Delay Analysis in Construction
Utilizing CPM Schedules

BACKGROUND

All construction projects consist of detailed scope of work that must be performed within a specified duration for an agreed amount of compensation. Failure to complete the project in the mandated time period can result in financial losses and penalties. Hence, the use of a properly prepared construction schedule is a necessity to satisfactorily complete projects and maintain profitability.

If a project is delayed, the construction schedule can be utilized to quantify the impact by comparing planned performance with actual execution. The majority of project owners as well as the legal system now require the use of properly prepared construction schedules to prove liability and entitlement of delay damages in construction projects.

The Critical Path Method (CPM) of developing a construction schedule consists of separating the entire project into individual tasks with associated durations and then assigning relationships between the various tasks such that all the tasks are completed within the permitted project duration. The project's "critical path" is the sequence of activities with the longest overall duration from the start of construction to the required completion date. Any activity delay on the critical path will result in a day-to-day extension to the completion date. A properly prepared CPM schedule is invaluable for the efficient use of available resources and advance warning of events that could delay the project's completion.

DELAY CLASSIFICATION

Project delays can be classified as an excusable delay or a non-excusable delay.

Excusable delays are those where the contractor is entitled to receive a schedule extension due to events that are out of his control. Typical examples include inter alia weather delays, unforeseen subsurface conditions or design changes.

Non-excusable delays are solely caused by the contractor and no good reason exists for granting an extension of contract time.

Excusable delays can be further classified as compensable or non-compensable delays.

Compensable-excusable delays are those where the claimant is entitled to recover remuneration for expenses incurred as a result of the delay. Typical examples include inter alia schedule extensions associated with scope changes, design changes, owner interference.

Non-compensable-excusable delays are those where the contract is extended but the contractor is not entitled to additional compensation. The contract often times defines the events that are non-compensable-excusable delays. A common example is a delay associated with unusual or severe weather.
DELAY CLAIM ANALYSIS

Schedule Analysis During Construction
Schedule delay analysis can be contemporaneously performed while the project is still underway and makes use of the best estimate of the future events. Many contracts require the contractor to utilize CPM schedule analysis to quantify the delay based on the information known at that time. To perform the contemporaneous analysis and to quantify the delay, the contractor should utilize the most recent schedule update and insert new activities into the schedule that reflect the changed condition. The resultant extension to the project's completion date is the delay associated with the changed condition.

Schedule Analysis After Construction
In a claim situation schedule delay analysis are performed after the project has completed and all of the impacts are known or recorded in the project record. There are many techniques used by consultants to quantify a delay claim.

One such analysis is the Total Time Approach which simply requests an extension for every day the contract is late. This technique is analogous to the Total Cost Claim in that the contractor assumes that it is perfect and that all delays are caused by others. The Total Time Approach is not favored by the courts.

Another technique is the Impacted As-Planned Method where the baseline schedule is adjusted to reflect delays that occurred during the project. This technique has some significant benefits in that it is easy and inexpensive to perform and is readily understood by a jury. However, there are many technical problems with this approach. For example, one could bias the result by only inserting "favorable" delaying events. Further, this technique ignores what actually happened during the project; such as contractor caused delays, change orders, etc. which could have impacted the schedule. Moreover, this technique improperly assumes the project's critical path in the baseline schedule does not change for the duration of construction. For these and other reasons, the As-Planned Approach many times is not favored by courts. However, there are situations where project records are so poor or where there are not any monthly schedule updates that one has no choice but to use the Impacted As-Planned Method. Prior to adopting the Impacted As-Planned Method one must carefully consider the risks associated with this technique. A qualified expert and counsel should be retained to assist in the decision and to make sure the technique is performed in such a manner that it will be accepted in court.

The most accepted approach to analyze schedule delays is commonly referred to as the Windows Analysis (or the Time Impact Analysis). This technique analyzes the delays experienced by the project between specific periods of time when the delaying event occurred.

