Schedule Delay Analysis

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ABSTRACT:
This article attempts to show that delay does matter and that different methods of analyzing schedule delay will lead to different results for the owner and the contractor. A delay is an act or event that extends the time required to perform tasks under a contract. It usually shows up as additional days of work or as the delayed start of an activity, and may or may not involve a change in the scope of the contract.

KEY WORDS: delay analysis, damages, recovery, as-built schedule, contemporaneous period analysis

A delay is an act or event that extends the time required to perform tasks under a contract. Delays usually show up as additional days of work or as the delayed start of an activity, and may or may not involve a change in the scope of the contract. Delays may or may not extend the schedule for performing the entire scope of the contract. By the most basic principle of critical path scheduling, delays on network paths off of the critical path do not extend the schedule until the entire float along those paths is consumed [4].

> The reason that the determination of the critical path is crucial to the calculation of delay damages is that only construction work on the critical path had an impact upon the time in which the project was completed. If work on the critical path was delayed, then the eventual completion date of the project was delayed. Delay involving work not on the critical path generally had no impact on the eventual completion date of the project [3].

So, why do we care what caused a delay or who is responsible? Or even whether a delay occurred? The project is already over, isn't it? What difference does it make now?

- Owners care because determination of who caused a delay may result in assessment of liquidated damages or require the payment of additional compensation to the contractor.
- Contractors care for equal but opposite reasons. They might be able to claim additional compensation or have to pay liquidated damages to the owner.
- Taxpayers care because delay damages can dramatically increase the final cost of a public works project.
- Bonding companies and sureties care because they have to indemnify contractor performance.

This article attempts to show that delay does matter and that different methods of analyzing schedule delay will lead to different results for the owner and contractor.

In general, there are three types of delays: independent, serial, and concurrent.

Independent Delays

These occur in isolation and do not result from a previous delay. The effect of an independent delay on the total project duration usually can be calculated. An independent delay may cause a serial delay.

Serial Delays

Serial delays occur solely as the result of an earlier, unrelated delay to preceding work. For example, a labor strike by sheet metal workers delays the installation of HVAC (heating, ventilation, and air conditioning) duct solely because there was an earlier design hold on the duct. For another example, winter weather delays installation solely because the earlier labor strike pushed the work into the winter season [4].

In serial delays, the timing of a delay with respect to other delays is the primary issue. While independent delays are single delays, serial delays are sequences of consecutive non-overlapping delays on a particular network path. In serial delays, the individual delays do not conflict, and the appropriation of the overall project delay is relatively easy to determine [1].

Concurrent Delays

These delays involve two or more delay events. Taken alone, either of the events would cause a delay in the project schedule, but if either of the delays had not occurred, the schedule would have been delayed by the other delay. Two unrelated delays may be concurrent if they fall on parallel critical paths. For example, an owner places a hold on approval of shop drawings for structural steel at the same time that the contractor faces a default by an unrelated subcontractor. Either or both of these delays would have extended the project end date.

Some corollaries to these types of delay are listed below.

- Two unrelated delays taking place in overlapping time frames are truly concurrent only if both delays fall on parallel critical paths.
- Delay on the critical path is not truly concurrent with another delay off of the critical path arising in an overlapping period.
- Delays off of the critical path may ultimately be concurrent to the extent that they exceed the total float available in those paths [4].

Generally, in a contract dispute that is being litigated or arbitrated, the responsibility for concurrent delays is not allocated between the parties unless the court or arbitrators perceive a reasonable basis for the allocation. All parties generally bear their own costs associated with concurrent delays. Usually, the owner is not entitled to liquidated or time-related damages, and the contractor must absorb its time-related costs [6].

CATEGORIES OF RECOVERY FOR DAMAGES

There are three categories of possible recovery for schedule delay damages: inexcusable delays, excusable and non-compensable delays, and excusable and compensable delays.

Inexcusable Delays

Inexcusable delays are within the control of the contractor, its subcontractors, or suppliers, at any tier. Examples include delay caused by late mobilization, late equipment deliveries, or an inadequate project work force. Inexcusable delays are not only not compensable, but they can expose a contractor to delay claims of its subcontractors and to liquidated damages by the owner (or actual damages if there is no liquidated damages clause) [6].

Excusable Delays

Excusable delays are not caused by the contractor's actions or inactions. These are delays over which the contractor had no control. Excusable delays typically entitle the contractor to contractual time extensions if a project's completion date were affected.

Excusable delays may affect noncritical paths on the project as well. When an excusable delay results in a time extension to contractual completion dates, the point in time from which the owner begins assessing liquidated damages is modified or extended. If a delay is found to be excusable, it must be determined if it is noncompensable or compensable.

Noncompensable Delays

Noncompensable delays are excusable delays caused by neither of the parties (or both in the case of concurrent delay). Since both the owner and the contractor have been damaged by the delay and neither (or both) has caused it, only time extensions are warranted. This generally precludes either party from recovering delay damages [5].

Noncompensable delays are typically outside the control of the parties. Some examples include delays caused by labor strikes, acts of God, and unanticipated abnormal weather. Generally, all parties bear their own costs associated with excusable noncompensable delays. Usually, the contractor is entitled to a time extension that eliminates its exposure to liquidated damages being assessed by the owner [6].

Compensable Delays

Compensable delays are excusable delays that are within the control of the owner and its agents or employees, including its construction manager, architect, engineer, or another prime contractor. These delays can arise from acts of the owner in its contractual capacity, from acts of another contractor in the performance of a contract with the owner, or from other events for which the owner has accepted responsibility under the contract. Examples of compensable delays include change orders, differing site conditions, suspension of work for owner convenience, and late review of submittals. A compensable delay may warrant a time extension and expose the owner to delay damages being claimed by the contractor for extended field office overhead and unabsorbed home office overhead [4].

Recovery of damages for concurrent delay is highly dependent upon the situation. The analyst must review the facts of each case carefully. The general rule is that concurrent delays are handled as noncompensable delays, where the certain benefit of excusability wipes out any potential benefit of compensability. The net result is an excusable delay with no liquidated damages or delay damages to the contractor. However, there are exceptions to this "no harm, no foul" rule.

- An inexcusable delay concurrent with an excusable delay generally yields a net excusable delay.
- An excusable delay concurrent with a suspension of work yields a net excusable delay. The US federal suspension clause clearly states that no adjustment shall be made if "the performance would have been so suspended, delayed, or interrupted by any other cause . . . [8]."
- An excusable delay concurrent with delays due to scope changes or differing site conditions may yield a compensable condition, provided that the contractor seeks recovery under these provisions only, as opposed to the suspension provision. Essentially, this is because the relevant federal clauses do not void recovery if other delaying factors materialize [8]. This means that the contractor is simply allowed to not prosecute the excusable issue and merely asserts that the issue of differing site conditions did increase the performance time.

METHODS OF SCHEDULE DELAY ANALYSIS

Many methods exist for schedule delay analysis. This article focuses on the four currently most common methods:

- the as-planned versus as-built comparison method;
- the impacted as-planned method;
- the collapsed as-built method; and
- the contemporaneous period analysis method.

The as-planned versus as-built comparison method compares the as-planned schedule to the as-built schedule. The as-planned schedule represents the contractor's original plan for completing the work required by the contract documents, within the time frames established by them. It includes, at a minimum, planned activities, their durations and relationships, and any completion dates imposed by the contract documents. The as-built schedule depicts the actual sequence of activities as they occurred during the project. This schedule shows the actual start and finish of each activity, including activity disruptions or discontinuity. Activities added to the as-planned schedule, as well as plan changes, should be shown. The comparison method is sometimes known as the total time approach. It assumes that the party using the method (the contractor) causes no delays, and that the owner causes all delays.

The impacted as-planned method uses the as-planned schedule as a basis. To assess the affect of a contractor's delays, add the contractor delay activities to the as-planned schedule to demonstrate the total delay attributable to the contractor. To assess the affect of owner-caused delays, add the owner delay activities to the as-planned schedule to demonstrate the total delay attributable to the owner. The impacted as-planned method is known as the "what-if" approach. Even though either side in the dispute can use the method, it can be an argumentative or one-sided approach that often ignores delays caused by the party using the method. Impacted as-planned schedules reflect how the as-planned schedule theoretically could have been impacted as a result of various owner- or contractor-caused delays that are inserted into the schedule. They also may reflect the contractor's plan to complete the remaining work, given these impacts on the project [5].

