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ESTABLISHING THE CAUSE AND EFFECT OF DELAY

It seems that a certain amount of delay is almost inevitable on construction projects. The potential causes of delay are innumerable, but delay generally falls into three categories. Compensable delay is caused by the act or omission of the project owner and may entitle the contractor to recover its increased performance costs, as well as an extension of time. Excusable delay is caused by factors beyond the control and without the fault of either the contractor or the owner. It may entitle the contractor to an extension of the performance period, but not an increase in the contract price. Nonexcusable delay results from the contractor's own shortcomings and may subject the contractor to the assessment of liquidated damages and even a termination for default.

Unfortunately, these three categories of delay are not always easily distinguished during the course of a construction project. Separate delays interrelate and overlap. Causation can be difficult to determine. Yet it is necessary to distinguish and document the cause and effect of different delay events in order to determine the rights of the respective parties. The customary administrative tools for this task are as-planned schedules, as-built schedules, and contemporaneous job site records. This article reviews cases where parties have, and have not, been successful in segregating delays and documenting their impact.

Concurrent Delay

At the outset, it should be noted that when two separate delay events overlap or coincide, they have the effect of canceling each other out. For instance, when an owner's delay in finalizing a contract modification occurred at the same time the contractor was experiencing problems with a supplier, the compensable delay was negated by the nonexcusable delay. The rationale was that even if the owner had met all its obligations, the contractor still would have been unable to perform due to the late delivery by its supplier. *Appeal of Hood Plumbing*, AGBCA No. 84-181-1 (October 28, 1987); *CCM* January 1988, p. 6.

Similarly, an owner's constructive change in the requirements for a material handling control system resulted in a 72-day delay in obtaining necessary components. But the contractor was behind schedule in the construction of the building that would house the system and would have been unable to install the equipment anyway. The contractor was therefore not entitled to any compensation. *Appeal of Beckman Construction Co.*, ASBCA No. 24725 (February 8, 1983); *CCM* May 1983, p. 5.

Apportionment of Fault

Even when two separate delay events are not contemporaneous, it may be

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impossible to segregate the effects of the delays and to apportion fault. When the owner and contractor both contribute to delay and the delays are so interwoven that they cannot be distinguished, the contractor loses the right to recover delay damages. For instance, a five-month delay in shop drawing approvals was caused in part by incomplete and untimely submittals by the contractor and in part by unreasonably slow responses from the owner. It was impossible to apportion fault, so the contractor was denied any recovery. *Appeal of J.B.L. Construction Co., Inc.*, VABCA No. 1799 (November 7, 1985); *CCM* January 1986, p. 5.

The project owner also loses its rights to a remedy for delay if it is impossible to apportion fault. On a dredging contract, the contractor failed to provide sufficient equipment, but the owner failed to promptly establish the necessary ranges and gauges. The two delays were so interwoven that they could not be apportioned. The owner was therefore denied recovery of liquidated damages. *Appeal of C. D. Murray Co., Inc.*, ENG BCA No. 5018 (October 31, 1988); *CCM* February 1989, p. 4.

Segregated Delays

When multiple delays occur on a project, it is sometimes possible to distinguish and segregate the delay periods, enabling each party to preserve its respective rights. For instance, an owner's constructive suspension of work could be distinguished from the extended performance period caused by the contractor's inadequate manpower. The contractor was allowed to recover for the period of suspension. *Appeal of H. A. Kaufman Co.*, PSBCA No. 2616 (July 31, 1990); *CCM* October 1990, p. 4.

Similarly, another contractor was able to identify and segregate periods of owner-caused delay, periods of contractor-caused delay, and periods of concurrent delay. This enabled the contractor to recover damages for periods of delay that were the exclusive responsibility of the project owner. *Appeal of Wickham Contracting Co., Inc.*, IBCA No. 1301-8-79 (March 31, 1986); *CCM* June 1986, p. 5.

A contractor is even entitled to recover unabsorbed home office overhead for periods of constructive suspension when those periods can be distinguished from periods of contractor-caused delay. *Appeal of Cieszko Construction Co., Inc.*, ASBCA No. 34199 (September 30, 1987); *CCM* December 1987, p. 5.

Frequently, separate delays can be segregated only through the use of critical path method (CPM) schedules or other computerized scheduling techniques. In one case, a contractor used CPM schedules to hold its subcontractor responsible for 83 days of delay. Critically scheduled work had been delayed a total of 106 calendar days, but the contractor, to the satisfaction of a federal court, accounted for 23 days when it experienced concurrent delay. *Williams Enterprises, Inc. v. Strait Manufacturing & Welding, Inc.*, 728 F.Supp. 12 (D.D.C. 1990); *CCM* May 1990, p. 2.

In another case, a portion of the work was suspended by the owner for 30 days. The owner argued that this had no effect on the overall progress of the work, but the contractor was able to use CPM schedules to prove entitlement to an 11-day extension. *Appeal of Santa Fe, Inc.*, VABCA No. 2168 (August 25, 1987); *CCM* November 1987, p. 5.

Causation

It should be stressed that when using CPM schedules to segregate and document delay, there must be some evidence, usually records maintained at the job site, that particular events caused particular periods of delay. As the Armed Services Board of Contract Appeals said in one case, "A comparison of CPM updates with the original CPM schedule discloses only the differences between them, but not the causes of those differences." *Appeal of Titan Mountain States Construction Corp.*, ASBCA No. 23095 (February 21, 1985); *CCM* May 1985, p. 5.

In another case, a contractor was unable to establish a causal relationship between an event and a delay because it could not prove the planned sequence of work it alleged. *Appeal of Volpe-Head, Joint Venture*, ENG BCA No. 4726 (July 14, 1989); *CCM* October 1989, p. 4.

Another contractor had consistently deviated from the planned sequence of work reflected in its approved progress schedule, so it was impossible to establish the effect of different events. *Titan Pacific Construction Corp. v. United States*, 17 Cl.Ct. 630 (1989); *CCM* December 1989, p. 2.

Impact on Project Completion

A final point needs to be made regarding the effect of delay. In order for a contractor to be entitled to a time extension or a price increase, the contractor must be able to show that a particular event delayed the completion of the overall project. "It is immaterial that some particular event came along which disrupted certain work or delayed its start or completion....It is [the contractor's] burden to convince us of the impact on the overall completion of the project." *Appeal of Essential Construction Co., Inc.*, ASBCA No. 18706 (February 7, 1989); *CCM* May 1989, p. 4.

