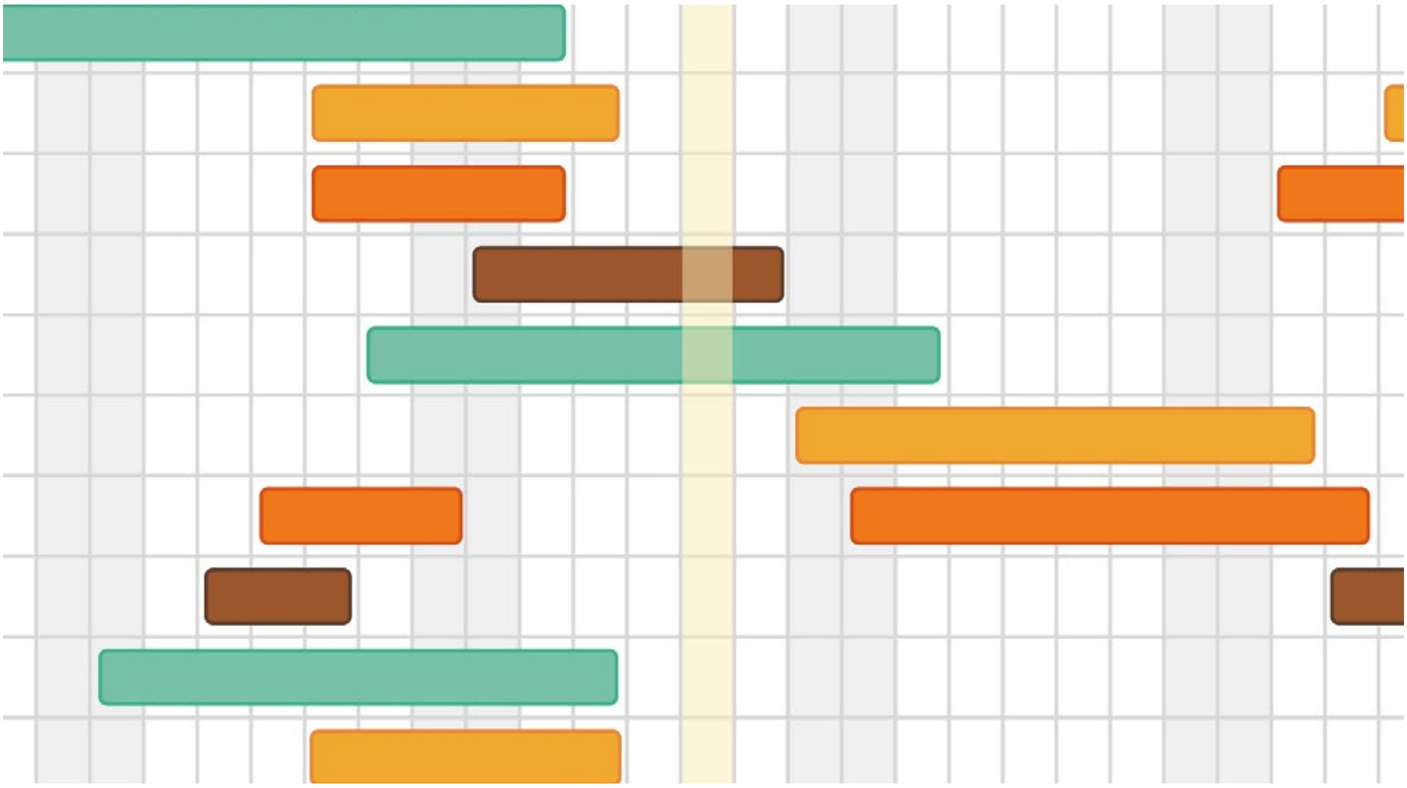

Overview of As-Planned Versus As-Built Forensic Schedule Analysis:

AACE International Recommended Practice No. 29R-03 Forensic Schedule Analysis MIP 3.1 and 3.2

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ABSTRACT

As-planned versus as-built forensic schedule analysis is a method used to identify and quantify delays and, most importantly, the delays that led to the later-than-planned completion of a project. The intent of this article is to provide the reader with an overview of as-planned versus as-built forensic schedule delay analysis. The Method Implementation Protocols (MIP) for this type of analysis are presented in AACE International's (AACE) Recommended Practice 29R-03, *Forensic Schedule Analysis (RP29R-03), Section 3.1 Observational/Static/Gross (MIP 3.1)* and *Section 3.2 Observational/Static/Periodic (MIP 3.2)*. The selection of the schedule delay analysis methodology used for a dispute arising from a particular project ultimately is the responsibility of the schedule analyst. In many situations, the methodology chosen may be based on requirements of the contract between the parties. In other situations, the schedule analyst is free to choose the methodology he or she believes best communicates his or her opinions based on the facts of the dispute and available contemporaneous project documentation. This article presents information about the procedures associated with MIP 3.1 and MIP 3.2 for consideration by the schedule analyst as may be applicable to the specific dispute at hand.