Contractors, in order to demonstrate a schedule that they allegedly could have achieved "but-for" the actions of the owner, usually use the collapsed as-built method. The contractor's interpretations of owner-caused delays are extracted from an as-built schedule that shows all delays by all parties in order to make this demonstration. Like the previous methods, this approach can be argumentative and one-sided because it often ignores certain delays caused by the contractor.

Contemporaneous period analysis makes use of schedule "windows" or "snapshots" to determine delay and allocate responsibility for delay during each of a number of discreet time windows or time periods during the course of the project. The intent of this method is to look at each snapshot of the project schedule in light of the information that was available to the actual parties at that time—as shown by contemporaneous project records and schedule updates.

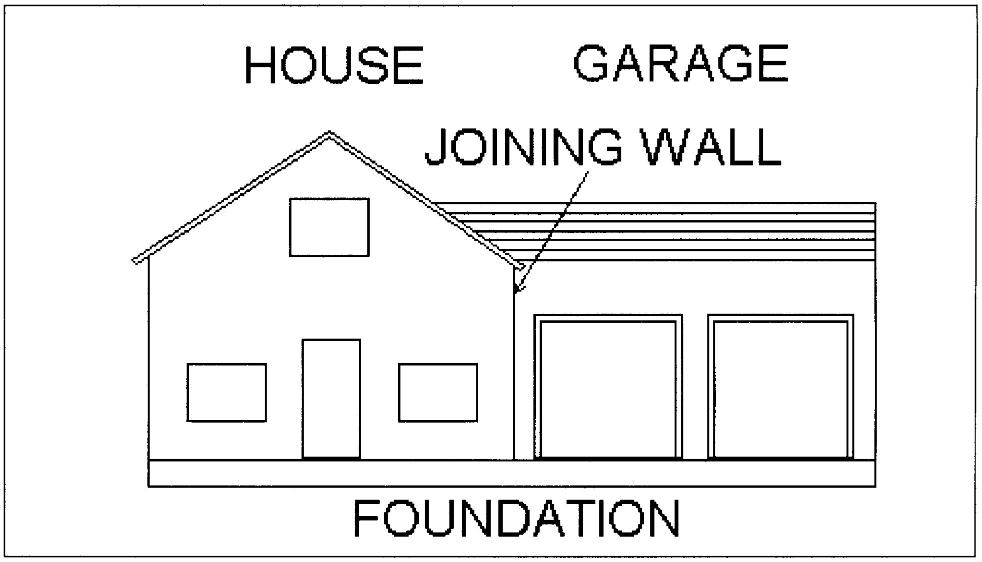

Figure 1—Home Construction Project

A CASE STUDY

To demonstrate the four methods of schedule delay analysis discussed above, it is helpful to look at a specific case study. The schedule used in the case study is for a simple home construction project with an attached garage, which shares a wall with the house (see figure 1). The facts relevant to project delays in the case study are given below.

- The contractor encountered unforeseen rock at the start of week #2 while excavating the foundation, and was delayed 3 weeks. Before encountering rock, the contractor was on schedule.
- The owner stopped work on the house walls 2 weeks after the start because he decided he did not like the windows called for in the original design. The owner took 2 weeks to decide that the original windows were satisfactory, after all.
- The contractor's framing subcontractor experienced financial problems and abandoned the job after working 2 weeks on the house and garage walls. At that time, both the house walls and the garage walls were 50 percent complete. It took 3 weeks for the contractor to get a new framer.
- The contractor did not order the garage doors until the end of week #11, which was 4 weeks later than the original late start date.
- The owner did not complete selecting finishes until the end of week #18, instead of at the end of week #12 as planned.
- The contractor took 2 weeks longer than planned to complete the interior finishes.
- The contractor took 1 week longer than planned to complete the garage walls.
- When the garage doors arrived at the end of week #17 (already 4 weeks late because of the contractor's late order), the owner changed his mind and requested different doors. It took 4 weeks to get the new doors.

THE AS-PLANNED VERSUS AS-BUILT COMPARISON METHOD

The first method used to analyze the case study is the as-planned versus as-built comparison method, in which the following steps are taken:

- prepare or recover the as-planned schedule;
- prepare or recover the as-built schedule;
- add delays to the as-built schedule; and
- analyze the as-built schedule to calculate owner-caused delay, contractor-caused delay, and concurrent delay.

In its simplest form, a total time approach compares the as-planned schedule to an as-built schedule and claims that the total amount of delay is recoverable. This approach presumes that the owner caused the delays, that the delays are recoverable, that the contractor is not responsible for any delay, and that the owner is responsi-