As a result of this rule, a contractor was denied an extension of time when change order work simply used up the "float time" in a schedule. *Appeal of Santa Fe, Inc.* VABCA No. 1946 (May 15, 1984); *CCM* August 1984, p. 5. But when a contractor could prove that delayed work was on the critical completion path, the contractor was entitled to an extension of the performance period. *Appeal of Continental Heller Corp.*, GSBCA No. 7140 (March 23, 1984); *CCM* July 1984, p. 5.

Quantifying and Apportioning Delay on Construction Projects

Lee Schumacher, PE

Most projects incur increased costs when completed later than planned. In the rare instance when the reasons for delayed completion are well defined, the responsible party recognizes its culpability and pays its fair share of the costs. However, in the vast majority of cases, each party points a finger at the others, so all are faced with proving and/or disputing claims for the construction delays.

For obvious reasons, assigning responsibility for project delays is critical to the allocation of responsibility for time-related costs. Over the last 30 years, the industry has characterized delays by responsibility in the following ways.

Nonexcusable noncompensable delays are within the control of the contractor; examples include delay caused by late mobilization, late equipment deliveries, or an inadequate project work force. Nonexcusable delays are not only noncompensable but they expose a contractor to delay claims of its subcontractors and liquidated damages (or actual damages if there is no liquidated damages clause) by the owner.

Excusable noncompensable delays are typically outside the control of all parties. They generally include delays caused by strikes, "acts of God," and 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 by the owner.

Excusable compensable delays are caused solely by the owner or his or her representatives. Examples include failure to provide site access, differing site conditions, or change orders. Excusable compensable delays entitle the contractor to a time extension and time-related costs.

Concurrent delays exist when an excusable compensable event causes a delay, but even if that event had not occurred, the project would have been delayed by a nonexcusable, noncompensable circumstance. Generally, 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 damages and the contract must absorb its time-related costs.

To determine who is responsible for the delays, review the contract documents to determine whether the delay was contemplated by the contract or if there are any specific provisions that assign responsibility for the delaying circumstance. Remember that all contracts also carry with them certain implied duties, which, if not fulfilled, can result in liability. Specifically, there are several implied duties associated with construction scheduling, including the duty not to delay, hinder, or interfere with others, the duty to cooperate with others, and the duty of each party to inform the others of circumstances that affect contract performance. Each party also has an implied obligation to mitigate the damages associated with construction delays. Consider the factual evidence and recollections of individuals familiar with the delay. Most importantly, be fair and reasonable when assigning responsibility for delays.

Most disputes about time impacts on construction projects are about what caused the project delay and not about who was responsible for specific delays. Construction projects are generally complex, and there are typically several ways that they can be built. It is not uncommon for projects to be constructed without the benefit of project schedules. For those that are scheduled, few are built in the same sequence as originally planned even if no owner changes occur during construction (which is very rare itself). Many separate events are taking place when delays are occurring in specific areas of the project. Critical path method (CPM) schedules, or other similar network techniques, allow the analysis of the relationship of the timing of the completion of specific work activities (and delay activities) to the completion of the project as a whole.

CPM scheduling has gained acceptance in the construction industry as the preferred method of scheduling for both simple and complex construction projects. All contractors should seriously consider using CPM to schedule their projects. In recent years, many owners are forcing contractors to make this choice, and an increasing number of construction contracts require the contractor to prepare an "as-planned" schedule that shows in CPM format how the contractor plans to construct the project.

CPM scheduling allows the determination of the "critical path"—the chain of interrelated activities in the schedule network having the longest duration, and therefore the earliest possible completion of the project. All activities on the critical path are known as "critical" activities. The project completion will only be delayed if an activity on the critical path is delayed, or if the time taken to complete a specific noncritical activity exceeds both the time allotted for it and the float time available to the activity when work on the activity began.

CPM schedules are only useful if the entire project team is committed to the schedule. The initial schedule must be a well-thought-out plan that reflects the contract requirements and an understanding of the project requirements and known constraints. The level of detail must be sufficient to satisfy short-term, on-site scheduling needs and identify long-term project requirements such as off-site procurement activities. The CPM schedule must be updated periodically to reflect changing project demands and increased certainties.

Many construction contracts also require the contractor to periodically update the CPM schedule. Some contractors believe these clauses are nuisances so

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they prepare, submit, and update the CPM schedules merely to satisfy the contract requirements and owner demands. In these circumstances, the CPM schedules may not accurately reflect what is happening on the project. It is not uncommon for contractors to manipulate the schedule logic and durations to show that the project is on time when it is actually behind schedule. It is human nature to be optimistic, want to please the owner, and avoid the confrontation that inevitably occurs when a project slips beyond the completion date.

Few contractors recognize the consequences of submitting overly optimistic schedules. The owner can and will use these schedules to deny the contractor's later claims for excusable and compensable delays during these periods. Even if the contractor provided written notice of delaying circumstances, the owner can argue that the delays were not critical to the timely completion of the project, using the project schedules updated by the contractor after the delays occurred. Sometimes contractors can overcome this argument by proving that the CPM schedule was grossly inaccurate and the owner knew it. However, there is the risk that the contractor will be made to "live and die" with the schedules generated during the project.

The use of CPM updates as a repository of historical information has long been recognized in the preparation and evaluation of delay claims. Until recently, it has been less common for the project CPM schedule updates to be analyzed in detail, since they are generated during the project to identify nonexcusable, excusable, and compensable delays. Events are fresh in the participants' minds, and you avoid the high costs of reconstructing the project on paper with incomplete, misleading project documentation and recollections clouded by the emotional atmosphere of the dispute environment.

Some construction contracts even require that contemporaneous CPM schedules are used as the baselines to evaluate contractors' requests for time extensions and delay-related compensation. Specifically, US Corps of Engineers and US Veterans' Administration contracts require concurrent evaluations of delay. The clauses force a contractor to properly update the CPM schedule or forego its delay claims and force the owner to address contractor's requests as they occur. Both the contractor and owner benefit from more effective scheduling during construction and from the lower costs of dispute resolution after the project is completed.

What is the best way to quantify delay? Use CPM schedules and take time to look back while the project is underway.

Time Impact Analysis

APPORTIONING DELAY ON CONSTRUCTION PROJECTS

In theory, apportioning delay appears to be very straightforward—you must only answer these questions:

- What was supposed to happen?
- What did happen?
- What were the differences?
- How did they affect the project schedule?

Sound simple? It very seldom is. The reasons for delays are often hotly disputed during construction, and in many cases sometime later during litigation.

