past the expiration of contract time when all activities would have negative float, it entitles the contractor to a time extension); *see also* Fire Security Sys., Inc., V.A.B.C.A. No. 5559-63, 02-2 B.C.A. (CCH) ¶ 31,977 (holding that after the expiration of contract time, all activities are critical).

29 Blinderman Constr. Co. V. United States, 39 Fed. Cl. 529, 585 (1997); Fortec Constructors vs. United States; 8 Cl. Ct. 490, 505 (1985): George Sollitt Constr. Co. v. United States, 64 Fed. Cl. 229, 240 (2005).

30 *Fortec Constructors,* 8 Cl. Ct. 490 (1985), ("If the CPM is to be used to evaluate delay on the project, it must be kept current and must reflect delays as they occur.").

31 *Id. See also Blinderman,* 39 Fed. Cl. at 585; *George Sollitt Constr. Co.,* 64 Fed. Cl. at 240.

32 *In re Fru-Con Constr. Corp.,* A.S.B.C.A. No. 53544, 05-1 B.C.A. (CCH) ¶ 32,936 (Apr. 14, 2005) ("a credible CPM time impact analysis should take into account and give appropriate credit for all of the impacts to the project").

33 George Sollitt Constr. Co. v. United States, 64 fed. Cl. 229 (2005) restated and summarized Gulf Contracting as follows:
In addition, [Sollitt's Expert], unlike the court, found no delays chargeable to Sollitt in Phases II and III construction, JE 235 at 4, which limits the usefulness of his delay analysis and makes his overall findings less credible. *See* *273 Gulf Contracting, Inc., A.S.B.C.A. Nos. 30195, 32839, 33867, 89-2 B.C.A. (CCH) ¶ 21,812, 1989 WL 46855 (Mar. 16, 1989) (rejecting a delay analysis because it "systematically excluded all delays and disruptions except those allegedly caused by the Government," "was inherently biased," and concluding that "[t]o be credible, a contractor's CPM analysis ought to take into account, and give appropriate credit for all of the delays which were alleged to have occurred"), *aff'd on reconsid.,* 90-1 B.C.A. (CCH) ¶ 22,393, 1989 WL 127734 (Sept. 20, 1989), *aff'd,* 23 Cl. Ct. 525 (1991), *aff'd,* 972 F.2d 1353 (Fed. Cir.) (table), *cert. denied,* 506 U.S. 999, 113 S. Ct. 598, 121 L. Ed. 2d 535(1992).
See also Bay Construction Co., V.A.B.C.A. Nos. 5594 et al.; 2002 WL 442118; Jimenez, Inc., V.A.B.C.A. No. 6351; 02-2 B.C.A. (CCH) ¶ 32,019.

34 Robinson v. United States, 261 US. 486 (1923); RP Wallace, Inc. v. United States, 63 Fed. Cl. 402, 409 (2004).

35 Bechtel Envtl., Inc., E.N.G.B.C.A. Nos. 6137, 6166, 97-1 B.C.A. CCH ¶ 28,640 (This Board has held that once a contractor encounters an excusable delay, it may reasonably reschedule its work without fear that it will be held responsible for a concurrent delay); John Driggs Co., Inc., E.N.G.B.C.A. No. 5926, 87-2 B.C.A. CCH ¶ 19,833 (after an owner delay the contractor is no longer bound to slavishly follow the now meaningless schedule). *See also* the sections on owner-caused delay and delay absorbing float below.

36 See the section on contractor-caused delay, below.

37 See the section on offsetting delay, below.

38 Fortec Constructors v. United States, 8 Cl. Ct. 490 (1985) ("If the CPM is to be used to evaluate delay on the project, it must be kept current and must reflect delays as they occur.").

39 Mergentime Corp. v. Wash. Metro. Area Transp. Auth., CIV. 89-1055 TFH, 2006 WL 416177 (D.D.C. Feb. 22, 2006) (extending the contract completion date is important for accurate schedules):
Revisions to the schedule that created a more realistic view of the job progress were dependent on WMATA's processing of change orders and issuance of contract modifications. This Court agrees with Judge Revercomb that the "[d]elays in issuing [such modifications] had a direct impact on obtaining a meaningful yardstick to measure job progress." Revercomb Op. at *82.