1. INTRODUCTION

As-planned versus as-built forensic schedule analysis is a method used to identify and quantify delays and, most importantly, the delays that led to the later-than-planned completion of a project. The intent of this article is to provide the reader with an overview of as-planned versus as-built forensic schedule delay analysis. The Method Implementation Protocols (MIP) for this type of analysis are presented in AACE International's (AACE) Recommended Practice 29R-03 *Forensic Schedule Analysis* (RP29R-03), *Section 3.1 Observational/Static/Gross (MIP 3.1)* and *Section 3.2 Observational/Static/Periodic (MIP 3.2)*.

As with the overall RP29R-03, [1] specifically, this article:

> '*…is not intended to establish a standard of practice, nor is it intended to be a prescriptive document applied without exception. Therefore, a departure from the recommended protocols should not be automatically treated as an error or a deficiency as long as such departure is based on a conscious and sound application of schedule analysis principles. As with any other recommended practice, the RP should be used in conjunction with professional judgment and knowledge of the subject matter. While the recommended protocols contained herein are intended to aid the practitioner in creating a competent work product it may, in some cases, require additional or fewer steps.*'

> '*…primarily focuses on the use of [as-planned versus as-built] forensic scheduling techniques and methods for factual analysis and quantification as opposed to assignment of delay responsibility. This, however, does not preclude the practitioner from performing the analysis based on certain assumptions regarding liability.*'

> '*…is not intended to be a primer on [as-planned versus as-built] forensic schedule analysis. The reader is assumed to have advanced, hands-on knowledge of all components of CPM analysis and a working experience in a contract claims environment involving delay issues.*'

The selection of the schedule delay analysis methodology used for a dispute arising from a particular project ultimately is the responsibility of the schedule analyst. In many situations, the methodology chosen may be based on requirements of the contract between the parties. In other situations, the schedule analyst is free to choose the methodology he or she believes best communicates his or her opinions based on the facts of the dispute and available contemporaneous project documentation. This article presents information about the procedures associated with MIP 3.1 and MIP 3.2 for consideration by the schedule analyst as may be applicable to the specific dispute at hand.

2. TAXONOMY AND NOMENCLATURE

RP29R-03 correlates common names for various forensic schedule analysis methods to taxonomic classifications comprised of five layers: timing, basic and specific methods, and the basic and specific implementation of each method. These layers are explained in detail in RP29R-03, Section 1.4.

In summary, as-planned versus as-built analyses are classified in RP29R-03 as:

- *Retrospective (Layer 1: Timing)* – performed after the delay has occurred.
- *Observational (Layer 2: Basic Method)* – analysis of the schedule, in general, performed without making any changes to the schedule.
- *Static Logic (Layer 3: Specific Method)* – performed based on comparison of as-built schedule to an as-planned schedule (preferably the approved or accepted baseline schedule).
- *Gross or Periodic (Layer 4: Basic Implementation)*
    - Gross – analysis of the entire project duration as a single period
    - Periodic – analysis of the entire project duration in segments
- *Fixed Periods or Variable Periods (Layer 5: Specific Implementation)* – applicable to Periodic Layer 4, but not applicable to Gross Layer 4 since that analysis is of the entire period as a single period.
    - Fixed Periods – analysis periods established by fixed dates and durations as defined by data dates used for contemporaneous schedule updates.
    - Variable Periods – analysis periods not established by data dates corresponding to contemporaneous schedule updates, rather by dates selected by the analyst that may represent dates such as:
        - Key milestones along the critical path
        - Changes in the critical path
        - Issuance of an agreed upon revised or recovery baseline schedule

RP29R-03 notes that retrospective/observational/static logic analyses are commonly referred to as "as-planned versus as-built" analyses and distinguishes between the gross and periodic basic implementation versions within this taxonomy by noting that periodic analyses are performed by comparing the as-planned and as-built data in time slices, sometimes called "windows."

3. COMMON NAMES

Forensic schedule analyses performed in general accordance with MIP 3.1 and MIP 3.2 are commonly referred to as:

- As-Planned versus As-Built
- AP versus AB
- Planned versus Actual
- As-Planned versus Update

4. UNDERLYING FUNDAMENTALS AND GENERAL PRINCIPLES

The following provides further information with respect to how the general principles identified in RP29R-03, applicable to forensic schedule analyses in general, specifically apply to MIP 3.1 and MIP 3.2.

- *Use CPM Calculations*—Calculation of the as-planned critical path and determination of the as-built critical path must be based on CPM scheduling principles and proper logic.
- *Data Dat***e**—Schedule updates must apply the use of a data date – status all activities that have started and/or finished, including appropriate actual dates, remaining duration, and percentage complete values as of the same (data) date—in order to have a complete understanding of the effect of all remaining activities on the forecasted project completion.
- *Shared Ownership of Network Float*—Unless stated otherwise in the contract, float belongs to the project and is available for use by the owner and contractor.
- *Update Float Preferred Over Baseline Float*—Available float values as determined in validated and contemporaneous schedule updates closer to the time the contractor actually performs an activity is preferred over baseline values for those same activities. This is a result of the effect reported actual start and finish dates and percentages complete associated with other activities have on other logically tied activities, as well as possible logic changes that may have been made to the schedule throughout the project up to the time the activity actually occurs.
- *Sub-Network Float Values*—Calculated float values associated with a string of activities will likely be different if calculated independent of all other activities in the overall schedule than if calculated when incorporated into the overall schedule. This can have a significant impact on float calculations when looking at an individual subcontractor's work activities, an individual area, or any other subset of the overall schedule independent of all other activities in the schedule.