To perform the Windows Analysis the original as-planned schedule is compared against the as-built schedule to identify differences in the planned performance and actual performance. The causes and effects of the variances between the schedules are then evaluated to determine which delay(s) are excusable or non-excusable as well as compensable or non-compensable. In a claim situation it is common that there are multiple delays to the project that must be deciphered to determine which event is controlling the delayed completion date. In this situation, the Windows Analysis is very useful because it quantifies the experienced delay at various project stages and allows one to segregate the impacts for different events.
For example, in a college construction project, it was alleged that the design errors and omissions was the cause of the delay in the fabrication and erection of structural steel. Schedule delay analysis showed there was a delay with construction of the foundations that was caused by the contractor which delayed the start of steel erection. Both independent events delayed the start of steel erection. As a result, the contractor was entitled to receive a non-compensable extension of time; the owner could not collect liquidated damages and the contractor could not collect delay damages because the delays were concurrent. To perform the above schedule analysis, an as-built schedule was prepared and compared to the as-planned schedule. A Windows Analysis confirmed that both delays were concurrent and that each independently delayed the project's completion date.

VERIFICATION OF THE AS-PLANNED SCHEDULE

Regardless of which schedule analysis method that is used, the first step is validation of the as-planned schedule to confirm that it includes the proper contract term, the proper start/finish dates, milestone dates and the entire scope of work. More importantly when performing Window Analysis the schedule's logic must be reviewed to validate that it is reasonable and that the schedule dates are not artificially constrained.

It is important to determine whether the as-planned schedule has been approved or agreed to by the various parties involved in the project. Occasionally we have been involved in claim analysis situations where the schedule was not officially approved by the owner. In these situations it is important to determine what schedule was used by the parties to track progress; this schedule could then be used as the as-planned schedule. The key in this situation is to be fair and reasonable in the determination of the as-planned schedule and to fully document/explain the basis for selecting the specific schedule.

It also is important to confirm the schedule used in the analysis actually is the as-planned schedule. Some schedulers may be sloppy and not properly change the name of the computerized CPM schedules to reflect revisions made prior to its approval. We have observed some consultants base their analysis on a schedule that they incorrectly thought was the baseline schedule. Obviously this error resulted in improper conclusions and an unhappy client.

It is also essential that any incorrect logic or unrealistic activity durations contained in the baseline schedule are corrected before the baseline schedule is used for proving a delay claim. We have observed many as-planned schedules approved by the owner with patent errors in the schedule sequence/logic and with improperly constrained dates. If the as-planned schedule contains errors, then any analysis/conclusion based on a faulty schedule could be rejected in court.

VERIFICATION OF MONTHLY SCHEDULE UPDATES

Further, we have occasionally observed updated schedules that incorporated significant logic changes to mask delays. Computer software exists that allows a consultant to locate these improper schedule changes.
For a school construction project, one of the periodic schedule updates introduced a winter shutdown calendar for the exterior masonry work. The contractor alleged that the rectification of structural steel design errors pushed the installation of exterior masonry into the shutdown period and delayed the project completion. Schedule analysis indicated that the exterior masonry installation work had already been pushed into the shutdown period prior to the start of the rectification of structural steel design errors due to contractor caused delay. The contractor was not entitled to receive additional compensation for winter masonry work.

PREPARATION OF THE AS-BUILT SCHEDULE

An as-built schedule can be created from scratch using the project's daily history of events. Periodic updates of the baseline schedule can also be used to generate the as-built schedule provided that:

- The schedule logic is corrected to reflect the actual sequence followed in the field
- The activity durations are revised to replicate actual durations
- The activity relationships are appropriately revised to address out-of-sequence work
- Actual start and finish dates for all activities are reproduced

Schedule updates should be specifically checked to identify manipulation of the schedule logic to disguise delays by the claimant.

During the construction of a sewerage treatment plant, one of the periodic schedule updates reported a critical construction activity was 100% complete which obviously removed it from the critical path of remaining work to be performed. In a subsequent schedule update the activity was reported to be only 80% complete, but the logic was changed to remove it from the critical path. The owner did not realize the change made to the schedule which hid the critical delay caused by the contractor.

CONCLUSION

Most projects happily complete on time without any claims. However, project delays do occur; sometimes caused by the owner/designer, sometimes caused by the contractor, and sometimes caused by unforeseen events/conditions. To maximize recovery of its damages, it is paramount for the contractor to utilize sound schedule analysis that withstands criticism. To minimize payments for contractor caused delays, an owner must fully review all schedules to ensure there are not any changes made to the underlying logic that masks contractor caused delays. The guideline is to be fair and reasonable at all times and to contemporaneously fully document all potential delaying events. If this guideline is followed, you can avoid costly litigation.

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