40 *See* George Sollitt Constr. Co. v. United States, 64 Fed. Cl. 229 (2005):
Without a timely grant of a time extension, *if Sollitt entered a delaying event on its CPM schedule update without the corresponding time extension that was granted later, Sollitt would appear to be further behind on the schedule than it actually was. See* Tr. at 141 (Mr. Maziarka) (agreeing with plaintiff's counsel's statement that, without the entry of a time extension, the CPM schedule "might show that it was late when it really wasn't'D'). Although this fact presents a possible motive for not updating CPM schedules accurately to reflect delays until a time extension is granted, it does not justify failing to fulfill the contract

requirement of providing updated CPM schedules that were accurate. (Emphasis added.)

41 *Id.* at 240:
The better methodology for a critical path delay analysis is to use the updated CPM schedules, not the baseline schedule prepared before construction began. *See* Blinderman v. United States, 39 Fed. Cl. 585 [529] (1997) (stating that "the only way to accurately assess the effect of the delays alleged ... on the ... project's progress is to contrast updated CPM schedules prepared *immediately* before and *immediately* after each purported delay"); *Fortec,* 8 Cl. Ct. at 505 (stating that "if the CPM is to be used to evaluate delay on the project, it must be kept current and must reflect delays as they occur"); Sollitt Br. at 44 (admitting that Sollitt prepared the updated analysis "in recognition of the widely accepted practice of using the updated schedules for the analys[i]s").

42 Similarly, if the owner has admitted an excusable delay and grants a unilateral time extension during the course of the project, it is generally not appropriate for an after-the-fact owner analysis to claim that time extension was unwarranted.

43 *In re* Perini Corp., A.S.B.C.A. Nos. 51160, 51573 04-1 B.C.A. (CCH) U 32,530 (2004).

44 *Blinderman,* 39 Fed. Cl. at 585; *Fortec Constructors,* 8 Cl. Ct. at 505; *George Sollitt Constr. Co.,* 64 Fed. Cl. at 240.

45 DeVito v. United States, 1147 (Cl. Ct. 1969); Olson Plumbing & Heating Co. v. United States, 602 F.2d 950, 956 (Ct. Cl. 1979); ITT Corp. v. United States, 509 F.2d 541 (Ct. Cl. 1975); Motorola Computer Sys., Inc., A.S.B.C.A. No. 26794, 87-3 B.C.A. (1987).

46 RDP Royal Palm Hotel v Clark Constr., Nos. 04-16202, 05-11713, 2006 U.S. App. LEXIS 2815 (11th Cir. Feb. 17, 2006; Technocratica, A.S.B.C.A. No. 48061, 06-2 B.C.A. (CCH) ¶ 33,316; Devito, 413 F.2d 1147; Banks Bldg. Co. V. Malanga, 926 A.2d 1 (Conn. App. 2007); Overhead Elec. Co., A.S.B.C.A. No. 25656, 85-2 B.C.A. (CCH) ¶ 18,026 (1985); Corway, Inc., A.S.B.C.A. No. 20683, 77-1 B.C.A. (CCH) ¶ 12,357 (1977); State of Fla. Dep't of Ins. v. United States, 81 F.3d 1093 (Fed. Cir. 1996); Sun Cal v. United States, 21 Cl. Ct. 31 (1990).

47 *ITT Corp.,* 509 F.2d at 548; Lanzen Fabricating, Inc., A.S.B.C.A. No. 40382, 93-3 B.C.A. (CCH) ¶ 26,079.

48 *RDP Royal Palm Hotel,* 2006 App. LEXIS 2815; Technocratica, 06-2 B.C.A. (CCH) ¶ 33,316.