- *Delay Must Affect the Critical Path*—When justifying delay to the contract completion, the identified issue(s) must have caused delay to the as-built critical path, regardless of whether it is an owner, contractor, or third-party delay. In practice, this necessitates comparison to the calculated late dates for activities, not reliance on the calculated early dates.
- *All Available Schedules Must Be Considered*—All schedules prepared for the project contain information (i.e., the contractor's original plan, changes to that plan, and as-built data) that can be of use in an as-planned versus as-built analysis.

It is important to note that commercially available CPM software programs are only a tool to perform the CPM calculations based on input from the project scheduler. As such, it may represent a tool to assist the schedule analyst perform his or her analysis. The use of any CPM software program is not, in and of itself, a CPM analysis nor a confirmation that any analysis performed with the assistance of a CPM software program is based on solid CPM fundamentals. Further, commercially available CPM software programs only perform calculations on the portion of the schedule forward (the future) from the data date. As such, these programs do not, and cannot, determine the as-built critical path at any point during the project.

5. AS-PLANNED VERSUS AS-BUILT METHOD IMPLEMENTATION

5.1. Description

As-planned versus as-built analyses involve comparison of a planned schedule (preferably an accepted or approved baseline) to as-built dates from an as-built schedule or other updated schedule that includes reported progress, or other means as discussed further later in this article. RP29R-03 identifies three types of as-planned versus as-built analyses and distinguishes between them in MIP 3.1 and MIP 3.2 and then identifies two specific implementation variations of MIP 3.2. Specifically, RP29R-03 defines these three implementations as:

- MIP 3.1 – Observational/Static/Gross
- MIP 3.2 – Observational/Static/Periodic
  - Fixed Periods
  - Variable Periods

RP29R-03 states MIP 3.2 "*analyzes the project in multiple segments rather than in one whole continuum*" as in MIP 3.1, and goes on to state:

> "*Because this (MIP 3.2) is essentially an enhancement of MIP 3.1, as a practical matter, the implementation of MIP 3.2 requires that prerequisites for MIP 3.1 be implemented first.*"

Since much of the analysis involved in the three types of as-planned versus as-built analyses is the same, the method of implementation specifics presented in this article apply to all three unless stated otherwise.

The as-planned versus as-built methodology is sometimes erroneously confused with a "total time" analysis. Total time analysis simply compares the planned completion date with the actual date, and in most general applications, assigns all that delay to a single, typically opposing, party. While the procedure described for a total time analysis uses the as-planned schedule and compares its completion to the as-built completion, the total time implementation fails to capture the necessary analysis for a proper as-planned versus as-built methodology described by this article. Specifically, in contrast to the total time analysis, the as-planned versus as-built methodology evaluates progress on an activity-by-activity basis and allows for identification of critical path delay on specific dates based on actual events on the project.

5.2. Recommended Source Validation Protocols

Section 2 of RP29R-03 provides four recommended Source Validation Protocols (SVP) pertaining to validating source data and identifying and quantifying delays as part of a forensic schedule analysis. The SVPs are:

- SVP 2.1 – Baseline Schedule Selection, Validation, and Rectification
- SVP 2.2 – As-Built Schedule Sources, Reconstruction, and Validation
- SVP 2.3 – Schedule Updates: Validation, Rectification, and Reconstruction
- SVP 2.4 – Identification and Quantification of Discrete Delay Events and Issues

A significant portion of as-planned versus as-built analyses involve comparison of data included in contemporaneous schedules, thus schedule data validation is crucial to reducing the chance of incorrect findings simply because the data used as the basis of the analysis was incorrect. The early stages of an as-planned versus as-built analysis should include source data validation to limit potential re-work that may be required if that as-built data is subsequently found to be incorrect.

SVP 2.1, SVP 2.2 or 2.3, and SVP 2.4 are recommended protocols for use in each as-planned versus as-built analysis. See RP29R-03, Section 2, for details associated with the implementation of each of these protocols.

5.3. Recommended Minimum Implementation Protocols

In its simplest form, an as-planned versus as-built analysis uses differences between planned and actual start and finish dates and/or activity durations to provide information from which delays, to the extent they exist in the performance of an activity, are identified and quantified and opinions formed. The comparison of actual dates should be made against planned late dates to determine the delays to activity start and finish dates. If the analyst compares actual dates against early dates, then the resulting number will include float if the activity was not on the critical path in the planned schedule.

The typical procedures to perform a basic as-planned versus as-built analysis on a relatively simple project include:

- Determine the baseline or other as-planned schedule that will be used. The preference should be to use the accepted (or approved) baseline schedule if one exists. This will allow for comparison of actual performance against a plan that the parties agreed was acceptable, at least early in the project. The more mutually-agreed-upon data that can be used in a forensic schedule analysis the better it is for all involved since it will reduce the number of items in dispute and focus discussion on differences in opinions formed based on interpretation of the data. Reference RP29R-03, Section 2, SVP 2.1 for more detailed recommendations about baseline schedule selection and validations.
- Determine the source(s) of as-built data that will be used. Validate as-built dates for planned and added work activities. Reference RP29R-03, Section 2, SVP 2.2, for more detailed recommendations about as-built schedule sources and data,

including discussion on the creation of a “Daily Specific As-Built” (DSAB).

