I. Introduction

Critical path method ("CPM") scheduling traces its roots to a study group created by the E.I. DuPont de Nemours Company in 1956. The group used a UNIVAC I computer to evaluate the potential for utilizing computers in scheduling construction work. In 1957, the Univac Applications Research Center, under the direction of Dr. John W. Mauchly, James E. Kelley, Jr. of Remington Rand, and Morgan Walker of DuPont joined this effort. This expanded group created a program that became the first CPM software.

Beginning in the mid-1960s, the Federal government first specified CPM scheduling for use on major projects. During this era, other governmental entities also mandated the use of CPM schedules on infrastructure projects, including several major subway projects being constructed in the late 1960s and 1970s. In these early days of CPM use, contractors had to employ consultants to assist in the preparation of their schedules and to computerize the initial schedule and all updates, as mainframe computers were necessary to generate the schedules and updates.

In September 1981, IBM introduced the first desktop personal computer ("PC"). Software for PCs soon became available permitting schedules to be fully prepared and updated at the job site in an economic manner. However, this development also permitted the scheduling process to be administered by individuals who often were less

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experienced than the outside specialists who had previously assisted in the process. As described below, this has introduced new concerns regarding the appropriateness of the schedule as a planning tool and a means for establishing project delay.

As originally developed, CPM schedules featured an I-J format. In the I-J format, each activity is represented by an arrow, with an activity number on each end. The activity number on the tail of the arrow is the I-node and the activity number on the head of the arrow is the J-node. The activity is designated by these two activity numbers.\(^3\)

The I node reflects the start date for an activity and the J node indicates the completion date. The arrow diagram is prepared by arranging activities into a planned sequence based on the logical relationship between the activities. “Three basic rules of logic should be applied to each activity:

1. What activities must be completed before the activity in question can start?
2. What activities can be done concurrently?
3. What activities must follow the completion of the activity in question?”\(^4\)

“The logical relationship between the activities is defined by the activity numbers. For example, activity 10-20 is preceded immediately by every activity in the network with a J-node of 10 (e.g., 4-10, 6-10, etc.) and immediately succeeded by every activity in the network with an I-node of 20 (e.g., 20-25, 20-40, 20-70, etc.).”\(^5\) One of the advantages of the I-J format is that one can easily determine the work that has been completed and the work that remains to be performed.

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\(^3\) E.g., if the I node is designated as 10 and the J node is designated as 20, the activity number is 10-20.


\(^5\) Jon M. Wickwire and Stuart Ockman, *supra* at 16.
The other, more recent, form of network diagramming is known as the precedence diagram method ("PDM"). "A precedence diagram has four precedence relationships, i.e., finish-to-start, start-to-finish, finish-to-finish, and start-to-start." Each activity description is shown in a box or oval, with the sequence or flow shown with interconnecting lines. In addition, the precedence diagram also permits the scheduler to use "leads" and "lags." Lead activities delay the start of a particular activity or group of activities by a certain time period. As an example of a lead item, the schedule may provide that Activity B cannot begin until 50% of Activity A is complete. Lag activities are those that cannot complete until the preceding activity is complete. For example, the last 30% of Activity B cannot complete until Activity A is complete. As a consequence of the above, the scheduler has more flexibility in diagramming the schedule than in the I-J format, but it is more difficult for the user to track progress and changes on a monthly basis.

Beginning in the early 1990s, large public agencies began showing a preference for precedence diagrams. In 1994, Primavera Systems, the principal supplier of CPM software, issued its Windows version of Primavera Project Planner ("P3"), which no longer supported I-J diagramming. PDM now has replaced the I-J format as the norm for construction scheduling on major projects.

II. **Admissibility of Expert Scheduling Testimony**

A. **Introduction**

In the realm of construction law, experts are a crucial connection between the

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6 *Id.*
8 Jon M. Wickwire and Stuart Ockman, *supra* at 16.
9 *Id.*
complex fact and contractual underpinnings of the case and the fact finders’ understanding of the dispute. Of course, before a litigant can utilize an expert’s opinions to enhance the fact finder’s understanding, the expert must be permitted by a court, board or arbitration panel to testify. Admissibility of an expert is a question of law to be determined by the judge or arbitrator and is controlled by Federal or State Rules of Evidence and the case law that interprets those rules.