49 Youngdale & Sons Constr. Co., Inc. v. United States, No. 553-88C, 1993 WL 9081 (Fed. Cl. Jan. 15, 1993) ("[T]he As-Built Schedule purports to depict the various activities which took place throughout the project in the manner in which they actually occurred .... However, we find, on this record, that many of plaintiff's major premises are not true because, when the court attempted to cross-check a particular alleged task or delay as to its time frame with the daily logs, said items were not depicted as referenced in the schedule .... Accordingly, based on the record as a whole, the court is compelled to conclude that plaintiff's expert's report is not sufficiently credible to carry its burden by the requisite quantum of proof.").

50 *See generally* Richard F. Smith & John M. Cook, *Obtaining Time Extensions, in* CONSTRUCTION LAW HANDBOOK at 850-52 (Cushman et al. eds. 1999) (discussing "Adjusted As-planned" analysis); Andrew D. Ness, *Delay, Suspension of Work, and Acceleration, in* FEDERAL GOVERNMENT CONSTRUCTION CONTRACTS 430-31 (Adrian Bastianelli et al. eds. 2003). *See also* Titan Pac. Constr. Corp. v. United States, 17 Cl. Ct. 630 (1989) (rejecting the "like time" theory for not comparing plan to actual progress); Ealahan Elec. Co., D.O.T.B.C.A. No. 1959, 90-3 B.C.A. (CCH) ¶ 23,177 (failure of method to consider actual performance); Freeman-Darling, Inc. G.S.B.C.A. No. 7112, 89-2 B.C.A. (CCH) ¶ 21,882; John T. Jones Constr. Co., A.S.B.C.A. No. 48303 1998-2 B.C.A. (CCH) ¶ 29,892 (1997); Gulf Contracting, Inc., A.S.B.C.A. Nos. 30,195, 32,839, 33,867, 89-2 B.C.A. (CCH) ¶ 21,812, *aff'd on recon.,* 90-1 B.C.A. (CCH) ¶ 22,393 (1989).

51 *Id.*

52 *Titan Pac. Constr. Corp.,* 17 CI. Ct. at 637-38.

53 SOC'Y OF CONSTR. LAW, Delay and Disruption Protocol,; Oct. 2002; *see also* Richard H. Lowe, Evans M. Barba & Gregory B. Lare, *View From Across the Pond: An American Perspective on the Society of Construction Law's Delay and Disruption Protocol,* CONSTR. LAW., Winter 2007, at 5.

54 SOC'Y OF CONSTR. LAW, *supra* note 53.

55 *Id.*

56 *Titan Pac. Constr. Corp.*, 17 Cl. Ct. at 637-38.

57 Neal & Co., Inc. v. United States, 36 Fed. Cl. 600 (1996) (analysis accepted where government's expert prepared a new baseline schedule after the project to add in logic ties for labor that were missing, then reupdated the schedule).

58 J.A. Jones Constr. Co., E.N.G.B.C.A. No. 6252, 97-1 B.C.A. (CCH) ¶ 28,918 (1997) ("[O]ne may wonder why a critical path analysis and updates are required. The Board in the past and in the present appeal finds such schedule analysis useful, inter alia, for not only for what was on, but what was left off the critical path, e.g. the floor strut changes, as representations of the contemporaneous views of Appellant. *The more a contractor departs in litigation from its contemporaneously-prepared schedules, the greater the need to explain and justify the reasons and assumptions underlying such departures to the Board*. Convincing explanations are lacking in this case. The Board also finds Respondent's expert more persuasive in part because his analysis closely mirrors Appellant's contemporaneously submitted schedules, (emphasis added)").

59 Santa Fe, Inc., V.A.B.C.A. No. 2168, 87-3 B.C.A. (CCH) 20,104 (Aug. 25, 1987).

60 *Id.*

61 States Roofing Corp., A.S.B.C.A. No. 54860, 10-1 B.C.A. (CCH) ¶ 34,356 (Jan. 12, 2010) ("In any event, the credible evidence supports the finding that the adjustments [contractor's expert] made were exactly as he described them: minor corrections to logic errors relating to submittals. The Navy did not dispute that there were such logic errors in the schedule and, to the extent there were, we consider correction of them to be in keeping with good scheduling practices.").