Delays that occur on complex construction projects should be analyzed within the context of the overall project schedule, as it existed when the delays occurred. Work on a particular activity may not be critical to the overall scheduled completion of the project at a particular point in time. A delay that occurs to this activity at that point in time does not affect the overall completion of the project. Critical path method (CPM) schedules, or other similar network scheduling techniques, should be used to analyze the interrelationships and interdependencies of work activities, and to thus determine those that control the progress and completion of the work.

Usually there are delays in specific work activities caused by each participant in the process; sometimes these delays occur at the same time. A concurrent delay by one party does not prevent it from recovering delay damages where this delay did not affect a critical path. There can also be multiple critical paths, so a critical delay by the contractor can occur concurrently with a delay by the owner on a different critical path, which would preclude either party from receiving delay damages from the other. These interrelationships cannot be properly addressed without using CPM schedules or other similar network scheduling techniques. If the delay evaluation does not consider the delays of all parties involved, it is suspect.

At least three techniques have evolved over the last 30 years. They are generically known as "what-if" evaluations, "but-for" evaluations, and Contemporaneous Period Analysis (CPA). Primarily, they differ in the baseline that is used to measure the delays.

The what-if method begins with an anticipated or as-planned schedule that indicates key milestone performance dates. Ultimately, the as-planned schedule is used as a baseline to measure project delays. But-for evaluation techniques use an as-built schedule instead of the as-planned schedule. CPA breaks the construction period into discreet time periods and examines the delays as the project participants would have when the delays occurred.

The what-if methodology was commonly used until recently. The industry is becoming increasingly aware of its potential shortcomings. What are they? There can be disputes over the adequacy of the as-planned schedule. On most projects, it is not economically possible, nor does it make sense, to schedule the entire project in detail at its inception. Project schedules are dynamic and evolve as the project progresses. It thus may be unreasonable to use a fixed as-planned schedule to evaluate project delays. The evaluation also requires a tremendous amount of judgment to segregate real project delays from those that occurred because of delays in other areas of the project. Most importantly, this approach can be one-sided and may fail to consider the delays of all parties.

The but-for evaluation technique evolved to correct these shortcomings in the what-if method. It identifies delays by all parties on the as-built schedule. The but-for schedule results from "pulling out" 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.

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 by others and the resulting reduced pace of the project.

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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 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 always is 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.

CPA is a very effective method of characterizing and quantifying delays on complex construction projects if 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 allocation of delay-related damages are allocated accordingly.

Like other evaluation techniques, Contemporaneous Period Analysis is seldom as easy as it sounds and should not be performed without using sound judgment. The schedule updates generated during construction should not be used until the information contained in them is verified using other project documentation. 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, to 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 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 update solely on information that was available at the time.

CPM 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. The beauty of Contemporaneous Period Analysis is that it divides these complicated schedules into "digestible portions." Equally important, this daily evaluation technique identifies and presents the critical delays in chronological order as the project itself 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.

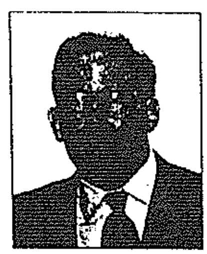
Each CPM evaluation technique requires you to establish how the project was constructed. Typically, you should prepare an as-built schedule using the job progress records, such as daily inspection reports, quality assurance reports, schedule updates, photographs, and other documents that contain information indicating when and where work was performed on the project. The level of detail necessary to evaluate delays is dependent on the complexity of the project and the nature of the delays.

The daily activities should be systematically plotted on a time-scaled chart that notes all significant activities, delays, work force, milestone completions, and any other significant activities that affect the schedule. There will be instances when there are discrepancies, inconsistencies, and blank spots in the written record. Do not automatically take the data that best supports your position. Instead, you should research the discrepancies, conduct interviews, and ascertain the data that best describe how the project was constructed. The CPM evaluation should be accompanied by support documentation, and if necessary, analysis of the data that substantiates the dates, durations, and logic in the evaluation. The as-built schedule must be an accurate representation of the progress and events that occurred on the project because it is the "backbone" of all of the CPM evaluation techniques. *

"backbone"

Which method should you use? Be flexible and use whatever method will work best considering the quantity, quality, and type of documentation that is available to substantiate your evaluation. Do not routinely apply any approach without exercising good judgment. To be effective, your schedule evaluation must be easily understood and supported by the project record.

The construction industry, the courts, and arbitrators have become increasingly knowledgeable and sophisticated. They will no longer naively accept as fact complicated and unintelligible evaluations based on fancy computer-generated printouts and charts. In general, you should use a practical approach, not "hocus-pocus," to apportion the delay.



Lee Schumacher, PE, is a senior consultant for High-Point, a worldwide construction consultancy firm specializing in the resolution of construction disputes. He is an expert in the evaluation of delays using critical path method scheduling, and the quantification of the monetary impacts associated with disruptions on construction projects. Mr. Schumacher developed Contemporaneous Period Analysis, an innovative project management tool and after-the-fact delay evaluation technique. He has lectured extensively on these subjects and is widely published. Mr. Schumacher is actively involved with alternative dispute resolution, has acted as an arbitrator, and is a trained mediator. He has worked throughout the US and Canada.

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CPM in Construction Management

JAMES J. O'BRIEN
Professional Engineer

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CHAPTER

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CPM IN CLAIMS AND LITIGATION

An important function of scheduling in the construction industry, both for the owner and those doing the construction, concerns claims which may evolve out of the failure to meet schedules. CPM can affect claims in two ways. First, the establishment of a realistic schedule through prebid CPM planning can furnish a legal basis for the enforcement of damages, while perhaps even more importantly, CPM can be utilized to evaluate actual claims situations through the reconstruction of a project's history or the use of an existing CPM plan to indicate the effects of changes on the original schedule.

In an early instance, a contractor, a consortium, was asked by a bridge authority to show cause why it should not be pressed for $550,000 in liquidated damages. Actually, the authority felt the contractor had done a good job, but because of the public trust involved, the authority also felt that it needed tangible proof of this good performance. To respond, the contractor used a construction CPM plan to demonstrate the effects of three different unforeseen circumstances: unusually bad weather, loss of special equipment by fire, and time lost in doing work claimed as extra. The presentation demonstrated the combined effect of the three causes (which, of course, was less than the serial effect) and the effects of any one

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or two of them alone and together. Thus, if any one or two of the factors had been deemed unacceptable, the effect of the remaining factor or factors was still quantified. On the basis of this finite presentation, the bridge commission did not press for the liquidated damages.