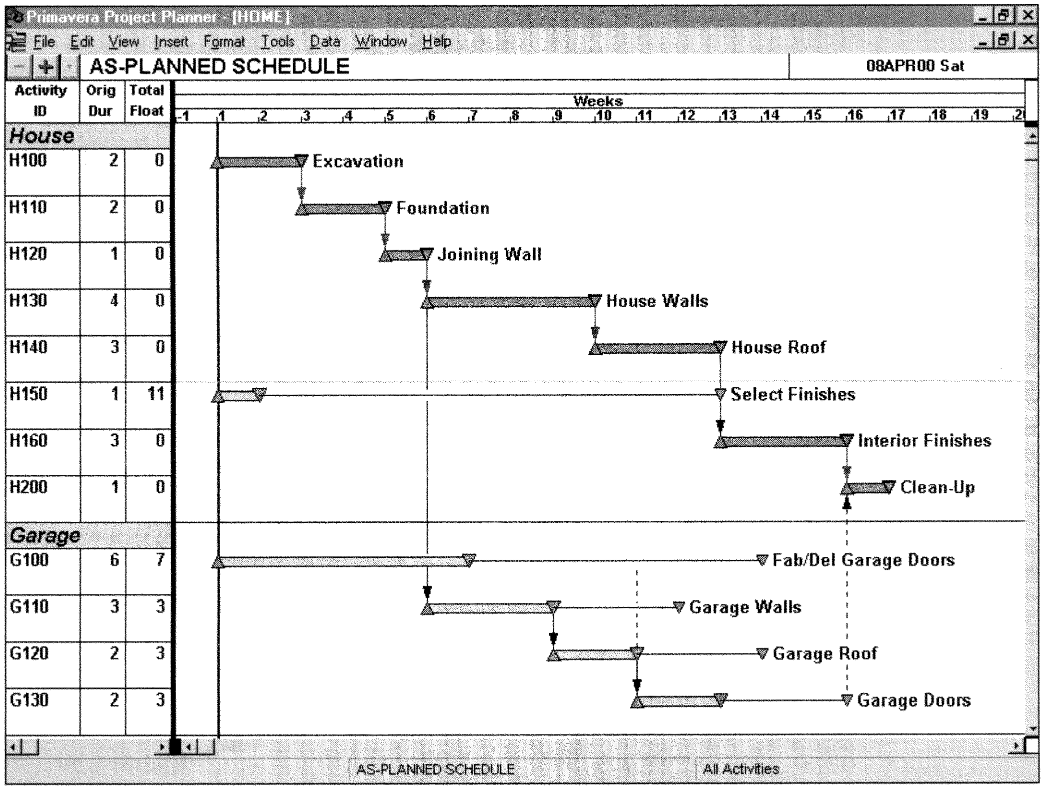

Figure 2—As-Planned Schedule

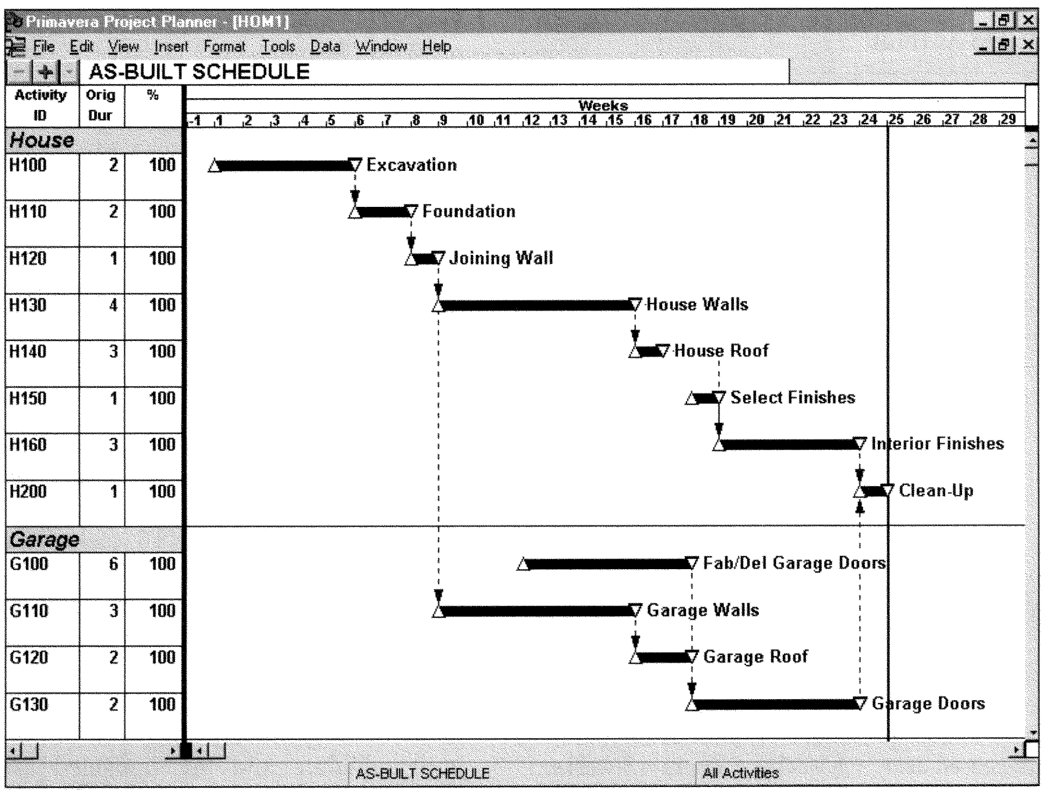

Figure 3—As-Built Schedule

ble for all of the delay. The total time approach typically does not consider whether liability for any delay should be apportioned among the parties [7].

Figure 2 shows the original as-planned schedule prepared at the beginning of the project. It shows a total project duration of 16 weeks. The critical path runs through the house, with 3 weeks of float through the garage.

Figure 3 shows the as-built schedule prepared at the end of the project. It shows a total project duration of 24 weeks. This reflects a total delay of 8 weeks. Relationships and float are not important and are not readily discernable in an as-built schedule.

Figure 4 is an as-built schedule that also shows the impact of and allocation for responsibility of the various delays. It shows the same total project duration of 24 weeks. The delays are categorized as owner- or contractor-caused. Relationships and float are not important and are not readily discernable in an as-built schedule. See table 1 for a comparison of the as-planned to the as-built.

Comments on the As-Planned Versus As-Built Comparison Method

The comparison method is easy to prepare if as-built information is available. As a simple mathematical calculation of what is basically a "two-line" schedule, it is very simplistic. It does not put delays into the context of when they occurred and assumes that the baseline schedule logic was accurate for the duration of the project. Therefore, the conclusion can be challenged, and the courts may reject it. The "total time" theory is not favored by the courts unless the evidence establishes that the contractor incurred so many delays that the only practical method of computing delay is by a jury verdict. A contractor is not precluded from recovery simply because the time extension due cannot be established with precision, as long as the record pro-

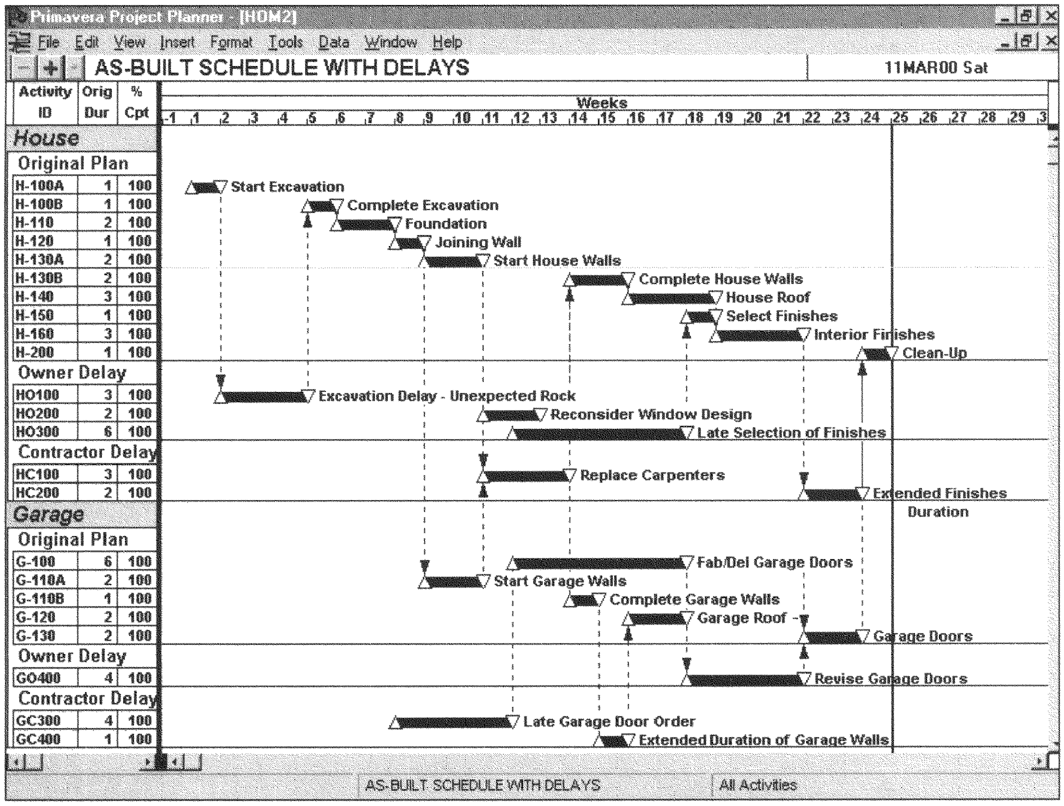

Figure 4—As-Built Schedule With Delays

Table 1—A Comparison of As-Planned to As-Built

Total Project Delay:	8 weeks
Owner-Caused Delays:	
Excavation delay	3 weeks
Reconsideration of windows	2 weeks
Late selection of finishes	6 weeks
Revise garage doors	4 weeks
	15 weeks
Contractor-Caused Delays:	
Replace carpenters	3 weeks
Extended duration garage walls	1 week
Late garage door order	4 weeks
Extended duration interior finish	2 weeks
	10 weeks

THIS METHOD USES A VERY SIMPLE CALCULATION

- Both parties were responsible for at least 10 weeks of delay, therefore concurrent delay = 10 weeks.
- The owner was responsible for a difference of 5 more weeks of delay than the contractor (15 - 10 weeks = 5 weeks), therefore owner-caused delay = 5 weeks.
- The total project delay is 8 weeks, and somebody (contractor) must be responsible for the balance, therefore the contractor-caused delay = 8 weeks - 5 weeks = 3 weeks.

vides some reasonable basis for the approximate amount of time due [8].

> The total time approach is no less susceptible to inaccuracies than the total cost theory. The contractor's presentation does not support its dependability here . . . We are not persuaded that the quantum of delay arrived at through this mode of computation is attributable to the owner rather than the builder or its subcontractors [9].

THE IMPACTED AS-PLANNED METHOD

The second method used to analyze the case study is the impacted as-planned method. In this method, the following steps are taken:

- prepare or recover the as-planned schedule;
- add owner-caused or contractor-caused delays (but not both, depending upon whose side the analyst is supporting); and
- calculate owner-caused delay, contractor-caused delay, and concurrent delay.

The what-if methodology begins with an anticipated or as-planned schedule that indicates key milestone performance dates. Ultimately, the as-planned schedule is used as a baseline against which to measure project delays [6].