- Compare as-planned late dates versus actual dates and planned durations versus actual durations for activities starting with the earliest planned activities and progressing through the latest planned activities. For each activity, calculate the difference between the planned late start versus actual start date, planned late finish versus actual finish date, and planned duration versus actual duration. All calculations should be performed on both a workday and calendar-day basis.
    - In commercially-available CPM schedule software, the forecasted dates for each activity are determined based on available workdays within the specific calendar assigned to each activity. It is possible, and in fact likely, that multiple calendars with different available workdays exist within the CPM schedule software. As such, if an activity is assigned to a calendar which limits workdays to anything less than a 7-workday work week, then the as-planned original duration for each of those activities must first be calculated on a calendar day basis prior to performing the calculations to determine the difference between the planned original duration and actual durations. For example, if a 5-workday activity is assigned to a calendar that allows 5 workdays per week, the 5-workday original duration must be adjusted by a factor of 7/5 (7 calendar days per week/5-workday workweek in the calendar) for a planned duration of 7 calendar days.

Activity ID	Activity Name	Original Duration (WDs)	Early Start	Early Finish	Late Start	Late Finish	Total Float	Successors
10	Notice to Proceed	0	3-Apr-17		3-Apr-17		0	20
20	Clear & Grub	20	3-Apr-17	28-Apr-17	3-Apr-17	28-Apr-17	0	30
30	Excavate	70	1-May-17	8-Aug-17	1-May-17	8-Aug-17	0	40
40	Grade	20	9-Aug-17	6-Sep-17	9-Aug-17	6-Sep-17	0	50, 80
50	Place Subgrade	30	7-Sep-17	18-Oct-17	7-Sep-17	18-Oct-17	0	60
60	Place Base Course	15	19-Oct-17	8-Nov-17	19-Oct-17	8-Nov-17	0	70
70	Place Surface Course	15	9-Nov-17	30-Nov-17	9-Nov-17	30-Nov-17	0	100
80	Place Sidewalk	10	7-Sep-17	20-Sep-17	9-Nov-17	22-Nov-17	40	90
90	Plant Landscaping	5	21-Sep-17	27-Sep-17	24-Nov-17	30-Nov-17	40	100
100	Project Completion	0		30-Nov-17		30-Nov-17	0	

FIGURE 1. Example Project – As-Planned Activities

Activity ID	Activity Name	Actual Start	Actual Finish	Actual Duration (CDs)	Actual Duration (WDs)
10	Notice to Proceed	4/3/2017		0	0
20	Clear & Grub	4/3/2017	4/28/2017	25	20
30	Excavate	5/1/2017	8/8/2017	99	70
40	Grade	8/1/2017	9/20/2017	50	34
50	Place Subgrade	9/21/2017	11/1/2017	41	30
60	Place Base Course	11/2/2017	3/7/2018	125	25
70	Place Surface Course	3/8/2018	3/28/2018	20	15
80	Place Sidewalk	11/15/2017	3/6/2018	111	15
90	Plant Landscaping	3/1/2018	3/7/2018	6	5
100	Project Completion		3/28/2018	0	0

FIGURE 2. Example Project – As-Built Data

Activity ID	Activity Name	Late Start - Actual Start (WDs)	Late Finish - Actual Finish (WDs)	Late Start - Actual Start (CDs)	Late Finish - Actual Finish (CDs)	Actual Duration - Original Duration (CDs)	Actual Duration - Original Duration (workdays)
10	Notice to Proceed	0		0		0	0
20	Clear & Grub	0	0	0	0	0	0
30	Excavate	0	0	0	0	0	0
40	Grade	6	-10	8	-14	22	14
50	Place Subgrade	-10	-10	-14	-14	0	0
60	Place Base Course	-10	-20	-14	-119	105	10
70	Place Surface Course	-20	-20	-119	-118	-1	0
80	Place Sidewalk	-4	-9	-6	-104	98	5
90	Plant Landscaping	-5	-5	-97	-97	0	0
100	Project Completion		-20		-118	0	0

FIGURE 3. Example Project – As-Planned Versus As-Built Dates and Durations Comparisons

- Based on the calculations above, determine the activities that experienced the largest differences between planned late start and/or finish dates and actual start and/or finish dates (actual date minus planned date) at any given point in time as the project progresses from start to finish, and then determine if these activities, or others based on construction experience, contemporaneous documentation, and expert opinion, represent a reasonable as-built critical path. Determination of the as-built critical path is discussed in detail in Section 5.5 of this article.
    - In either MIP 3.1 or MIP 3.2, the assessment of activity status can occur at any point during the performance of the project. This process may begin initially by assessing the relative status of activities at a key contractual milestone. As the schedule analyst continues the as-planned versus as-built forensic schedule analysis, the assessment of activity status will occur at smaller increments, such as to align with the project's periodic schedule updates, and may occur as frequently as individual days as necessary to determine changes, or potential changes, to the as-built critical path. See Section 5.4 of this article for more discussion on enhanced implementation protocols.
- Analyze differences between as-planned late dates and actual dates and between

as-planned and actual durations of activities that are on the as-built critical path and near-critical paths and determine timing, duration, and reason for each delay. This process should incorporate extensive analysis of available project documentation for the schedule analyst to use as support for his or her conclusions.