In a complex multimillion-dollar suit and countersuit back in 1966, the owner, an airport authority, used a detailed CPM to evaluate realistically the overall effects of the changes which both the owner and the contractor had imposed on the project. This network, set up on a historical basis, could be run so as to consider the combined effect of the changes as well as the separate effects of individual changes. Information from daily, weekly, and monthly field reports was utilized in preparing the historical CPM network, and the calculated results were quite interesting—and they were invaluable to the owner's engineer for preparing a factual testimony. The pretrial and trial periods extended over a number of years, and without this historical network, factual testimony would have become almost impossible.

In negotiating extra work, contractors have often neglected the effects the change order will have on working time, so that either they have requested no time extension or an extension equaling the total period they estimate the additional work will require. Generally speaking, however, extra work on a project affects float areas, and any time extension granted should be less than the total incremental time needed to complete the additional work. At Cape Canaveral, the combined emphasis on time and public pressure for completion of projects reversed this situation. Contractors recognized more clearly the time-money relationships and usually made substantial requests for additional time as well as for extra money to implement changes. The Corps of Engineers and NASA required network analysis for the basic work on most of the major projects undertaken there. Thus most of the contractors prepared network-oriented fragnets to demonstrate the effects that additional work would have on scheduling. Although there were abuses, in the long run CPM was used by both parties to evaluate requests for time extensions fairly, and many claims were settled without the drudgery of formal legal suits.

Also at Cape Canaveral, a new type of claim evolved, a claim for acceleration charges. Contractors would often accept extra work items and agree to perform them in the originally allotted time span. To balance this obvious inequity of additional work but no time extensions, a fee for work acceleration would be charged to compensate for the costs of overtime and other problems that arose such as the inefficiencies generated by the overstaffing of particular areas of work.

The type of contract originally signed for a project has an impact on whether or not there is a potential for easy resolution or settlement of claims should they arise. Claims relating to construction management and

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order had the potential to delay the project. And in fact, it probably did delay it unless there were methods to work around the change—methods that must themselves be demonstrated to have been used.

Another area to be researched is stop orders or suspensions. These are applied to a network in the form of actual dates, or as activities inserted in the stream of activities affected.

TIME IMPACT EVALUATIONS

When all the causative factors have been identified, a time impact evaluation (TIE) is prepared for each one. The information is assembled as described previously, and prepared in a format such that the impact of each factor on the as-planned network can be determined and applied to it. When the impacts of all the causative factors have been correctly determined and applied, the result should be an approximation of the as-built network. Then the impacted, as-planned network should be compared with the as-built one, and any major disparities between them should be examined to identify whether TIEs were incorrectly applied, or whether there were additional causative factors not identified.

The theoretical effects of the impacting factors on the as-planned network must be explainable in terms of the as-built network, or the proposed analysis is probably incorrect. Some professionals take a different position, however. One well-known scheduling consultant expounds the theory of the "500 bolts": If an owner is to provide 500 bolts, and has delivered only 499, in the consultant's opinion the activity involved will be impacted until that 500th bolt has been delivered. But it appears more logical to examine the function of the 500th bolt. For instance, if it is a spare or there is a readily acceptable substitute which permits construction to proceed, then it is not, theoretically speaking, proper to claim that the as-planned network has been impacted by its absence.

Another position, often taken by schedulers who conduct impact analyses on as-planned networks for contractor evaluations, is that all float belongs to the contractor. This has been a continuing argument in the profession. In fact, some recent owners' specifications, in order to counteract such claims, outright state, "All float belongs to the owner." Neither position is tenable, however. Float is a shared commodity. Like a natural resource, it must be used with common sense. The owner should be permitted to use float for order changes, shop drawing reviews, and other owner-responsible areas. On the other hand, it is obvious that owners should not use float excessively to the point that the entire project becomes totally critical. This would be an overreach on the part of owners. Conversely, contractors should be expected to utilize float only to balance

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slow delivery of the well pump, the initial site work network now has float as shown in Figure 22.5. There are, however, an additional 8 days of float in the early activities prior to the installation of the well pump. The 8-day differential in float along the well drilling path is still imposed by the late delivery of the well pump. However, there is no impact upon the overall project because the late steel delivery takes precedence.

To determine the cumulative effect of all delays, all TIEs should be developed and impacted against the network simultaneously. To evaluate the impact of any one category, just the TIEs representing that category (i.e., owner's responsibility, *force majeure*, contractor responsibility, etc.) should be applied to the network.

EVIDENTIARY USE OF CPM

During the 1960s, CPM schedulers, technicians, and engineers anticipated that Critical Path Method would be utilized as a tool in construction claims and litigation at some point in time. In fact, as early as 1962 to 1965, consultants to the litigants on both sides of a case involving the Atomic Energy Commission utilized CPM to prepare their positions, although a case citation is not available, and no wide exposition of the results was made. (The firm providing consultants to both sides was Mauchly Associates.)

In the 1970s, CPM techniques were used in presenting, and defending, delay claims cases in many instances. In no case where OKA was involved was the use of CPM questioned by opposing counsel or the court. Some of these cases include the following (dates are approximate):

- IBM vs. Henry Beck Construction; Federal Court, Florida, 1973
- Somers Construction vs. H. H. Robertson; Arbitration, Philadelphia, 1973
- E. C. Ernst vs. City of Philadelphia; Eastern Federal District Court, Philadelphia, 1976
- Arundel vs. Philadelphia Port Corp.; Commonwealth Court, Pennsylvania, 1979
- Buckley vs. New York City; New York State Court, 1979
- Federal Construction vs. Blake Construction; Federal District Court, Washington, DC, 1980
- Kidde-Briscoe vs. University of Connecticut; Connecticut State Court, 1980–1982
- Keating vs. City of Philadelphia; Eastern District Court, Philadelphia, 1981.

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Bennett Co. (GSBCA 2362, 72-1 BCA ¶ 9364 (1972)) which . . . affirms the need to properly update a CPM and support the study with accurate records. The contractor's claim in this appeal was founded on a letter from the contracting officer ordering completion of the work by the contract completion date. The contractor argued this requirement was an acceleration order, which was denied by the contracting officer because of a lack of meaningful evidence. The contracting officer rejected the accuracy of the contractor's critical path method construction plan on the basis of errors in the interrelationships of activities.