The Impacted As-Planned Method With Owner-Caused Delays

Figure 5 shows an as-planned schedule to which owner-caused delays have been added. The total project duration is now 22 weeks. The critical path runs through the owner's late selection of finishes to the end of house construction. Because of the slip in the project end date, there are now 6 weeks of float in the garage construction.

In this method, the total duration of the as-built schedule is 24 weeks. The total duration of the impacted as-planned schedule with owner-caused delays is 22 weeks, and the total duration of the original as-planned schedule is 16 weeks. The owner is responsible for the difference between the impacted and the original as-planned schedules (22 - 16 = 6 weeks); this will be charged as compensable delay, which leaves the contractor responsible for the remaining difference between the as-built schedule and the impacted as-planned schedule (24 - 22 = 2 weeks), and liable for liquidated damages (if any) for this period.

The Impacted As-Planned Method With Contractor-Caused Delays

Figure 6 shows an as-planned schedule to which contractor-caused delays

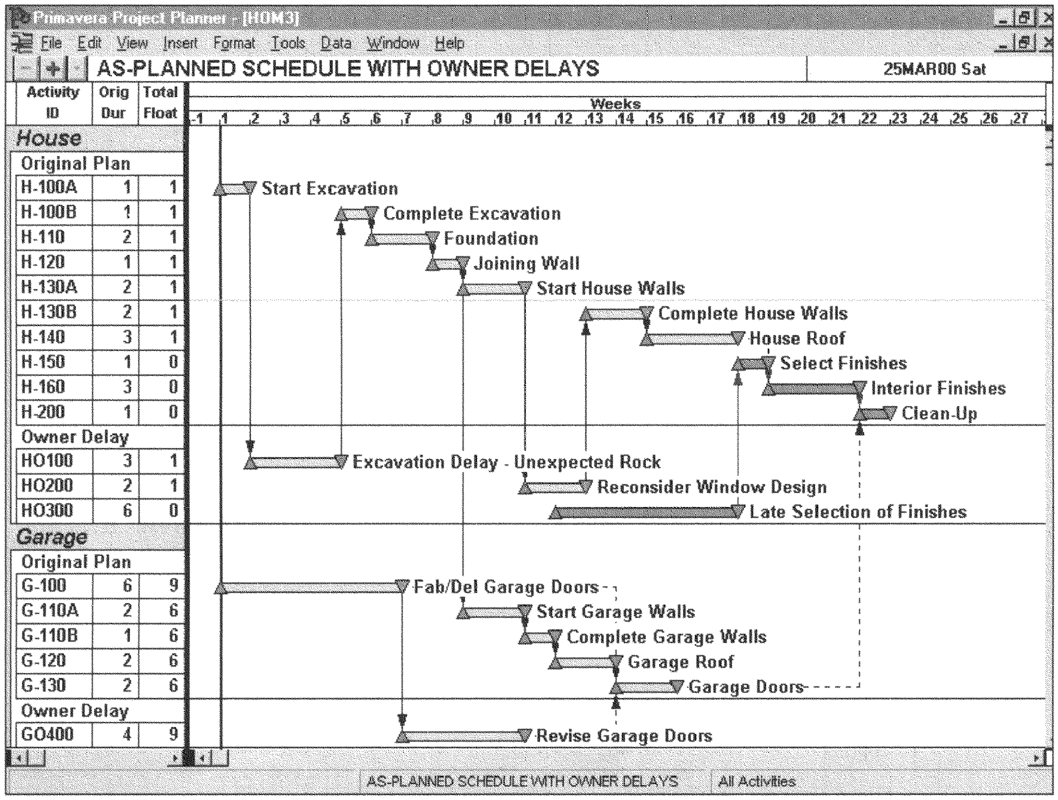

Figure 5—Impacted As-Planned Schedule With Owner-Caused Delay

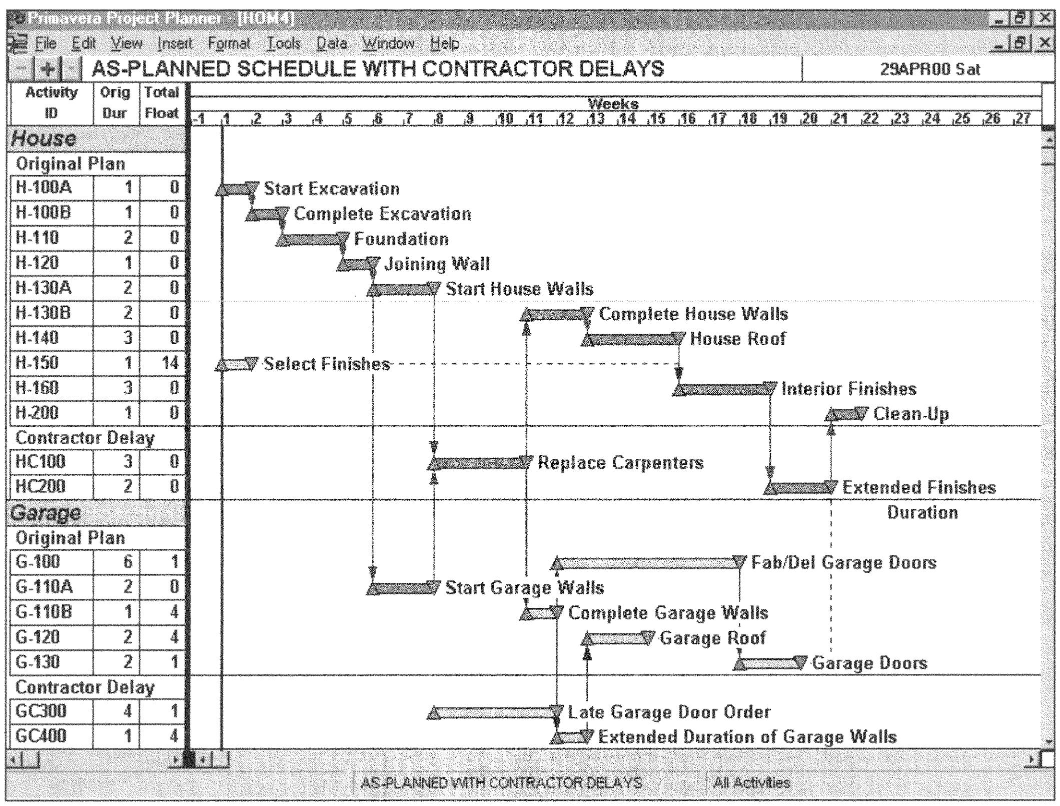

Figure 6—Impacted As-Planned Schedule With Contractor-Caused Delay

have been added. The total project duration is now 21 weeks. The critical path runs through the house, including the delay to replace the framing subcontractor, with only 1 week of float through the garage.

In this method, the total duration of the as-built schedule is 24 weeks. The total duration of the impacted as-planned schedule with contractor-caused delays is 21 weeks, and the total duration of the original as-planned schedule is 16 weeks. The contractor is responsible for the difference between the impacted and the original as-planned schedules (21 - 16 = 5 weeks), and is liable for liquidated damages (if any) for this period. That leaves the owner responsible for the remaining difference between the as-built schedule and the impacted as-planned schedule (24 - 21 = 3 weeks). This is charged as compensable delay.

Comments on the Impacted As-Planned Method

An impacted as-planned analysis can be prepared quickly and easily, but it has some potentially fundamental flaws. First, it may assume that the as-planned schedule is perfect. The method also might assume that the contractor always followed the original schedule, and it may assume that there is nobody to blame for delays except the owner. Project schedules are dynamic and evolve as the project progresses. It thus is unreasonable to use a fixed, as-planned schedule to evaluate project delays [6]. Furthermore, the as-planned logic usually magnifies the effect of delays because of various scheduling simplifications the original planners made. This method also may assume that there is nobody to blame for delays but the owner (or the contractor, if the analyst is on the other side). The method may ignore what actually happened on the project and thus can be viewed as argumentative rather than a truly analytical method.

THE COLLAPSED AS-BUILT METHOD

The third method used to analyze the case study is the collapsed as-built method, which includes the following steps.