**B. The Frye “General Acceptance” Standard**

For the 70-year period prior to 1993, the standard for admission of expert testimony in federal courts emanated from a two-page decision, with no citations, issued by the United States Court of Appeals for the D.C. Circuit. This decision, *Frye v. United States*,\(^{10}\) reviewed the trial court’s rejection of an expert’s findings and proffer founded on the results of a rudimentary lie detector test. The test in question measured systolic blood pressure as an indicator of truth. The theory espoused by the expert was that the utterance of a falsehood requires conscious effort and thus raises systolic blood pressure. The truth apparently is spontaneous and has no impact on blood pressure. The Court concluded that the expert’s theory did not have scientific recognition among psychological and physiological authorities as would justify the admission of the testimony. The oft-quoted passage that defined the *Frye* standard is as follows:

> Just when a scientific principle or discovery crosses the line between experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.\(^{11}\)

\(^{10}\) 293 F. 1013 (D.C. Cir. 1923).
\(^{11}\) *Id.* (emphasis added).
C. Federal Rules of Evidence

The Federal Rules of Evidence (“FRE”) were adopted in 1975. Several rules expressly are applicable to experts and their testimony.\(^\text{12}\) Rule 702, as adopted in 1975, described the underlying basis for admission of expert testimony as follows:

If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise.\(^\text{13}\)

Other rules allow an expert to base an opinion on facts or data known before or at the hearing, even if not admissible themselves (Rule 703); allow an expert to offer an opinion on the ultimate issue in a dispute (Rule 704); and allow an expert to offer an opinion without disclosing the facts or data underlying the opinion (Rule 705).

Rule 702 addresses scientific, technical and other specialized knowledge that may assist the trier of fact in understanding the evidence or determining a fact in issue. The drafters of the new rule did not expressly adopt the “Frye” standard of general acceptability. Instead, the FRE standard is premised on whether the expert testimony is considered helpful to the trier of fact. Upon adoption of the FRE, an immediate issue arose as to whether the rules superseded the Frye test.

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\(^{12}\) See Fed. R.’s Evid. 702-706.

\(^{13}\) Rule 702 was revised in December 2000 as a consequence of the Supreme Court’s decisions in Daubert and Kumho, infra. The current text of the rule is as follows: If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified by knowledge, skill, experience, training or education, may testify thereto in the form of an opinion or otherwise, provided that (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.
D. **Daubert and Its Progeny**

In 1993, the Supreme Court granted *certiorari* to entertain the question of whether Rule 702 superseded the “*Frye* general acceptance” standard for admission of expert scientific testimony at trial. The Court answered the question in the affirmative in *Daubert v. Merrell Dow Pharm., Inc.* \(^\text{14}\)

In *Daubert*, the substantive issue for resolution was whether ingestion of the drug Bendectin during pregnancy caused birth defects. At the trial court, summary judgment was granted to the defendant on the basis of a well-credentialed expert’s affidavit, based on a review of extensive published scientific literature on the subject, stating that the maternal use of Bendectin has not been shown to be a risk factor for human birth defects. Plaintiff had presented eight other well credentialed experts who concluded that Bendectin could cause human birth defects. These conclusions were based on unpublished studies involving test tube and live animal research. None of the studies had undergone peer review. The trial court concluded that the expert evidence proffered by plaintiff did not meet the *Frye* standard of general acceptance in the scientific community in that it was not based on epidemiological data. Accordingly, the lower court granted the defendant’s motion for summary judgment. \(^\text{15}\) After granting *certiorari*, the Supreme Court acknowledged that, “[i]n the 70 years since its formulation in the *Frye* case, the ‘general acceptance’ test [had] been the dominant standard for determining the admissibility of novel scientific evidence at trial.” \(^\text{16}\) In ruling that the *Frye* standard no longer was applicable, the Court noted that the FRE now “occupy the field” of evidence


\(^{15}\) *Id.* at 583 (citing to the district court’s opinion at 727 F.Supp. 570, 572 (S.D. Cal. 1989)). The 9th Circuit affirmed. *See* 951 F.2d 1128 (1991).

\(^{16}\) *Id.* at 585.
and the common law was to serve only as “an aid to their application.”

The Court also concluded that “[n]othing in the text of [Rule 702] establishes ‘general acceptance’ as an absolute prerequisite to admissibility.” Further:

[T]he assertion that the Rules somehow assimilated Frye is unconvincing. Frye made ‘general acceptance’ the exclusive test for admitting expert scientific testimony. That austere standard, absent from, and incompatible with, the Federal Rule of Evidence, should not be applied in federal trials.