62 Hensel Phelps Constr. Co, A.S.B.C.A. No. 49270, 99-2 B.C.A. (CCH) ¶ 30,531 (1999).

63 Utley-James, Inc., G.S.B.C.A. No. 5370, 85-1 B.C.A. (CCH) (1984) (mentions physical constraints versus preferential sequencing).

64 *Id.*

65 *See, e.g.,* S. Comfort Builders, Inc. v. United States, No. 00-542C, 2005 WL 1804325 (Fed. Cl. July 29, 2005):
[The] government also stated that SCBI should "[k]eep in mind that access to the construction site will be governed by the 'Work Area Access Constraints' clause." The constraints clause of the contract is found at Article 18 of the contract, which discusses the particular time and access restrictions within which SCBI was to complete the contract. Specifically, the contract was restrictive in that it set forth the precise sequence in which SCBI was to complete the MLP work and required all work packages to be completed in three modification periods or work windows, each six weeks long. The contract included thirteen work packages for each MLP, which were required to be performed during the NASA specified work windows.

66 *Id.*

67 *See, e.g.,* Neal & Co., Inc. v. United States, 36 Fed. Cl. 600 (1996) (use of proper crew constraints and other resource scheduling make up a contractor's realistic scheduling tool).

68 Santa Fe, Inc., V.A.B.C.A. No. 2168, 87-3 B.C.A. (CCH) ¶ 20,104 (Aug. 25, 1987).

69 J.A. Jones Constr. Co., E.N.G.B.C.A. 6348, 00-2 B.C.A. (CCH) ¶ 31,000 (analysis was not accepted when the expert found a better way to have scheduled the project).

70 *Neal& Co.,* 36 Fed. Cl. 600 (government's expert rescheduled baseline after project to add in logic ties for labor that was missing, then reupdated schedule; this was acceptable to courts for use in TIA analysis).

71 Leads are constraints on the CPM schedule logic relationship that make the follow-on activity start before the subsequent activity by the number of days specified in the lead. In Oracle's Primavera, a lead is a negative lag.

72 Lags are constraints on the CPM schedule logic relationship with another activity that make the follow-on activity start after a delay specified by the days in the lag. Oracle's Primavera defines both leads and lags under the term *lag* as "An offset or delay from an activity to its successor. Lag can be positive or negative and it is based on the calendar of the successor activity."

73 Constr. Co., A.S.B.C.A. No. 47310, 98-2 B.C.A. (CCH) U 30,076 (1998) (the critical path in the schedule was incorrect due to use of leads and lags in the schedule).

74 There are generally four types of logic relationships in a CPM schedule: finish-to-start, start-to-start, start-to-finish, and finish-to-finish. All four represent constraints on activities that determine that activities relationship to another activity. Sometimes these logic relationships are referred to as "logic ties" or "ties" for short because they ""tie" one activity to another in the CPM schedule.

75 *Donohoe Constr. Co.,* 98-2 B.C.A. ¶ 30,076.

76 *Id.*

77 Retained logic is a CPM schedule setting that arises when schedule work is performed out of sequence. For example, in an A-B-C activity chain with finish-to-start relationships, activity B finishes but still has an incorrect logic relationship to its predecessor activity A that has not yet finished. In retained logic, the successor activity C retains activity B's unfinished predecessor logic relationship to activity A even though activity B is already finished. Therefore, retained logic means that an activity does not start until all activities that are in logic relationships leading up to that activity have been completed. Also, Oracle's Primavera provides, "When you choose Retained Logic, the remaining duration of a progressed activity is not scheduled until all predecessors are complete."