At the board, the appellant presented a computer analysis of the CPM used on the project to isolate the delays caused by government activities. The board held that the usefulness of this analysis was dependent upon three things: 1) the extent to which the individual delays are established by substantial evidence—this requirement is concerned with the project records and evidence available for the appellant to show the underlying causes of delay; 2) the soundness of the CPM system itself—this requires the contractor to demonstrate the logic of the CPM and show that its theoretical and scheduling analyses are sound; and 3) the nature of and reason for any changes to the CPM schedule in the process of reducing it to a computer program—this relates to the exactness and accuracy with which the appellant has reduced the CPM network to a computer analysis and how effectively this analysis can be used in a claim presentation.

As expected, the appellant in Bennett argued that the CPM was the proper basis for any analysis of the project since the plan was submitted by the appellant and approved by the government.

However, the board rejected the appellant's CPM analysis because it: 1) contained numerous mathematical errors; 2) failed to consider foreseeable weather conditions; 3) changed the critical path and float times without reason; and 4) was prepared without the benefit of any site investigation and after the project was already completed. . . .

The gradual acceptance of CPM presentations when properly documented is demonstrated in the case of Continental Consolidated Corp. ENG BCA 2743, 2766, 67-2 BCA ¶ 6624 (1967). . . .

In this case a claim was submitted for extra costs due to suspension of work and subsequent acceleration directed by the government. The appellant alleged it was entitled to time extensions due to government delay in approving shop drawings. The government's failure to grant time extensions for these delays made the work appear to be behind schedule as of certain dates when in fact, if proper time extensions had been granted, the appellant would have been on schedule. As a result, government directives to work overtime and/or extra shifts would have been unnecessary. . . .

The contract set completion dates for various elements of the work which in effect required a critical path for each element within an overall work plan. With the use of the appellant's CPM analysis, the board was able to separate out the delay costs due appellant and the additional costs incurred due to a compensable acceleration order. This evidentiary tool allowed the board to identify the periods of delay and actual progress on the job and thereby

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determine when an acceleration order was properly issued from that point in time when such an order was compensable because the contractor was back on schedule.

Thus the boards have recognized the value of a CPM developed contemporaneously with the work or subsequent to the work so long as it based upon the relevant records available.

The records may include daily logs, time sheets, payroll records, diaries, purchase orders.

While the boards have accepted the CPM as an evidentiary tool, this tool cannot rise above the basic assumptions and records upon which it is founded. The board can accept the theoretical value of a CPM presentation, but reject its conclusion for failure to base the analysis on the actual project records. (See C. H. Leavell & Co., GSBCA 2901, 70-2 BCA ¶ 8437 (1970); 70-2 BCA ¶ 8528 (1970) [on reconsideration] where the contractor failed to establish the accuracy of the input data for its computer analysis of delays due to design deficiencies.)

Where the board has received persuasive evidence that the CPM network is either logically or factually inaccurate, incomplete or prepared specifically for the claim, the board will discount its evidentiary value. A CPM must be linked to the job records, as a CPM analysis is primarily concerned with visually portraying the job records to establish the cause of delay or disruption.

The extent to which a CPM presentation may be used to document a claim can be seen in Canon Construction Co. (ASBCA 16142, 72-1 BCA ¶ 9404 1972) where the contractor gained total acceptance of its CPM schedule to establish a delay claim. In this opinion, the board recognized the underlying logic and evidence presented in the appellant's original CPM schedule and the value of CPM techniques to prove extended overhead costs.

In Canon, the contractor was awarded his overhead costs determined by the difference between the actual date of completion and the date the contractor would have completed the work absent government fault and performance of changed work. But the recovery for extended overhead costs was held to be limited by either the extended period of performance time or the aggregate net extent of delays caused by government fault or changed work, whichever is the lesser. Using this formula the board recognized that the contractor was not entitled to recovery for the group of excusable but noncompensable delays including weather delays, reasonable suspensions of work, etc. . . .

The Canon decision is extremely important since it shows that a properly prepared and presented CPM schedule will be accepted by the board as the basis for computing project delays. In this regard it is noted that the board clearly indicated that it was "relying principally on the CPM chart and only using the witness' testimony to ascribe an aspect of reasonableness to the chart."

The Canon decision is also significant since it provided further guidance as to the application of CPM principles to claims. For example, the board acknowledged that delays incurred off the critical path would not delay ultimate performance. Further, the board found that where the sequence estab-

But-For Schedules—Analysis and Defense

James G. Zack Jr.

ABSTRACT: The purpose of this article is to discuss the use and abuse of but-for schedules (sometimes called collapsed as-built schedules) in today's claims oriented construction industry. This article also discusses ways to analyze but-for schedules when they are presented as evidence of either an excusable or a compensable delay. Finally, the article discusses ways to defend against but-for schedules should the reader need to do this in negotiation, litigation or some alternative dispute resolution forum (e.g., mediation, arbitration, summary jury trial, etc.).

KEY WORDS: but-for schedules, claims, delay, dispute resolution, and mediation

But-for schedules are usually used to present delays and time extension requests after a project is built. They are more reliable than several other delay analysis techniques. They are, however, subject to abuse and manipulation. Those faced with the task of analyzing such delay analyses need to be cautious. Reviewers must ascertain that a but-for schedule presented in support of a claim has not been abused so badly as to render it meaningless or dangerous. This article discusses ways to do this.

DELAY ANALYSIS TECHNIQUES

There are, generally, seven analytical techniques used to perform schedule delay analysis.

Bar Chart Analysis

This form of schedule analysis compares an as-planned bar chart with an as-built bar chart. The concept portrayed is that the activities shown on the bar chart would have been completed exactly as planned, were it not for certain delays. The delays indicated in the analysis (that are typically shown simply as extended bars) are highly dependent upon whether the owner or the contractor is performing the analysis. The analysis is merely graphical, and systematically ignores the lack of underlying logic between the activities.

CPM Update Review

This technique makes no attempt to create a separate delay analysis diagram. The technique examines each progress schedule update submitted on the project and explains what caused the delay on each update without performing any further analysis. Again, the explanation of delay depends on whether the owner or the contractor is doing the analysis.

As-Planned Versus As-Built Analysis

Like the bar chart analysis above, this technique simply compares the baseline or as-planned schedule with the final or as-built schedule. This analysis is similar to a total cost claim analysis wherein one subtracts the amount paid from the amount expended to calculate the amount owed. With respect to time, this type of analysis subtracts the time planned from the actual time expended to determine the time owed, thus presenting a "total time claim" with an explanation about why the time was extended and how it was the other party's "fault."

Impacted As-Planned Analysis

This technique is sometimes referred to as the as-planned plus delay technique. In this technique, the scheduler simply takes the as-planned schedule and adds new activities that represent delays (generally caused by the other party) to demonstrate why the project was completed later than planned. Again, the selection of what new activities are added to the schedule depends upon who is performing the schedule analysis.