This decision solidified a clear trend of federal courts around the country to apply the more liberal standard of admissibility described by the FRE, in place of the Frye standard when deciding on the admissibility of scientific testimony.

Uncharacteristically, the Court did not stop with this ruling. Feeling compelled to articulate the parameters of Rule 702, the Court first stated that the rule places clear limits on the admissibility of scientific evidence. “[U]nder the Rules, the trial judge must ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable.”

The requirement that an expert’s testimony pertain to “scientific knowledge” establishes a standard of reliability, i.e., does application of the expert’s underlying principle produce consistent results?

With regard to relevance, the Court stated that Rule 702 mandates that the expert testimony must assist the trier of fact to understand the evidence or to determine a fact. Thus, expert testimony must be sufficiently tied to the facts of the case so that it is capable of assisting the trier of fact in resolving a factual dispute. Sometimes referred to

17 Id. at 587-88.
18 Id. at 588.
19 Id. at 589.
21 Daubert, supra at 589.
as “helpfulness” or “fit”, Rule 702 requires “a valid scientific connection to the pertinent inquiry as a precondition to admissibility.”

Whether an expert will be permitted to testify under the Daubert standard thus requires a judge to determine whether (1) the expert’s reasoning or methodology is scientifically valid, and (2) it can be applied properly to the facts of the case. With regard to the first issue, and an expert’s theory or technique, the Court set forth a variety of factors that may have a bearing on the issue of scientific validity:

1. Has the theory or technique been tested?
2. Has the theory or technique been subjected to peer review and publication?
3. Is there a known or potential rate of error?
4. Is the approach generally accepted in the scientific community?

The Court was clear in stating that the foregoing factors were not exclusive as “[t]he inquiry envisioned by Rule 702 is a flexible one.” None of the four expressed factors is intended to be dispositive, and no formula is offered for their application. In response to a concern that jurors would be exposed to bad science under the standard in the case, the Court noted, “[v]igorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence.”

The Court further noted in Daubert the difference between “the quest for truth in courtroom and the quest for truth in laboratory.” Thus, the trial judge’s role is that of a gatekeeper to prevent the introduction of scientific testimony that does not contribute to the final and quick resolution of disputes.

22 Id. at 592.
23 Id. at 594.
24 Id. at 596.
25 Id. at 596-97.
We recognize that, in practice, a gatekeeping role for the judge, no matter how flexible, inevitably on occasion will prevent the jury from learning of authentic insights and innovations. That, nevertheless, is the balance that is struck by Rules of Evidence designed not for the exhaustive search for cosmic understanding but for the particularized resolution of legal disputes.\footnote{Id. at 597.}

Six years later, in \textit{Kumho Tire Co. v. Carmichael},\footnote{\textit{Kumho Tire Co. v. Carmichael}, 526 U.S. 137 (1999).} the Supreme Court again reviewed Rule 702 and concluded that \textit{Daubert} also was applicable to technical and other non-scientific expert testimony. \textit{Kumho} involved the presentation of an engineering analysis related to the failure of a tire. The failure of the tire had resulted in at least one death and injury to others. Although the tire in question was worn, showed evidence of abuse, and had been punctured and repaired, the plaintiff’s expert opined that the cause of the blowout was a defect in the manufacture or design of the tire. The defendant moved the District Court to exclude the expert’s testimony on the grounds that it did not meet the reliability standard set forth in \textit{Daubert}. The District Court excluded the testimony and the Court of Appeals for the 11\textsuperscript{th} Circuit reversed. The latter court concluded that \textit{Daubert} only applies where an expert relies on the application of scientific principles.

The Supreme Court reversed the 11\textsuperscript{th} Circuit stating that “[w]e conclude that \textit{Daubert’s} general ‘gatekeeping’ obligation—applies not only to testimony based on ‘scientific’ knowledge, but also to testimony based on ‘technical’ and ‘other specialized’ knowledge.”\footnote{Id. at 141 (Citation omitted).} “We also conclude that a trial court \textit{may} consider one or more of the more specific factors that \textit{Daubert} mentioned when doing so will help determine that testimony’s reliability.”\footnote{Id. at 141.}
The *Kumho* decision emphasized the trial judge’s discretion to determine how to assess the reliability of expert testimony. “[T]he law grants a district court the same broad latitude when it decides how to determine reliability as it enjoys in respect to its ultimate reliability determination.”[^30] In reviewing the trial judges’ decision to exclude the expert’s decision, the Court explained that the “relevant issue was whether the expert could reliably determine the cause of *this* tire’s separation.”[^31] The Court found that the expert’s testimony was relevant, but lacked sufficient reliability to pass the gatekeeper. This conclusion was based on a logical critique of the expert and his analysis.