78 Progress override is a CPM schedule setting that arises when schedule work is performed out of sequence. For example, in an A-B-C activity chain with finish-to-start relationships, activity B finishes but still has an incorrect logic relationship to its predecessor activity A that has not yet finished. In progress override, the successor activity C does not retain activity B's unfinished predecessor logic relationship to activity A. Because activity B is already finished, activity C can start because the progress override setting overrides the chain of logic preceding activity B. Therefore, progress override means that an activity can start as soon as its predecessors are finished without regard for any improper residual logic relationships leading up to the predecessor activity. *Also,* Oracle's Primavera provides, "When you choose Progress Override, network logic is ignored and the activity can progress without delay."

79 See the definition of critical in the section "Identify Critical Delays."

80 Framlau Corp., A.S.B.C.A. No. 14479, 71-2 B.C.A. (CCH) ¶ 9082, at 42,106.

81 *Id:,* Jan R. Smith, Contractor, F.A.A.C.A.P. No. 66-21, 65-2 B.C.A. (CCH) ¶ 5306; A. Brindis Co., G.S.B.C.A. No. 3085, 70-2 B.C.A. (CCH) ¶ 8527.

82 *Framlau,* 71-2 B.C.A. (CCH) ¶ 9082.

83 *See* Mark Boe, *Identifying Concurrent Delay,* CAUSE & EFFECT, Winter 2004. *See also* Andrew D. Ness, *When the Going Gets Tough - Analyzing Concurrent Delays, available at* http://www.constructionweblinks.com.

84 George Sollitt Constr. Co. v. United States, 64 Fed. Cl. 229, 238 (2005) ("The exact definition of concurrent delay is not readily apparent from its use in contract law, although it is a term which has both temporal and causation aspects. Concurrent delays affect the same 'delay period.' *See* Tyger Constr. Co. v. United States, 31 Fed. Cl. 177, 259 (1994) ('In cases of concurrent delay, where both parties contributed significantly to the delay period by separate and distinct actions, justice requires that the cost of the delay be allocated between the two parties proportionally.'). A concurrent delay is also independently sufficient to cause the delay days attributed to that source of delay. *See* Beauchamp Constr. Co. v. United States, 14 Cl. Ct. 430, 437 (1988) (noting that a concurrent action 'would have independently generated the delay during the same time period even if it does not predominate over the [G]overnment's action as the cause of the delay' (citations omitted)).").

85 Morganti Nat'l, Inc. v. United States, 49 Fed. Cl. 100, 132 (2001), *aff'd,* 36 F. App'x 452 (Fed. Cir. 2002); *see also* RP Wallace, Inc. v. United States, 63 Fed. Cl. 402, 410 (2004).

86 *Framlau,* 71-2 B.C.A. (CCH) ¶ 9082. *See also* BARRY B. BRAMBLE & MICHAEL T. CALLAHAN, CONSTRUCTION DELAY CLAIMS § 11.09, at 11-79 (3d ed. 2000) (defining "offsetting delays" as "delays that have the same effect on project completion but do not occur within the same general time period").

87 Framlau, 71-2 B.C.A. (CCH) ¶ 9082, at 42,106. ("The Government does not deny that it took some additional time to perform the extra work. It denies the request for an extension of time only on the ground that the work could be performed concurrently with items of uncompleted work under the basic contract. The Government's position fails to recognize a distinction between requests for time extensions to support claims for relief from assessment of liquidated damages, and to support claims for upward price adjustments. In assessing liquidated damages, a contractor will not be charged for its delays which are concurrent with Government-caused delays. Since the Government directed a change and has assessed liquidated damages, appellant should not be charged for the number of days it took to perform the additional work, even though the work was performed concurrently with other work. On the other hand, appellant may not use these days for computing an equitable adjustment in price for the increased time of performing the contract if the work was performed concurrently with other work required by the contract or during an extended period of performance resulting from delays caused by appellant."); Jan R. Smith, Contractor, F.A.A.C.A.P. No. 66-21, 65-2 B.C.A. (CCH) ¶ 5306); A. Brindis Co., G.S.B.C.A. No. 3085, 70-2 B.C.A. (CCH) ¶ 8527.