But-For Schedules

This technique is also referred to as the collapsed as-built schedule analysis technique. This technique attempts to create an as-built schedule, identify "actual delays" caused by two parties, and then remove one party's delays from the as-built schedule to "collapse" the schedule leaving in the schedule those delays caused solely by the other party. The argument is, "but-for the other party's delays, this is when the project would have been completed." The amount of delay and the resulting damage are then calculated.

Windows Analysis

This technique is occasionally referred to as contemporaneous period analysis [1]. The technique is to validate the as-planned or baseline schedule, and then, using contemporaneous project documentation, update the schedule one period at a time (monthly, quarterly, seasonally, etc.). The technique builds one period analysis upon the previous period's analysis, examining each new period for delay, causation, and liability as the analysis proceeds. This method puts delays in their proper time frame within the overall context of the project.

Linear Schedule Analysis

This technique is only used with linear type projects (water mains, sewer lines, highway construction, etc.). It is a form of progress quantity charting applied to the progress of a specific construction project; it plots construction activity progress over time. The delay analysis technique compares as-planned to actual linear progress (similar to plotting as-planned versus actual cash flow curves, for example). The analyst then offers an explanation of why the two lines diverged when they did (that is, causation and liability) in an effort to justify the delay requested.

BUT-FOR SCHEDULES

Why Are But-For Schedules So Popular?

Bar charts largely have been abandoned in public works construction in the US in favor of critical path method (CPM) scheduling, while linear scheduling, because of its inherently narrow range of applicability, is infrequently used. Therefore, these two schedule analysis techniques are rare due to the infrequent use of the scheduling methodology they are applied to. As-planned versus as-built schedule analysis (the total time claim) and the CPM update review method have a number of critical flaws, that are beyond the scope of this article to discuss. Therefore, they are rarely used today in litigation. The impacted as-planned technique has so many flaws that most courts have widely discarded its use.

This generally limits the scheduler to the remaining two delay analysis techniques. While windows analysis is probably the more accurate of the two delay analysis techniques, it is usually more expensive due to the amount of time and effort needed to perform it. It also typically takes longer to perform, due to the need to validate all scheduling data used in the analysis. Thus, if the time and budget needed to perform a delay analysis are limited, windows analysis may not be achievable within the confines of these two constraints.

But-for schedules are frequently used when performing a delay analysis. But-for schedules generally require less time and less effort. They can normally be done more quickly and at less cost than a windows analysis. But-for schedules are, however, more easily manipulated, so the scheduler is more likely to be able to demonstrate the point trying to be made.

Schedulers using this technique generally refer to the "as-built critical path," which they say has been calculated from "as-built information." The implication is that this form of scheduling analysis is based solely on facts. Additionally, since the scheduler constantly refers to "as-built dates," it appears that this schedule analysis is highly accurate. The analysis resulting from but-for schedules is easily understood, making them very popular with schedulers and claims consultants. Because of the above reasons, most people reviewing a but-for schedule will conclude that it is factual, accurate, and correct. But-for schedules are, however, deceptively simple. I contend that they should not be relied on unless a great deal of independent research and analysis is done.

But-For Schedules—Underlying Assumptions

As with any methodology, there are a number of assumptions that underlie the theory of the but-for schedule. These assumptions are listed briefly below.

- While unstated, it is generally implied that an as-built critical path is readily identifiable. The portrayal most frequently offered is that one can "look backward" down the as-built critical path to determine what events or activities actually caused the project to be completed late.
- Also unstated is the implication that there was but a single, unchanging critical path that can be identified at the end of the project and analyzed for delay and causation purposes for the entire project duration.
- Another unstated assumption is that the project would have been built the exact same way if the various project delays had not arisen. The assumption is that the contractor made no attempt to change the schedule to mitigate the effect of delays.
- It is also assumed that accurate start and completion dates are available from project records for every schedule activity. Thus, one need only find and record these dates to fill out this analysis.
- Once as-built start and complete dates are determined, it is assumed that work on each activity is continuous for the entire time between the start and completion dates.
- Yet another assumption is that as-built schedule logic can be entered easily once the as-built dates are found.
- Finally, it is assumed that the scheduler has reviewed all project documentation and interpreted the information objectively and accurately.

But-For Schedules—Analysis and Defense

If presented with a but-for schedule, what analysis should be performed? How can an owner or owner's representative defend against a but-for schedule with its implied factual basis, accuracy, and correctness? There are, in my opinion, three ways to accomplish this, as set forth below.

- Challenge assumptions—as noted above, a series of assumptions have been made by the scheduler preparing the but-for schedule. Challenge these assumptions to test for accuracy in each specific case.
- Challenge theory—question the theory concerning the but-for schedule to see if it has been accurately applied to this specific delay analysis.
- Challenge analysis—use the reviewer's analysis of the project documentation to challenge the but-for schedule to test the objectivity of the scheduler and the accuracy of the work.

Once the reviewer has performed the above tasks, a conclusion can be reached concerning the objectiveness of the scheduler preparing the but-for schedule, as well as the accuracy and reliability of the but-for schedule presented in support of a claim.

CHALLENGE ASSUMPTIONS

The most fundamental assumption underlying an as-built schedule is that an as-built critical path can be easily identified, reviewed, and analyzed to ascertain delays, but can an as-built critical path actually be calculated?

By definition, the "critical path" is the longest uninterrupted chain of events through the schedule network. The critical path dictates the length of the project as it is " . . . the longest path into the last event, since it establishes the latest event time for that last event [2]." A project's critical path is computed by the forward and backward passes that mathematically identify the longest uninterrupted chain of events through the network. These calculations are entirely dependent on the activity durations and logic (or sequence of activities) input by the scheduler.

The critical path is determined by a forward-looking set of calculations only! It starts at a point in time and calculates how long it will take to reach the project's end. By definition then, an "as-built" critical path cannot be calculated as all activities on an as-built schedule are completed. (Unless, of course, schedule activities have been left unstatused by the scheduler. If they are unstatused, then the schedule is

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not an "as-built schedule.") While completed activities are identifiable and actual durations perhaps known, the schedule logic no longer comes into play in the calculation process. One cannot therefore "calculate" an as-built critical path. "As-built" critical paths can be identified, perhaps, but a great deal of judgment goes into such an effort, and manipulation of the schedule is accomplished. This is considerably different than "calculating" a critical path!