- Reconcile differences between delays to the as-built critical path and approved time extensions, to the extent that time extensions were granted.
- Reconcile differences that may exist between delays to individual as-built critical path activities and delays to project completion. A delay that is determined to have caused a delay during the performance of an as-built critical path activity may be the cause of a delay to a subsequent critical path activity that is much later in the project. An example of this is a delay to one activity that delays a weather-dependent activity from being performed during an anticipated good weather period to a winter weather period. Such delay to the second activity may show up in the delayed start of the activity, but not in the actual duration of the activity, if the actual duration is the same as the planned duration.

In general, an expert having performed these procedures for a basic as-planned versus as-built forensic schedule analysis will be able to form an opinion as to the timing, amount, and reason for delays that caused the late completion of a project.

5.4. Recommended Enhanced Implementation Protocols

On more complex projects or projects for which the as-planned and as-built critical paths may be significantly different, an as-planned versus as-built forensic schedule analysis may require more in-depth analysis to provide the information necessary to form a well-founded and supportable opinion. In these situations, an as-planned versus as-built analysis simply comparing activity dates and durations at periodic intervals may not result in enough detail to make informed decisions and therefore may require calculations on as much as a day-for-day basis while activities were in progress (see discussion of Daily Delay Measure (DDM) in RP29R-03, Section 3.1, F). While possible to do by hand, these calculations are more easily performed and analyzed using an electronic spreadsheet or database.

5.5. As-Built Critical Path Identification

Determination of the as-built critical path is one of, if not the most significant part of an as-planned versus as-built analysis. It is also one of the most contested parts of an as-planned versus as-built analysis.

A schedule analyst cannot determine the as-built critical path using a commercially-available computer scheduling software. A schedule analyst should consider as much contemporaneous documentation as possible and based on facts, CPM scheduling and construction principles, and his or her own experience, determine a reasonable as-built critical path that fits the project circumstances. Without a reasonable and supportable determination of the as-built critical path, any comparison to a plan and determination of delays as critical delay is equally unsupportable.

Prior to attempting to determine the as-built critical path, the analyst should first understand the project requirements including the contract, scope of work, special (non-standard) requirements, contractor's original as-planned schedule, and general construction sequencing. With this understanding, followed by validation of the as-planned schedule and as-built data and recommended calculations noted previously, the analyst can begin the process of determining the activities that were controlling the progress to project completion at any given point during the project. The analyst should also carefully analyze any potential critical and near-critical activities to determine if there were significant periods of no work between activity actual start and actual finish dates. This process can be a relatively quick determination on a small and non-complex project, however, it can be equally lengthy on a major and complex project and involve analysis of numerous near-critical paths prior to a final determination.

While going through the process of determining the as-built critical path, consideration of the following can provide useful information to assist the analyst in supporting and/or rejecting activities being considered part of the as-built critical path:

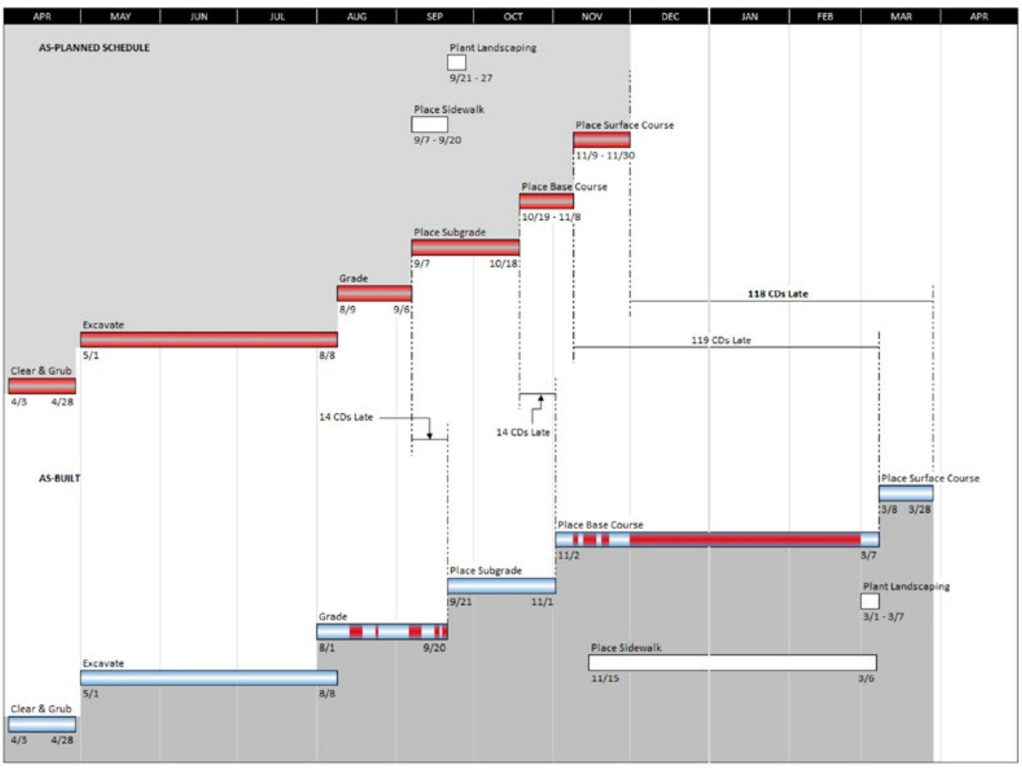

FIGURE 4. Example Project – Graphical Comparison Of As-Planned Versus As-Built Dates