- prepare or recover the final as-built schedule;
- include all delay activities;
- analyze and remove all apparent owner-caused delays;
- collapse the schedule;
- the result should be the schedule that the contractor could have achieved but-for the actions of the owner; and
- calculate owner-caused delay, contractor-caused delay, and concurrent delay.

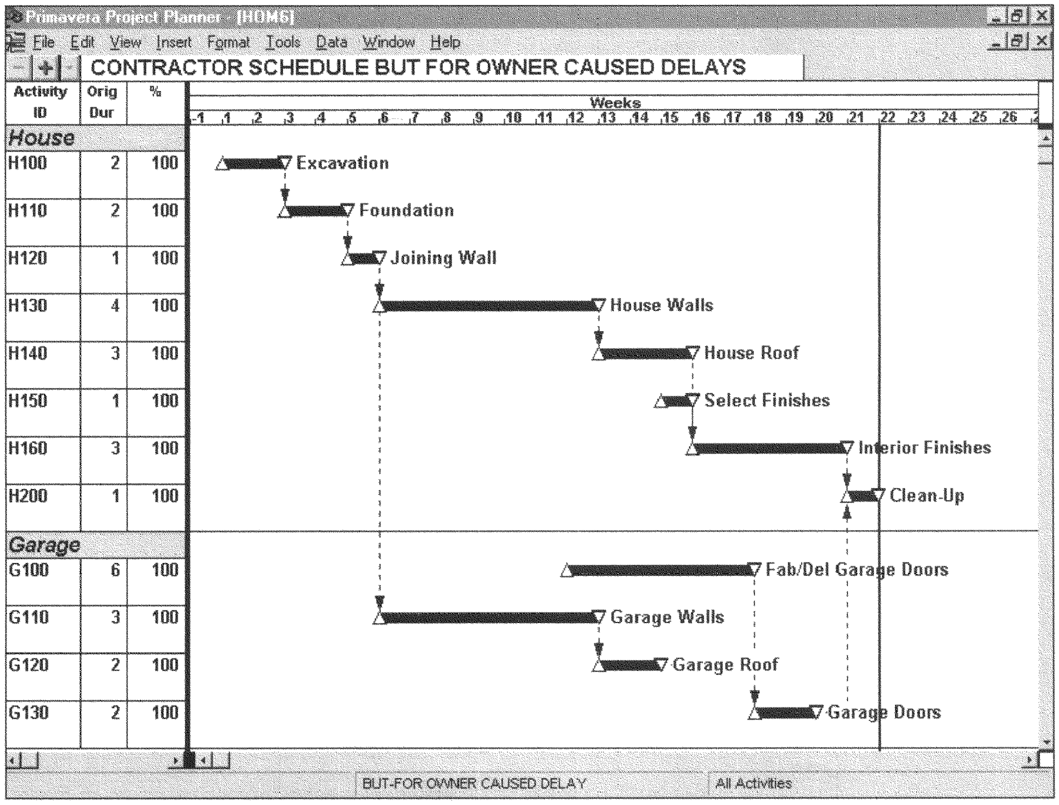

Figure 7—Collapsed As-Built Schedule

Collapsed as-built (or but-for) evaluation techniques use an as-built schedule instead of the as-planned schedule. The but-for evaluation technique was created to correct the shortcomings of the what-if method. It identifies delays by all parties on the as-built schedule. The but-for schedule results from removing all owner delays that affected the as-built critical path. The amount of compensable delay is the difference in time between the actual completion date shown on the as-built schedule and the completion date shown on the but-for schedule [6].

The but-for approach is less of a critical path method (CPM) technique than a legal standard for evaluating delay claims. When determining the merit of such a claim, the but-for approach compares the actual date of project completion with the point in time when the work would have been completed but-for delays caused by other factors or parties. This approach requires determining when the work would have been completed but-for delays, the net aggregate effect of owner delays, and the actual completion date. This information is used to establish the extended period of performance for recovering time-related costs [7].

Figure 7 shows how the as-built schedule would look with the owner-caused delays removed. This is the schedule that the contractor believes could have been achieved but-for the actions of the owner. The total project duration now shows as 21 weeks. Relationships and float are not important and are not readily discernable in an as-built schedule.

In this method, the total duration of the as-built schedule is 24 weeks. The total duration of the collapsed as-built schedule is 21 weeks; the total duration of the original as-planned schedule is 16 weeks. The owner is responsible for the difference between the as-built and the collapsed as-built (24 - 21 = 3 weeks). This is charged as compensable delay. This leaves the contractor responsible for the remaining difference between the collapsed as-built schedule and the original as-planned schedule (21 - 16 = 5 weeks), and the contractor is liable for liquidated damages (if any) for this period.

Comments on the Collapsed As-Built Method

A collapsed as-built analysis can be prepared quickly and is not difficult to prepare if there is a good as-built schedule. However, it has flaws similar to the impacted as-planned method as an analytical tool. First, it may assume the existence of an as-built critical path, which has to be discerned by the analyst. As a project slows down because of a delay, all paths tend to become critical because contractors pace their work to meet the delayed milestones. Since the contractor's analyst chooses which delays to analyze, the collapsed as-built method also may assume that there is nobody to blame for delays but the owner. Therefore, it can be seen as an argumentative rather than analytical method. Finally, the method makes no attempt to put delays into the context of when they occurred.

This method eliminates reliance on an as-planned schedule as a baseline schedule. However, it is not as easy as it sounds, and on complex projects the as-built critical path is usually not readily apparent. Care must be taken to adjust durations that appear to be delays by one party but are really a direct result of delays caused by others and the resulting reduced pace of the project. Owner-caused delays may have changed the sequence of construction so much that merely removing the owner delays results in an unrealistic but-for schedule. In these cases, adjustments must be made to make the but-for schedule one that could actually have been followed by the contractor. The but-for schedule must reflect actual project circumstances to be credible.

The challenge in but-for evaluations is the determination of the as-built critical path. No activities in the as-built schedule have float because they are actual dates. However, there is always at least one path that dictated the project completion. Identifying this path can be very difficult, especially on delayed projects where there may be more than one critical path as the project nears completion. When you use but-for schedules, the other party may attempt to identify a different critical path going through work activities unaffected by that party. In many cases, the determination of the real as-built critical path will then be left to the court or arbitrators [6].

CONTEMPORANEOUS PERIOD ANALYSIS (CPA)

The fourth method used to analyze the case study is contemporaneous period analysis. In this method, the following steps are performed:

- prepare or recover the original as-planned schedule;
- select meaningful window periods to analyze;
- enter actual progress and delay activities to a copy of the original as-planned schedule, using contemporaneous project documents for the first window period;
- calculate the schedule to analyze delay for the first window period;
- calculate owner-caused delay, contractor-caused delay, and concurrent delay for the first window period;
- copy the schedule to use as a basis for the second window; and
- repeat this procedure for each period to the end of the project.

Contemporaneous period analysis breaks the contract period into discreet time periods and examines the delays in the same context that the project participants would have when the delays occurred. It can be a very effective way to characterize and quantify delays on complex construction projects when CPM schedules were prepared and periodically updated during the construction period.

> The first update is compared to the original schedule, and any delays to the project that occurred during that period are analyzed using a but-for approach. The first update becomes the new baseline, and the process is repeated at the end of the second update period. The evaluation is performed at the end of each update period until the project is complete. The excusable, compensable, and noncompensable delays sum to the cumulative delay on the project, and the delay-related damages are allocated accordingly [6].

The window analysis approach uses fragnets and windows to isolate and analyze specific impacts to individual segments of a project's schedule. Windows are selected time periods that are broken out from the overall as-planned and as-built schedule in order to focus on delay impacts within specific time periods. A fragnet is useful in demonstrating the relationship and effect of specific events on specific work activities. Windows are useful to facilitate the analysis of given events during a particular time period. A series of windows can highlight the impact to the evolving as-built critical path activities over time and thereby provide a basis for identifying and segregating owner-caused, contractor-caused, and/or excusable delay, as well as create a way to evaluate overall schedule loss or gain in each window [7].