In 1997, the Supreme Court adopted the abuse of discretion standard for reviewing a trial court’s ruling on the admissibility of expert testimony under the *Daubert* factors.[^32] An abuse of discretion occurs “when a material factor deserving significant weight is ignored, when an improper factor is relied upon, or when all proper and no improper factors are assessed, but the court makes a serious mistake in weighing them.”[^33]

In applying the *Daubert* standard, a trial judge is not to determine whether the expert’s opinion is beyond reproach or which expert opinion is most credible. Instead, the trial judge need only decide whether the expert’s opinion has been arrived at in a scientifically sound or otherwise reliable manner.[^34] In the latter case, the trial court granted a motion *in limine* excluding a defense expert who was to testify as to toxicology and causation issues related to an automobile accident. It was alleged that the driver of the plaintiff’s vehicle was impaired, based on a toxicology report showing the presence of

[^30]: Id. at 142.
[^31]: Id. at 154.
[^33]: *Foster v. Mydas Assocs. Inc.*, 862 F.2d 910, 923 (1st Cir. 1988).
cocaine in the deceased’s bloodstream. The trial judge concluded that the expert was relying upon published articles in concluding that the deceased had ingested and absorbed sufficient quantities of cocaine within one hour of the accident to impair driving ability. Because the court found from the articles that the accuracy of the technique employed by the expert was not precise, since people metabolize cocaine differently, the testimony was deemed non-reliable.

On appeal, the First Circuit ruled that the trial judge erred in concluding that, as a threshold requirement, science be able to declare that a precise quantity of cocaine in the bloodstream produces an equally precise quantity of impairment. As further stated by the Court, Daubert does not require the trial judge to “solicit a level of assurance that science realistically cannot achieve” in order to admit scientific evidence.\(^{35}\)

At least half of the states have adopted the Daubert test. Other states apply the Frye standard or their own test. The Supreme Court of North Carolina has rejected application of the Daubert/Kumho standard.\(^{36}\) The North Carolina Court observed that, like the Federal standard, under Rule 702(a) of the North Carolina Rules of Evidence, “if scientific, technical or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion.” In applying this rule, however, the North Carolina Court stated that trial courts traditionally had been given a wide latitude of discretion and, on appeal, the exercise of this discretion was not to be reversed absent a showing of abuse of discretion. The Daubert standard, and its requirement that the trial judge serve as the gatekeeper for

\(^{35}\) Id. at 86.

admissibility on extraordinarily complex and technical issues, was deemed by the Court to be an unfair burden on trial judges. Instead, the Court affirmed the standard set forth previously in *State v. Goode*, wherein the Court prescribed a three step inquiry for evaluating the admissibility of expert testimony: (1) Is the expert’s proffered method of proof sufficiently reliable as an area for expert testimony?; (2) Is the witness testifying at trial qualified as an expert in that area of testimony?; and (3) Is the expert’s testimony relevant?\(^\text{38}\)

CPM methodologies have been used now for at least forty years before courts and other tribunals and there is case law to justify the reasonableness of a number of forensic scheduling approaches. As will be discussed below, for the hypothetical being presented in this seminar wherein the respective experts have analyzed delay using the Windows approach and Collapsed As-Built method, both methods have been accepted by courts and other forums. However, reliability of each methodology still may be challenged based on schedule defects and/or the manipulation of the scheduling data used in the respective methodologies. For example, in *Fortec Constructors, Inc. v. United States*, the United States Claims Court reviewed past decisions from the Federal courts related to the use of CPM schedules in the proof of delay. Of great significance to the court was judicial recognition that the critical path can change and that items not originally on the critical path can become critical.\(^\text{40}\) The court further observed that if the CPM is to be used to evaluate delay on the project, it must be kept current and must reflect delays as

\[\text{37} 341\text{ N.C. 513, 461 S.E.2d 631 (1995).}\
\[\text{38} \text{Howerton, 358 N.C. 458 – 469.}\
\[\text{39} 8\text{ Cl.Ct. 490 (1985).}\
\[\text{40} \text{Id. at 505.}\

they occur. In *Fortec*, since the CPM was not updated to include earlier additional work or change orders, the court found that it could not be used to evaluate subsequent delays to the project.