- Was the activity on the as-planned critical path?
- Was the activity on the critical path in the schedule update prior to its actual start and/or during its performance if the activity was in progress at the time of a given update?
- Was the activity performed out-of-sequence from what was represented in the contractor's as-planned schedule?
- Were planned successor activities performed out-of-sequence; especially prior to or concurrent with the activity, or concurrent with other planned critical activities in the successor string.
- Does comparison of as-planned versus actual dates show that the activity was the most delayed of all activities at the time of its actual start and/or finish?
- Were there unexplained, and potentially significant periods of no work on the activity between its actual start and actual finish dates?
- Was the activity weather dependent, and if so, were there periods of inclement weather immediately before or during the activity's actual date range? Did the contractor incorporate anticipated inclement weather considerations in the as-planned schedule, and if so, how?
- Were the same trade resources working on other activities immediately prior to the start or at the same time as the activity being considered? If so, is this how the contractor planned to accomplish these activities?
- Does contemporaneous project documentation (correspondence, meeting minutes, daily reports, photographs, staffing reports, etc.) identify that the parties acted as if the activity was critical during the project?

This list should not be considered all inclusive, nor should an answer to any one or multiple of these be considered absolute justification for including the activity on the as-built critical path. The schedule analyst should consider all the information he or she has and form his or her opinion based on the facts, scheduling and construction principles, and his or her own experience.

5.6. Concurrency and Pacing

Concurrent delay and pacing are often presented as arguments by one of the parties to a delay dispute to offset a delay for which the party may be responsible, and more specifically, in an attempt to limit responsibility for liquidated damages or for extended general conditions costs claims for which the party may be responsible. In general, concurrent delay can be described as: two or more delays occurring at the same time that are the legal responsibility of different parties, each of which, independent of the other, delay the completion of the project.

Since the topic of concurrent delay could be a topic unto its own, this article will not address the topic in depth. However, the concept of concurrent delay and the similar components to pacing arguments should be understood by an analyst and taken into consideration in a forensic schedule analysis if it is believed that they may have existed. The reader is referred to RP29-03, Section 4.2 Identification and Quantification of Concurrent Delay, for more details of the topic.

5.7. Quantification of Delays

Critical delays computed during a forensic schedule analysis are typically grouped into one of three categories based on the cause and party responsible for each of the delays:

1. *Excusable, Compensable*—A critical delay to the project completion for which the contractor is due a time extension and additional compensation.
2. *Excusable, Non-Compensable*—A critical delay to the project completion for which the contractor is due a time extension but no additional compensation
3. *Non-Excusable (or Inexcusable)*—A critical delay to the project completion for which the contractor is not due a time extension nor additional compensation and may be exposed to assessment of liquidated damages.

Prior to the categorization of each delay the analyst should have a full understanding of the project specifications, particularly those pertaining to delays since contract language may specify how certain delays and delay associated costs are to be addressed. In addition, an analyst must be careful to reconcile calculated critical activity delays with the delay to project completion, or in some circumstances to interim completion milestones. These are not always day-for-day and must take into consideration non-workdays (such as weather, holidays, etc.) incorporated into the contract and schedule.

The as-planned versus as-built methodology calculates delay as it actually occurred. At any measurement point, it does not consider future events on the project, either planned or actual, but allows for forensic identification and quantification of delays, or conversely accelerations, when they occurred. Since it reflects the actual delay as measured at the activity under consideration, the analyst should consider that delays that show up in subsequent as-built critical path activities may have an earlier delay as the root cause.

5.8. Quantification of Mitigation/ Acceleration

Comparison of as-planned versus as-built dates cannot demonstrate, on its own, that a contractor mitigated potential delays especially if arguing it did so by accelerating its work on certain activities. However, an as-planned versus as-built analysis can demonstrate the potential that this may have occurred. The analyst should consider the following, and determine if they represent signs the contractor may have mitigated delays through acceleration:

- Does the as-built critical path include out-of-sequence work? If the out-of-sequence work was performed by mobilizing additional workers and/or equipment, then the out-of-sequence work may have been accomplished through acceleration. If the out-of-sequence work was performed by ignoring preferential logic and did not involve mobilizing additional workers and/or equipment, then the contractor may have mitigated potential further critical delay without incurring additional costs and thus not accelerated.
- Was the as-built duration significantly less than the as-planned duration for any activity or activities on the as-built critical path? If so, and if the contractor can demonstrate it expended significantly more worker-hours and/or equipment (than planned) to accomplish this reduced duration, then the contractor may be able to demonstrate acceleration. However, if the contractor's actual worker-hours and/or equipment expended to accomplish the activity were essentially the same or less than planned, then the reduced duration may have been the result of an over-estimated duration and been achieved at no additional costs to the contractor.