For our case study, figure 8 (also see table 2) shows the first window. The excavation has been delayed for 3 weeks by the discovery of unexpected rock. The overall project duration is now 19 weeks. Since the owner accepted responsibility for dif-

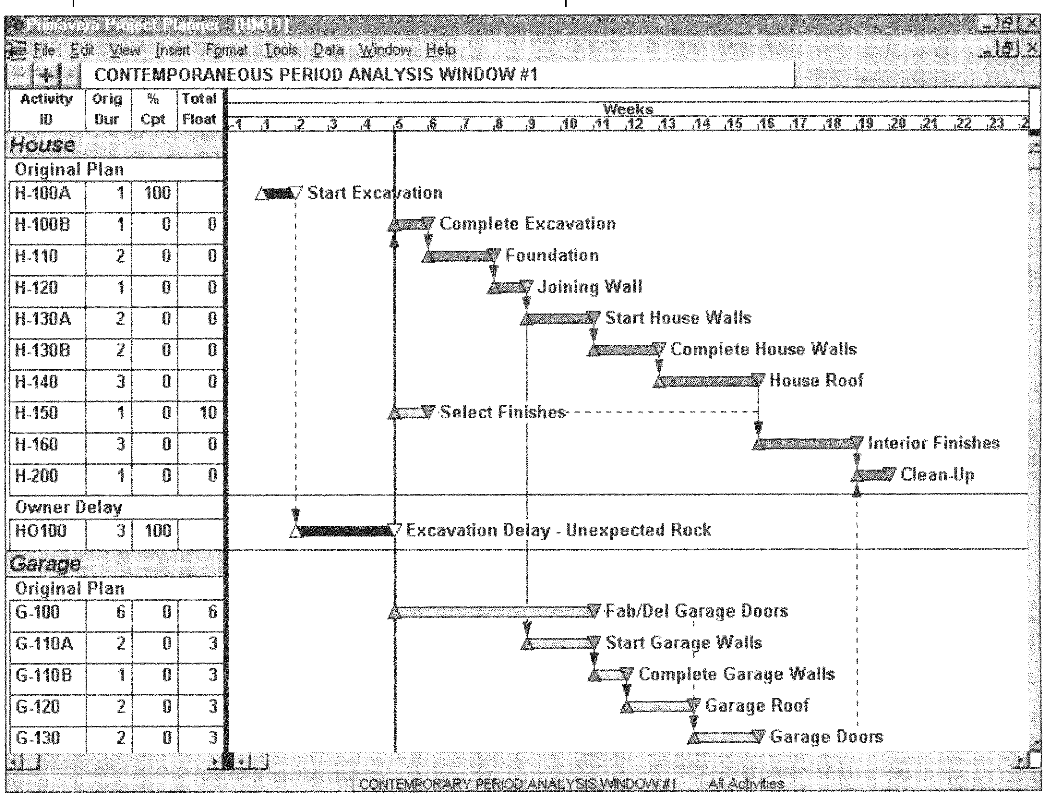

Figure 8—Window #1

Table 2—Window #1

UPDATE NUMBER	SCHEDULE DATE (WEEK NO.)	PROJECT COMPLETION (WEEK NO.)	SLIP DURING PERIOD	DELAYS NON EXCUSABLE	DELAYS EXCUSABLE NONCOMPENS	DELAYS EXCUSABLE COMPENSABLE	REMARKS
0	0	16	0	0	0	0	
1	4	19	3	0	0	3	Unforeseen Site Condition

fering site conditions under the contract, this delay is charged to the owner as an excusable, compensable delay. The critical path still runs through the house, and the garage still has 3 weeks of positive float.

At the end of the second window, shown in figure 9 (also see table 3), there have been no additional delays. The overall project duration is still 19 weeks. There is no chargeable delay during the period. The critical path still runs through the house, and the garage still has 3 weeks of positive float.

During the third window period, shown in figure 10 (also see table 4), there are two overlapping delays. The owner's indecision regarding the window design has delayed the project by 2 weeks, and the bankruptcy of the framing subcontractor has delayed the project by 3 weeks—overlapping the owner's delay. The overall project duration is now 22 weeks; therefore, 2 weeks are charged to concurrent delay (excusable and noncompensable), and 1 week is charged to the contractor as inexcusable delay because the contractor is responsible for the performance of its subcontractors. The critical path still runs through the house, and the garage still has 2 weeks of positive float.

There was a contractor-caused delay during the fourth window, shown in figure 11 (also see table 5), because the contractor did not complete the garage walls in accordance with the duration of the original baseline schedule. However, this delay was not on the critical path and did not affect the end date of the project. The overall project duration is still 22 weeks. There is no chargeable delay during the period. The critical path still runs through the house, and the garage still has 2 weeks of positive float.

There was an owner-caused delay during the fifth window, shown in figure 12, of 4 weeks to reorder the garage doors. However, since there were 2 weeks of positive float for the garage construction, this resulted in a net change to the project end date of only 2 weeks, for

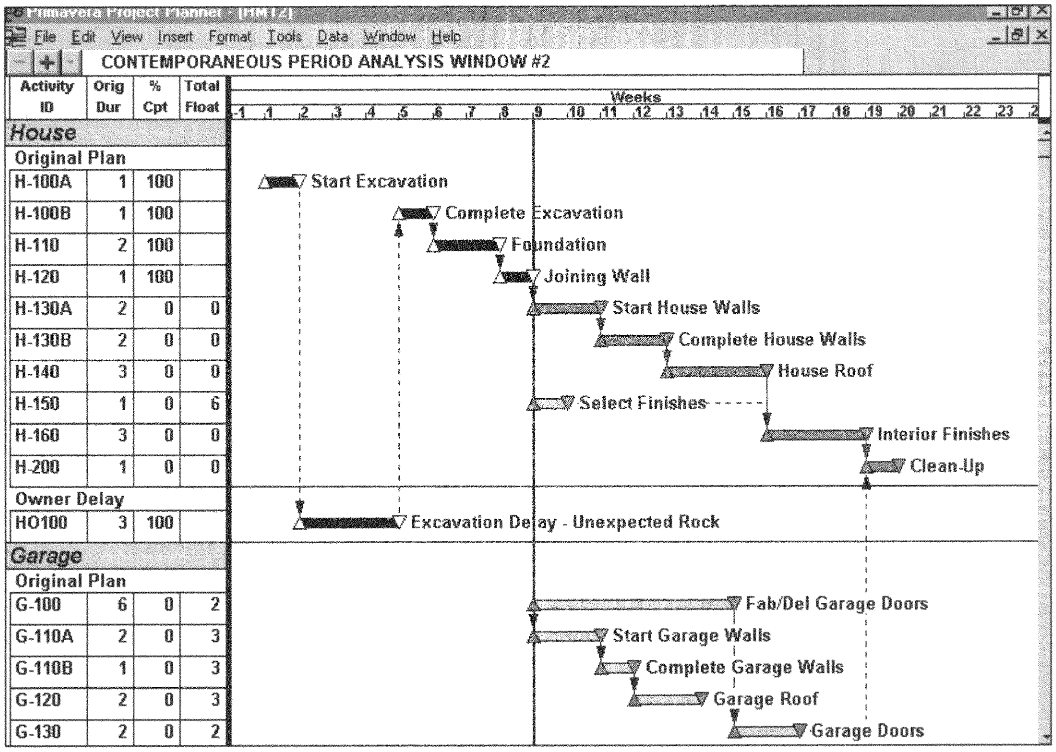

Figure 9—Window #2

Table 3—Window #2

UPDATE NUMBER	SCHEDULE DATE (WEEK NO.)	PROJECT COMPLETION (WEEK NO.)	SLIP DURING PERIOD	DELAYS NON EXCUSABLE	DELAYS EXCUSABLE NONCOMPENS	DELAYS EXCUSABLE COMPENSABLE	REMARKS
0	0	16	0	0	0	0	
1	4	19	3	0	0	3	Unforeseen Site Condition
2	8	19	0	0	0	0	No Delay during Period