Equally open to challenge is the assumption that there was a single, unchanging critical path throughout the life of a project. It is my experience that a schedule and its critical path are dynamic in nature. They are subject to change for a wide variety of valid reasons (late equipment deliveries, adverse weather, late responses to submittals, issuance of change orders, subcontractor defaults, etc.). Further, the critical path may change monthly, or even more frequently, on a project with a myriad of problems.

Thus, schedule activities that have a great deal of float in the early portion of a project may end up on the critical path during the middle of the project and then be returned to a noncritical status with float time at the end of a project. Assuming this is an accurate portrayal of the dynamics of project scheduling, to find a single critical path and analyze the effect to it, at the end of the job, ignores these dynamics. For example, at the end of a project, looking at the as-built critical path, a change order that caused a demonstrable time effect in June 1997 (at the time of issuance) may have 100 days of float when the as-built critical path is determined in December 1998. Should the owner take back the previously approved time extension that was valid in mid-1997, but that has been proven not to be critical by the end of 1998? Or, in light of this scheduling methodology, should owners refuse to grant any time extensions until the project is totally completed and the as-built critical path identified? Neither is reasonable, and both fly in the face of good contract management practices, in my opinion.

The assumption used in the but-for schedule methodology fails to put delays in their proper context. The methodology denies the dynamics of project scheduling in the real world. The methodology assumes the existence of a single critical path that was unchanging throughout the project and can be analyzed for delay at the end of the job. This assumption ignores reality and thus is subject to serious challenge.

CHALLENGE THEORY

There are three aspects of the theory of but-for schedules that are subject to attack.

First, would the work of the project have been done in the same manner had the delays not occurred? It is my experience that contractors faced with delays (both critical and noncritical) will resequence activities in order to compensate. Contractors do this to mitigate potential effect or damage. Sometimes, schedule resequencing is done for other reasons. Thus, the but-for schedule should be critically examined to find logic or sequence changes when compared to the as-planned schedule. Assuming such sequence changes are found, the reviewer should try to determine if any of the changes were "preferential"—not an unavoidable consequence of the delay. For example, were activities resequenced simply to mask concurrent contractor or subcontractor-caused delays? If resequencing of this nature can be demonstrated, then this is a strong indicator the project probably would have been built differently, absent the delays. If this can be shown, the reviewer can assert that this part of the theory is false with respect to this particular delay analysis. That is, the reviewer will have shown that schedule logic was modified by the contractor during the project, thus proving that the project would not have been built the same way without the delays.

Second, would the project have been built at the same speed in the absence of these delays? Again, it is my experience that when faced with a project delay, contractors tend to slow down other noncritical work. They tend to take the position "Why should I hurry up and later have to wait due to an owner's delay?" Such extension of activity durations effects or distorts the project schedule. Activity duration extensions of this nature tend to exacerbate schedule effects. Therefore, the reviewer should compare the but-for schedule to the as-planned schedule to find activity durations that took significantly longer than planned but that were not affected by any identifiable delays. The reviewer should ascertain whether these were simply "pacing delays." If they were, then this theory has been shown to be unsupported, at least insofar as this specific analysis is concerned. If "pacing delays" [3] can be demonstrated by the reviewer, then this is proof that the speed of the project would not have been the same.

The third theory subject to challenge is perhaps the most important of all. Were the activities on the but-for schedule prosecuted continuously from start to finish? This is the way most schedulers show an activity on the but-for schedule. The scheduler will show "install conduit, basin 1" with an actual start of June 1, 1998, and an actual completion of June 30, 1998. The unstated implication, of course, is that this activity actually took 30 calendar days, or 22 work days, and was prosecuted continuously—work was performed on this activity every day for all 22 work days. If the reviewer can document, through a review of contemporaneous project records, that a number of activities shown on the but-for schedule were not prosecuted continuously, as shown, then substantial doubt can be cast on this theoretical aspect of the methodology. Since it demonstrates that the but-for schedule is not as accurate as it was held out to be.

CHALLENGE ANALYSIS

The largest part of the effort in challenging a but-for schedule analysis is in examining the details. As the old saying goes, "The devil is in the details!" Likewise, the most substantial challenge to a but-for schedule lies in challenging the details of the analysis presented to determine accuracy, reliability, and correctness.

Challenge the Manner in Which the As-Built Schedule Was Derived

Questions to be asked include the following. What are the sources of the as-built dates used in the but-for schedule? How did the scheduler ascertain logic between the as-built activities? What was the source of the information for the as-built logic? The point here is that a but-for schedule analysis places a heavy burden on a scheduler to ferret out all of the facts and make the series of discretionary choices necessary when employing this analytical technique. There are so many choices that the temptation to skew the schedule analysis in favor of one's client is all too real.

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Challenge the Dates Shown on the But-For Schedule

Check the accuracy of the dates shown on the but-for schedule against contemporaneous project records. Look in the project records to see if conflicting information can be found. Reviewers should look for conflicting information concerning start and completion dates in project documents such as weekly or monthly meeting minutes, project correspondence, RFI and change order logs, schedule updates, payment applications, daily inspection records, daily diaries, project photographs, and monthly status reports. If contradictory information can be found, challenge the scheduler's use of that information. If the reviewer can document that information exists that the scheduler failed to use or ignored, or can find project documentation that contradicts the dates contained in the but-for schedule, then substantial doubt concerning the validity and accuracy of the but-for schedule can be raised.

Challenge the But-For Schedule's Critical Path

Look especially at start and completion dates for activities on the critical path. Challenge the scheduler's starting dates. What, exactly, constitutes "start work" for each activity identified? Let's look at an activity identified as "install conduit, basin 1." Does work start when the conduit is delivered to basin 1? Is it when the first hanger is installed? Is it when the first piece of conduit is hung? What constitutes "work complete"? Do ~~all of~~ the hangers and conduit have to be painted before it's complete, for example? Challenge the scheduler to define precisely the scope of work for each activity on the but-for schedule's critical path. Compare this information to contemporaneous project documentation to determine whether it is accurate.

Challenge the Premise That There Was a Single, Unchanging Project Critical Path

Examine the project records to see if any time extensions were requested by the contractor for events that are not shown on the critical path in the but-for schedule. Question the scheduler on why such time extension requests were made. Examine the project records to determine whether any time extensions were granted for activities or events that are not on the as-built critical path in the but-for schedule. Ask the scheduler whether the owner should be "credited" with these time extensions since the as-built critical path analysis demonstrates that they were not critical, in the end?