6. GROSS VERSUS PERIODIC AS-PLANNED VERSUS AS-BUILT ANALYSES

As-planned versus as-built analyses are performed by implementing the same basic steps regardless of whether they are performed using a gross (entire project) duration or by breaking the project into smaller performance periods with fixed or variable durations. Properly performed, the analyses should produce the same result.

The specific type of as-planned versus as-built analysis selection is most often one of preference of the analyst and can be influenced by the complexity of the project and available project documentation. A forensic schedule analysis of a relatively simple project may be easily presented using the gross method, while a project with numerous critical path activities, multiple phases or interim milestones, or changes in the critical path between as-planned and as-built will likely be easier to present, and easier for a trier of fact to understand, using a periodic analysis.

7. METHOD SELECTION

A properly performed as-planned versus as-built forensic schedule analysis allows the analyst to determine what the parties planned, what actually happened, and the quantification of any discrepancies between the two. The analyst is essentially telling the story of the project based on supported facts instead of hypothetical or what-if scenarios that may have never occurred or may not have been controlling when they did occur. The as-planned versus as-built forensic schedule analysis methodology has been accepted by courts because of its ease of understanding, its basis upon the original plan for the project and actual events, and its avoidance of hypothetical projections. Further, because it measures delay or acceleration as it actually occurs and does not forecast future events, it more closely reflects contemporaneous progress than many other forensic schedule delay methodologies. Like all forensic schedule delay methodologies, the methodology can be manipulated or, if done without sufficient care, result in poorly supported conclusions. Understanding some of the common criticisms of the methodology will assist the analyst in developing a more accurate and better supported set of conclusions.

The following list contains some of the more common criticisms and purported limitations of the as-planned versus as-built forensic schedule analysis methodology, including those noted in RP29R-03, and ways in which these criticisms or limitations may be mitigated:

- *Unreliable for Use in Analyzing Long Duration Projects*—This argument may be overcome by carefully identifying the changes in actual progress and explaining how and why the analyst determined activities appear on or disappear from the as-built critical path.
- *Unreliable for Use in Analyzing Projects Constructed in a Manner Significantly Different From Planned*—This may be overcome by accounting for and reconciling the impact of differences between the as-planned and as-built approaches to constructing the project when determining and quantifying critical delays. Analyzing and explaining sequencing changes incorporated into any contemporaneous "re-baseline" schedule also provides a mechanism through which to increase reliability in these situations.
- *Unreliable for Projects With Multiple Concurrent Critical Paths*—Whether the multiple concurrent critical paths exist in the as-planned schedule or are determined at times in the as-built performance of the project, the reliability is improved by not only analyzing both the as-planned and as-built critical paths but also near-critical paths, and any other paths as necessary and appropriate, instead of a singular as-planned or as-built critical path.
- *Choices and Use of Select As-Built Data From the Schedule May Give Appearance of Manipulation*—This may be overcome by validating the as-built data in contemporaneous schedules with other contemporaneous documents. In addition, the use of the enhanced implementation techniques discussed in Section 5.4 of this article, allow the analyst to provide daily justification for the selection of each as-built date based on the whole of available project data, not just data from the project schedule.
- *Choices and Use of Select Start and End Dates of Periods*—This may be overcome by selecting period start and finish dates based on standard periods used contemporaneously during the project (i.e., schedule update data dates), as-built critical path activity start or finish dates, or contract milestone dates, and thoroughly documenting the reason for each selection.
- *May Not Identify All Critical Delays*—This may be overcome by progressing the analysis from the start of the project through completion.
- *Does Not Account for Granted Time Extensions*—This may be overcome by reconciling the findings with approved time extensions and the determined cause and specific dates of the as-built critical path delays.
- *Does Not Adequately Consider Pacing Issues*—This may be overcome by combining the as-planned versus as-built analysis of critical and near-critical paths with analysis of planned versus actual resource data and other contemporaneous documentation.
- *Does Not Consider That Changes to the As-Planned Schedule May Have Been the Actual Cause of Delay Versus Other Identified Delays*—This occurs when an analyst relies solely on comparison of as-planned versus as-built dates and focuses quantification of delay on activities that show the greatest differences between the two without reconciling delays based on all factors. This can be overcome by analyzing out-of-sequence progress and using other contemporaneous documentation to support findings as to why.
- *Typically Fails to Consider Chronological Order of Delays*—This may be overcome by progressing analysis from the start of the project through completion.
- *Typically Fails to Reconcile New Forecasted Critical Paths in Periodic Schedule Updates With the Analyst-Determined As-Built Critical Path*—This may be overcome by analyzing critical and near-critical paths instead of a single path. In addition, this may be overcome by using periodic schedule updates and other contemporaneous documentation to assess the intent of the parties and any influence that had upon the actions or inactions of any party ultimately determined responsible for critical path delay.
- *Unreliable for Clearly Demonstrating Acceleration*—This may be overcome by combining findings from the as-planned versus as-built analysis of critical and near-critical paths with analysis of planned versus actual resource data and other contemporaneous documentation.
- *Project Specification Changes Section Requires Use of Another Methodology*—This argument typically applies to the parties' consideration of a potential change and agreement prior to the performance of changed or added work during the course of construction. Most

contracts are silent as to how to analyze critical delays after they have occurred. In these situations, the schedule analyst may determine that the as-planned versus as-built methodology is the appropriate retrospective analysis technique for the project in question.