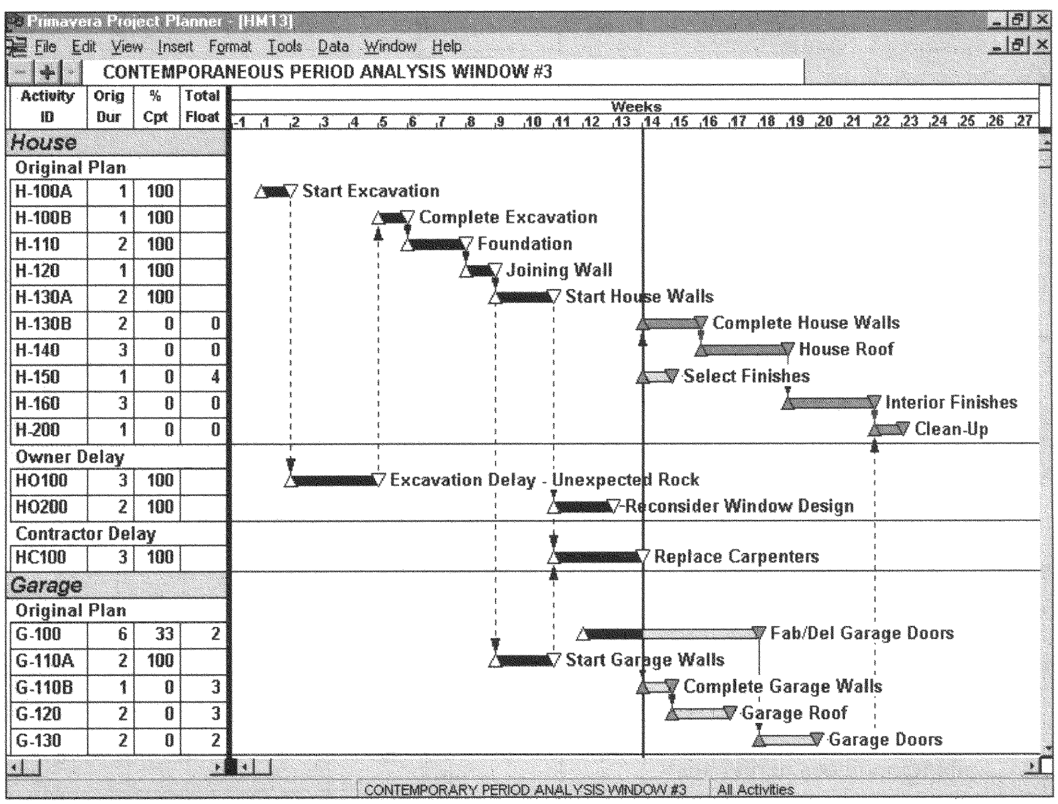

Figure 10—Window #3

an overall duration of 24 weeks. This delay is charged to the owner as an excusable and compensable delay. The critical path now has shifted into the garage for the little remaining work.

Since we have now accounted for the entire delay of 8 weeks (24 - 16 = 8), it is not necessary to analyze any more windows. Furthermore, we can add the columns of table 6 to determine the total delay, by category of delay, for all of the windows. The totals add up to 1 week of inexcusable delay, chargeable to the contractor as liquidated damages; there are 2 weeks of third-party or concurrent delay, where the parties bear their own costs or damages; and 5 weeks of compensable delay, which is chargeable to the owner as extended contractor overheads.

Comments on the CPA Method

The CPA (windows) method is often the most time-consuming schedule delay analysis method. However, it can be very accurate, and has the potential to be the least controversial and the most analytical; it can be equitable to all parties. The windows method puts all delays in the context of the time, place, and circumstances of the project as revealed in the contemporaneous documentation for the window period. This places an added burden on the analyst to review all significant and relevant documents or risk losing credibility. The windows method is an accepted way to analyze schedule delays for trial or arbitration testimony, especially in the federal courts.

Table 4—Window #3

UPDATE NUMBER	SCHEDULE DATE (WEEK NO.)	PROJECT COMPLETION (WEEK NO.)	SLIP DURING PERIOD	DELAYS NON EXCUSABLE	DELAYS EXCUSABLE NONCOMPENS	DELAYS EXCUSABLE COMPENSABLE	REMARKS
0	0	16	0	0	0	0	
1	4	19	3	0	0	3	Unforeseen Site Condition
2	8	19	0	0	0	0	No Delay during Period
3	13	22	3	1	2	0	Framing Contractor left job Owner indecision on Windows

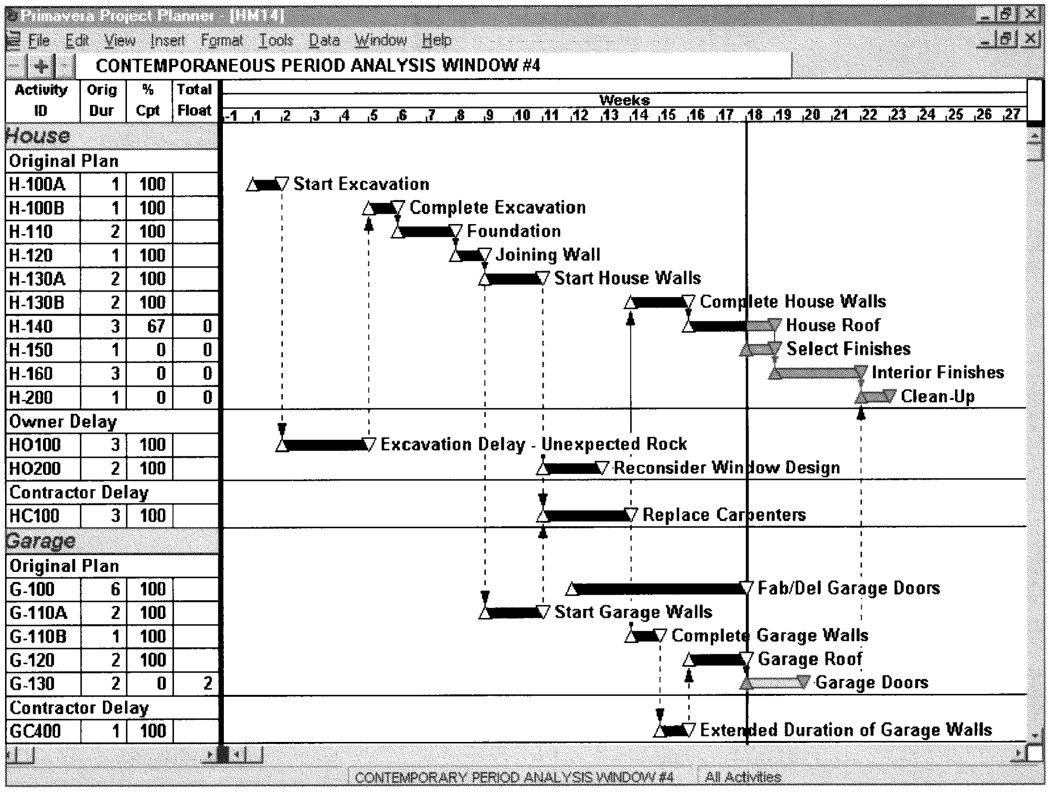

Figure 11—Window #4

Table 5—Window #4

UPDATE NUMBER	SCHEDULE DATE (WEEK NO.)	PROJECT COMPLETION (WEEK NO.)	SLIP DURING PERIOD	DELAYS NON EXCUSABLE	DELAYS EXCUSABLE NONCOMPENS	DELAYS EXCUSABLE COMPENSABLE	REMARKS
0	0	16	0	0	0	0	
1	4	19	3	0	0	3	Unforeseen Site Condition
2	8	19	0	0	0	0	No Delay during Period
3	13	22	3	1	2	0	Framing Contractor left job Owner indecision on Windows
4	17	22	0	0	0	0	Extended Garage Walls Not on Critical Path

Like other evaluation techniques, CPA is seldom as easy as it sounds and should not be performed without using careful analysis and sound judgment. The schedule updates generated during construction should not be used until the information contained in them is verified using other project documentation [6].