Challenge the Assumption of Continuous Work on Schedule Activities

As noted earlier, an activity on the but-for schedule may be shown as 22 work days. The implication, of course, is that the contractor worked on this activity for each of the 22 days shown on the but-for schedule. Take the example given above, "install conduit, basin 1" with actual start and completion dates of June 1 and June 30, 1998. Let's say it can be shown (through analysis of the contractor's labor distribution reports) that the contractor employed an 8-person crew on this activity from June 1 to June 5, then no work was performed on the activity again until June 29, when there was a 2-person crew who completed the work on June 29 and 30, 1998. If this were the case, the reviewer could certainly show that this was not an activity with a 22-work day duration, but actually had a duration of 7 work days over a 30-calendar day period and one that accomplished approximately 91 percent (40/44 worker days) of the work in the first 5 work days (320 mh/352 mh). This is hardly the same picture as the but-for schedule indicates, which is work by a full crew every day for 22 work days.

Challenge the But-For Schedule Logic Diagram

A careful review of the as-planned schedule compared to the as-built schedule should be performed. The reviewer should look for and question the following items.

- Added delay activities: have new activities been added to represent delays? If so, what delays were added? Why were they added with these dates? What project records document these activities and their recorded dates? Why were they added in this particular sequence? What project record documents this logic?
- Added change order activities: have new activities been added to represent change orders? If so, what change orders were added and in what manner? What project records document the logic and duration of the added change orders?
- Deleted activities: were any activities from the as-planned schedule deleted in the as-built schedule? If so, why? What project records document the reasons for activity deletion?
- Changed activities: were any activities changed? For example, were two activities merged or hammocked into a single activity or was one activity split into two or three? If so, how and why? What project records document such a change?
- Differing activity durations: were any activity durations changed? What project records document these changes?
- Differing lag times: were the lead and lag time between activities changed? If so, how and why? What project records document these changes?
- Differing activity relationships: were relationships between activities from the as-planned schedule changed when put into the as-built schedule? If so, how and why? What project records document such changes?

Given the above research, the reviewer should be in a good position to critique the but-for schedule and to challenge the scheduler concerning schedule manipulation. It is my experience that but-for schedules are frequently manipulated to produce exact dates desired to support a claim. If schedule manipulation can be demonstrated by the reviewer, then the scheduler's objectivity and the But-For Schedule's accuracy can be seriously called into question.

SUMMARY OF CHALLENGES

A reviewer tasked with responsibility for analyzing, critiquing, and defending against a but-for schedule should focus most effort on the critical path activities shown on the as-planned schedule and the but-for schedule.

- Find conflicting information from contemporaneous project documentation. Challenge the scheduler to see how the critical path would change if conflicting dates were used.
- Challenge the scheduler as to why the dates used are more reliable or accurate than the conflicting dates found in project records by the reviewer.

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- Challenge the scheduler to justify the logic relationships used in the but-for schedule. As noted earlier, it is not possible to "calculate" an as-built critical path, and in my experience, it is rare that contractors or owners keep sufficiently detailed daily records to reconstruct a completely accurate record of all logic relationships on an as-built schedule. Therefore, a considerable amount of judgment must be exercised in identifying an as-built critical path. Test the scheduler's judgment.
- Challenge the scheduler to determine whether the critical path in the but-for schedule differs from the evolutions of the critical path shown on contemporaneous project schedule updates. If so, in what way? Are the differences due to unexpected events during the project or manipulation of the schedule (either during the project or during the but-for-schedule analysis)? Why is the but-for schedule more believable than the contemporaneous schedules prepared and submitted by the contractor during the project?
- Challenge the scheduler on whether the but-for schedule was manipulated to arrive at the work product produced? Was conflicting information found? If so, why use the information presented and not the conflicting information? Did the But-For Schedule come out this exact way on the first run as the document submitted? (This is almost a practical impossibility.) If not, why not? What did the scheduler do to "fix it"?
- Challenge the scheduler concerning various changes in logical relationships, lead times, lag times, etc. Ascertain whether the scheduler inserted certain relationships simply to "force fit" the but-for schedule with the claim.

REASONS FOR REJECTING BUT-FOR SCHEDULES

As noted earlier, but-for schedules are commonly used to support delay damage and disruption claims. At first glance, most but-for schedules look impressive, as they are meant to. Most schedulers will tell the reviewer that "We rebuilt the as-built schedule exactly the way the project was built and then simply removed the delays to determine when the project would have finished but-for the actions of . . . ." As has been shown, most but-for schedules should be challenged and perhaps rejected for the following reasons.

- But-for schedules assume that the project would have been constructed in exactly the same manner even without the delays.
- But-for schedules assume that non-delayed activities would have been constructed at exactly the same speed or pace without the delays.
- But-for schedules assume that an as-built critical path can be calculated and analyzed.
- But-for schedules assume the existence of a single, static, unchanging critical path on the project which can be analyzed.
- But-for schedules assume that accurate start and complete dates for all activities can be found in the project records and recorded on the as-built schedule.
- But-for schedules assume that logic between all activities can be determined from the project records and recorded on the as-built schedule.
- Finally, but-for schedules assume that the scheduler preparing them is, at all times, both thorough and objective.

But-for schedules are very popular in claim presentations. They appear to be accurate, correct, and reliable, and the outcome of a but-for schedule analysis is easily understood by a trier-of-fact. However, as has been shown, but-for schedules are deceptively simple. The assumptions and theories underlying them are all subject to challenge. But-for schedules are all too easily manipulated. While this is a valid form of delay analysis and is still acceptable in a claim or dispute situation, but-for schedules need to be reviewed and analyzed with a great deal of care. Both the but-for schedule and the scheduler must be challenged to determine whether the but-for schedule is accurate or skewed.

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James G. Zack Jr. is Executive Director of Corporate Claims Management at Fluor Daniel, One Enterprise Drive, S3-148 Aliso Viejo, CA 92656-2606. He previously was a vice president of PinnacleOne and the director of the PinnacleOne Institute, an educational organization established to provide professional development seminars in project management, claims mitigation, and claims management. Mr. Zack also was the project manager for the company's on-call construction claims support services contract with the California Department of Transportation and was a senior claims consultant for a similar contract with the California Department of Corrections. For 30 years, he has worked on government contract and grant projects. He has worked for public clients throughout the US and in Alexandria and Cairo, Egypt. Mr. Zack has been involved in more than 2,500 claims and has been designated as an expert witness in mediation, arbitration, and litigation. Mr. Zack is a member of AACE International, is the Region 6 Director, and is a well-recognized speaker, author, and trainer. He can be reached at jim.zack@fluor.com◆