- *As-Built Critical Path Does Not Really Exist Since It Is Not a Calculated Path*— The as-built critical path represents the path of interrelated activities (based on analysis of as-built logic, actual events, circumstances, and actions of the project participants, and CPM scheduling principles), that in the expert's opinion, controlled the project finishing when it did. As discussed previously in this article, commercially available CPM software programs only perform calculations on the portion of the schedule forward (future) from the data date (in other words, the work yet to be performed or yet to be completed). As such, these programs do not, and cannot, determine the as-built critical path at any point during the project.
- *Methodology is a 'total time' analysis* – this is typically the case when an analysis is presented that states the total delay based simply on a comparison of the planned and actual project completion dates and then identifies causes of delay without assigning the delays to specific as-built critical path activities nor identifying the specific dates the delays occurred. This may be overcome with detailed review of the project record and by identifying specific delays to the as-built critical path, including the issue, the delayed critical path activity, the date(s) the delay occurred, and quantification of the total corresponding delay.

REFERENCES

1. AACE® International Recommended Practice 29R-03, Forensic Schedule Analysis, TCM Framework: 6.4 – Forensic Performance Assessment, April 25, 2011 Revision

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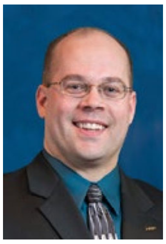

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APPENDIX – EXAMPLE PROJECT

As-Planned Schedule Activities

Activity ID	Activity Name	Original Duration (WDs)	Successors
10	Notice to Proceed	0	20
20	Clear & Grub	20	30
30	Excavate	70	40
40	Grade	20	50, 80
50	Place Subgrade	30	60
60	Place Base Course	15	70
70	Place Surface Course	15	100
80	Place Sidewalk	10	90
90	Plant Landscaping	5	100
100	Project Completion	0	

As-Planned Schedule Activities – Dates

Activity ID	Activity Name	Original Duration (WDs)	Early Start	Early Finish	Late Start	Late Finish	Total Float	Successors
10	Notice to Proceed	0	3-Apr-17		3-Apr-17		0	20
20	Clear & Grub	20	3-Apr-17	28-Apr-17	3-Apr-17	28-Apr-17	0	30
30	Excavate	70	1-May-17	8-Aug-17	1-May-17	8-Aug-17	0	40
40	Grade	20	9-Aug-17	6-Sep-17	9-Aug-17	6-Sep-17	0	50, 80
50	Place Subgrade	30	7-Sep-17	18-Oct-17	7-Sep-17	18-Oct-17	0	60
60	Place Base Course	15	19-Oct-17	8-Nov-17	19-Oct-17	8-Nov-17	0	70
70	Place Surface Course	15	9-Nov-17	30-Nov-17	9-Nov-17	30-Nov-17	0	100
80	Place Sidewalk	10	7-Sep-17	20-Sep-17	9-Nov-17	22-Nov-17	40	90
90	Plant Landscaping	5	21-Sep-17	27-Sep-17	24-Nov-17	30-Nov-17	40	100
100	Project Completion	0		30-Nov-17		30-Nov-17	0	

As-Built Data

Activity ID	Activity Name	Actual Start	Actual Finish	Actual Duration (CDs)	Actual Duration (WDs)
10	Notice to Proceed	4/3/2017		0	0
20	Clear & Grub	4/3/2017	4/28/2017	25	20
30	Excavate	5/1/2017	8/8/2017	99	70
40	Grade	8/1/2017	9/20/2017	50	34
50	Place Subgrade	9/21/2017	11/1/2017	41	30
60	Place Base Course	11/2/2017	3/7/2018	125	25
70	Place Surface Course	3/8/2018	3/28/2018	20	15
80	Place Sidewalk	11/15/2017	3/6/2018	111	15
90	Plant Landscaping	3/1/2018	3/7/2018	6	5
100	Project Completion		3/28/2018	0	0

Schedule Calendar

Planned non-workday

No paving or planting allowed per Contract

APR

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

MAY

SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

JUN

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

JUL

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

AUG

SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

SEP

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

OCT

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

NOV

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

DEC

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

JAN

SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

FEB

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

MAR

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

As-Planned versus As-Built Data Comparisons

Activity ID	Activity Name	Late Start - Actual Start (WDs)	Late Finish - Actual Finish (WDs)	Late Start - Actual Start (CDs)	Late Finish - Actual Finish (CDs)	Actual Duration - Original Duration (CDs)	Actual Duration - Original Duration (workdays)
10	Notice to Proceed	0		0		0	0
20	Clear & Grub	0	0	0	0	0	0
30	Excavate	0	0	0	0	0	0
40	Grade	6	-10	8	-14	22	14
50	Place Subgrade	-10	-10	-14	-14	0	0
60	Place Base Course	-10	-20	-14	-119	105	10
70	Place Surface Course	-20	-20	-119	-118	-1	0
80	Place Sidewalk	-4	-9	-6	-104	98	5
90	Plant Landscaping	-5	-5	-97	-97	0	0
100	Project Completion		-20		-118	0	0