Current cases indicate that the courts will not uphold a windows analysis that is based only on questionable schedule updates. In a recent case, the Board of Contract Appeals said the following:

> [the] respondent's CPM expert was recognized by the board as an expert in scheduling analysis and the review of planned schedules. [He] employed a contemporaneous time frame analysis to evaluate the delay on this job . . . [he] divided the work into 17 windows. The critical path used was that shown on Cogefar's schedule updates. [He] then performed an analysis on each window determining whether Cogefar or the FBOP was responsible for the delays. [He] admitted that, while Cogefar changed the logic

in its December 21, 1992, schedule, he did not use this change since the FBOP had rejected that schedule . . . [he] failed to use a current CPM schedule to evaluate the delay on the project. This is mandatory to achieve an accurate assessment of whether an item of delay affects the overall completion of the project [2].

According to Lee Schumacher,

In most cases, an as-built schedule based on the entire written record should be developed to add credibility to information contained in the contemporaneous schedule updates, and if necessary, modify them to more accurately describe the status of the construction at the time of the update. Care must be used not to make modifications based on hindsight.

The absence of schedule updates, in itself, does not prohibit the use of CPA. The as-built schedule, in conjunction with the reasonable as-planned schedule, can be used to recreate schedule updates as if periodic updating had been performed during construction. Good judgment is especially important in this type of evaluation. When recreating the schedule updates, it is extremely important that your expert bases the schedule status solely on information that was available at the time. Critical path method schedules or complex construction projects can contain thousands of work activities, but generally there are relatively few that dictate the critical path in particular discreet time periods [6].

The beauty of CPA is that it can divide these complicated schedules into "digestible portions."

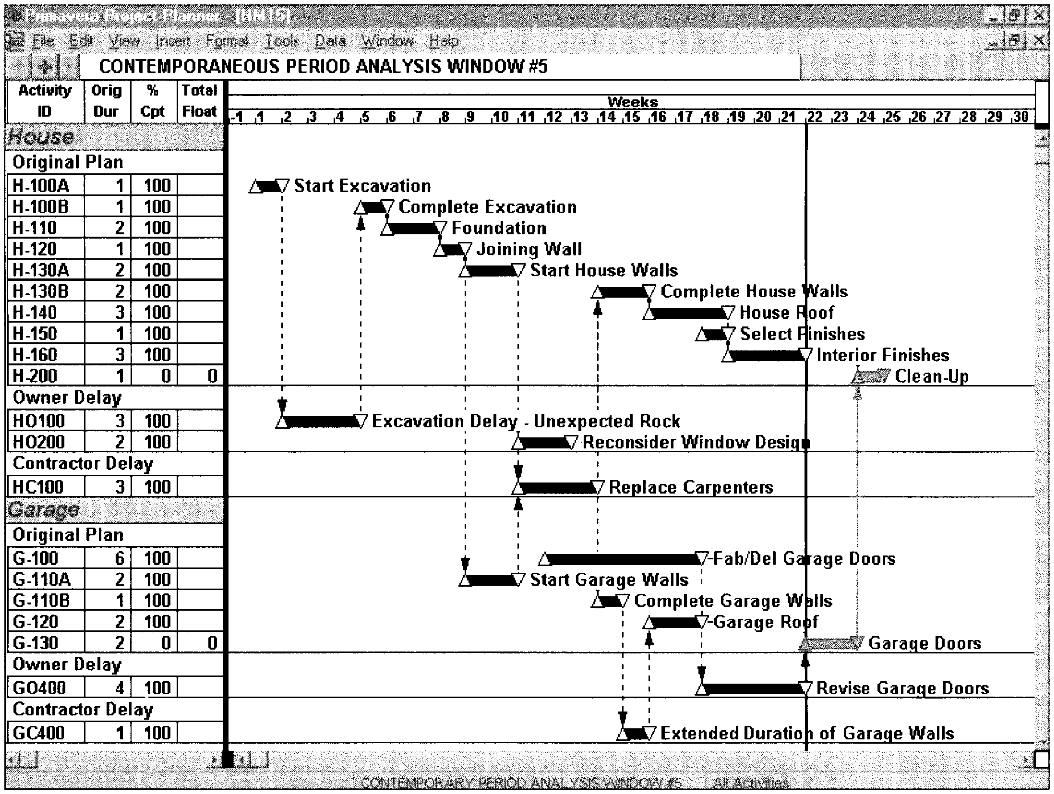

Figure 12—Window #5

Table 6—Window #5

UPDATE NUMBER	SCHEDULE DATE (WEEK NO.)	PROJECT COMPLETION (WEEK NO.)	SLIP DURING PERIOD	DELAYS NON EXCUSABLE	DELAYS EXCUSABLE NONCOMPENS	DELAYS EXCUSABLE COMPENSABLE	REMARKS
0	0	16	0	0	0	0	
1	4	19	3	0	0	3	Unforeseen Site Condition
2	8	19	0	0	0	0	No Delay during Period
3	13	22	3	1	2	0	Framing Contractor left job Owner indecision on Windows
4	17	22	0	0	0	0	Extended Garage Walls Not on Critical Path
5	21	24	2	0	0	2	Owner revised Garage Doors
	TOTALS		8	1	2	5	

Table 7—Results of the Comparison of All Methods

METHOD	NON-EXCUSABLE NON-COMPENSABLE (CONTRACTOR CAUSED)	EXCUSABLE NON-COMPENSABLE (3RD PARTY CAUSED)	EXCUSABLE COMPENSABLE (OWNER CAUSED)
COMPARISON METHOD (TOTAL TIME)	3		5
IMPACTED AS-PLANNED (OWNER DELAYS)	2		6
IMPACTED AS-PLANNED (CONTR DELAYS)	5		3
COLLAPSED AS-BUILT (BUT-FOR)	5		3
CONTEMP PERIOD ANALYSIS (WINDOWS)	1	2	5

Equally important, this daily evaluation technique identifies and presents the critical delays in chronological order as the project unfolds. For these reasons, it is easy to understand. In addition, CPA recognizes the concept of float as a resource to the project and facilitates the distinction of actual delays from apparent delays caused only by the pace of the project [6].

As you can see in table 7, the different analysis methods provided quite different outcomes for the contract parties. It does matter which method is used, and how carefully and rigorously the analysis is performed. The courts today are much more likely to accept the windows or but-for methods in expert testimony than they are to accept other methods.

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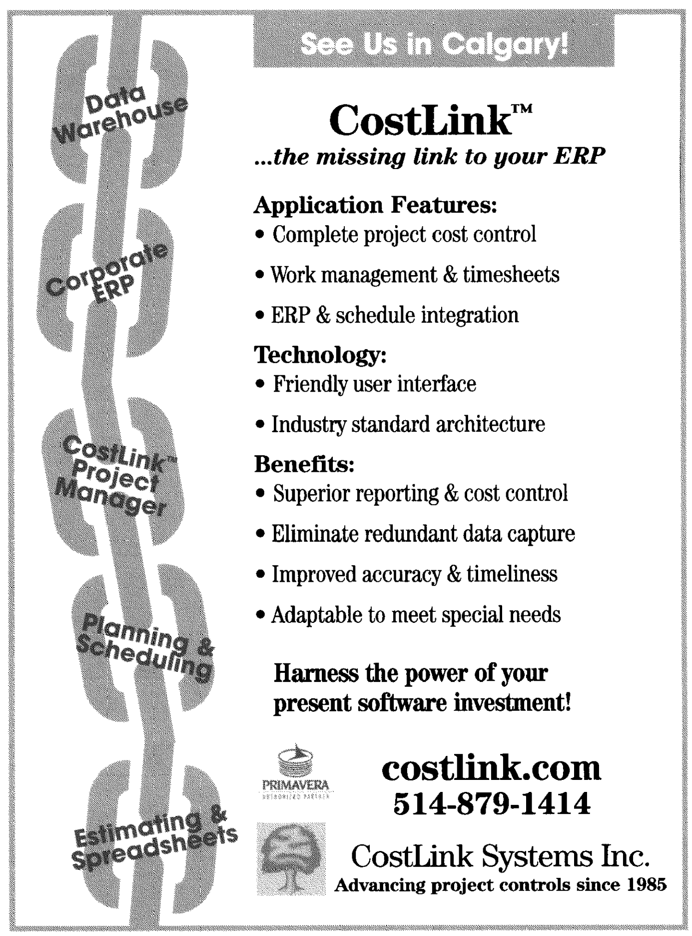

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