88 Santa Fe Eng'rs, Inc., V.A.B.C.A. Nos. 1943, 1944, 1945, 1946, 84-2 B.C.A. (CCH) ¶ 17,341.

89 John Driggs Co., Inc., E.N.G.B.C.A. No. 5926, 87-2 B.C.A. (CCH) ¶ 19,833 (after an owner delay the contractor is no longer bound to slavishly follow the now meaningless schedule).

90 FAR 52.249-10(b)(1). A typical list of force majeure events is included in the Federal Acquisition Regulations:
(i) Acts of God or of the public enemy,
(ii) Acts of the Government in either its sovereign or contractual capacity,
(iii) Acts of another [c]ontractor in the performance of a contract with the Government,
(iv) Fires,

(v) Floods,
(vi) Epidemics,
(vii) Quarantine restrictions,
(viii) Strikes,
(ix) Freight embargoes,
(x) Unusually severe weather, or
(xi) Delays of subcontractors or suppliers at any tier arising from unforeseeable causes beyond the control and without the fault or negligence of both the [c]ontractor and the subcontractors or suppliers.

91 Such as some form of time impact analysis, or as-planned versus as-built.

92 James K. Bidgood Jr., Steven L. Reed, & James B. Taylor, *Culling the Knot on Concurrent Delay,* Thomson West Construction Briefings, Feb. 2008.

93 509 U.S. 579(1993).

94 *Id.* at 588-89.

95 *Id.* at 593-94.

96 526 U.S. 137(1999).

97 293 F. 1013 (D.C. Cir. 1923).

98 *Id.* at 1014.

99 For more detailed discussions of the admissibility of schedule analysis testimony, *see* Jocelyn L. Knoll, Rebecca Weisemberger, Christopher J. Heffernan, & Tracy L. Steedman, *Successfully Defending or Asserting a* Daubert *Challenge in Construction Disputes,* American Bar Association Forum on the Construction Industry (April 14-16, 2011); Hubert J. Bell & Gene J. Heady, *Challenging or Obtaining Recognition of a Scheduling Expert's Testimony in a Construction Delay Case*. ABA Section of Public Contract Law (Annual Meeting 1999).

100 The A201 (2007) Schedule Provisions:
3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES
3.10.1 The Contractor, promptly after being awarded the Contract, shall prepare and submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall not exceed the time limits current under the Contact Documents, shall be revised at appropriate intervals as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for the expeditious and practicable execution of the Work.
3.10.3 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

101 The ConsensusDOCS-200 (2007) schedule provisions:
6.2 SCHEDULE OF THE WORK
6.2.1 Before submitting the first application for payment, the Contractor shall submit to the Owner, and if directed, its Architect/Engineer, a Schedule of Work that shall show the dates on which the Contractor plans to commence and complete various parts of the Work, including dates on which information and approvals are required from the Owner. On the Owner's written approval of the Schedule of the Work, the Contractor shall comply with it unless directed by the Owner to do otherwise or the Contractor is otherwise entitled to an adjustment of the Contract Time. The Contractor shall update the Schedule of the Work on a monthly basis or at appropriate intervals as required by the conditions of the Work and the Project.

6.2.2 The Owner may determine the sequence in which the Work shall be performed, provided it does not unreasonably interfere with the Schedule of the Work. The Owner may require the Contractor to make reasonable changes in the sequence at any time during the performance of the Work in order to facilitate the performance of work by the Owner or Others. To the extent such changes increase Contractor's time and costs the Contract Price and Contract Time shall be equitably adjusted.

102 The EJCDC schedule provisions:

2.05 BEFORE STARTING CONSTRUCTION

A. Preliminary Schedules: Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:

1. A preliminary Progress Schedule; indicating the times (number of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2.07 INITIAL ACCEPTANCE OF SCHEDULES

A. At least 10 days before submission of the first Application for Payment, a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05A. Contractor shall have provided an additional 10 days to make corrections and adjustments and to compare and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere or relieve Contractor from Contractor's full responsibility therefore.

6.04 PROGRESS SCHEDULE

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.

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