Current affordable scheduling software, with its many bells and whistles, permits data to be manipulated. The following schedule features may distort logic and/or progress to date, remaining duration of work on an activity, and the status of work in general:

- Excessive activity durations
- Use of Multiple Calendars
- Use of Retained Logic versus Progress Override

Whether alleged schedule errors or manipulation of the schedule affect the expert’s credibility or the reliability of the conclusions reached by the expert will determine whether testimony is heard in the first place.

**III. Forensic Scheduling Techniques**

Depending on how one categorizes a method of analysis, there may be nine or more commonly used methodologies for determining the impact of an event on a project schedule using a CPM. The questions for counsel and the expert become (1) what

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41 Id.
42 This is a pre-*Daubert* decision and expert testimony was not precluded. Nevertheless, it points out the type of analysis that may result in a court limiting testimony post-*Daubert*.
43 For examples of the impacts caused by these software features, see Jon M. Wickwire and Stuart Ockman, *supra* at pp. 17-19.
44 *See The Weitz Co. v. MH Washington, et al.*, www.ca8.uscourts.gov/opndir/11/01/093116P.pdf, where the 8th Circuit allowed a “windows analysis” testimony from a scheduling expert even though he had created, after the fact, the baseline schedule used in the his analysis, which schedule did not identify critical path activities or float. “Expert opinion necessarily involves some speculation” and quoting from an earlier 8th Circuit opinion: “A certain amount of speculation is necessary, an even greater amount is permissible (and goes to the weight of the testimony), but too much is fatal to admission.”
45 For example, in the AACEI Recommended Practice, as discussed below, there are nine protocols discussed. As pointed out in the AACEI Recommended Practice, however, there are regional variations of
approach, if any, is mandated by contract; (2) what if the contractually specified methodology is ill-suited to a retrospective analysis;\textsuperscript{46} (3) if the contract does not mandate an approach, what methodologies have been recognized by the venue having jurisdiction to resolve the dispute at hand; and (4) what methodology makes the most sense given the type of dispute, the forum resolving the dispute, and the economics of the litigation.

For purposes of this presentation, and the hypothetical dispute being presented, two methodologies are addressed here; namely, a “windows” approach and a “collapsed as-built” analysis.

A. Windows Approach/Time Impact Analysis

The Windows approach is a variation of the Time Impact Analysis methodology. Although there are different protocols that may be referred to as Time Impact Analyses, and the distinction between a Windows analysis and a Time Impact Analysis may blur, common methodologies so that a time impact analysis or a windows approach may be known by multiple names. In fact, of the nine protocols discussed by the AACEI, four are known commonly as windows approaches, one is referred to as a time impact analysis, and one is called both a time impact analysis and a windows approach. Two of the protocols identified by AACEI commonly are known as collapsed as-built methodologies. The remaining protocol listed by the AACEI is an as-planned versus as-built approach. The accompanying paper for this seminar written by Andrew Ness discusses three commonly used methods (impacted as-planned, collapsed-as-built and time impact analysis/windows), with the time impact analysis and windows methods being grouped together. Jon M. Wickwire and Stuart Ockman, supra at pp. 14-15 discuss five methodologies (bar chart, but-for/collapsed as-built analysis, total time analysis, impacted as-planned, time impact analysis and windows analysis). In an excellent article on Forensic Schedule Analysis written by Jennifer W. Fletcher and Laura J. Stipanowich, seven methods are discussed (as-planned/what-if analysis, impacted as-planned, total time analysis, time impact analysis, but-for/collapsed as-built analysis, as-built analysis and windows). See, Jennifer W. Fletcher and Laura J. Stipanowich, Successful Forensic Schedule Analysis, 1:1 J ACCL 226-234 (Winter 2007). The latter article acknowledges that several methodologies are known as Windows approaches. Based on the foregoing, there is relative commonality among authors as to common methodologies, even though the nomenclature and specific protocols may differ slightly. Not all of the identifiable approaches have been sanctioned by the courts.

\textsuperscript{46} Consider the following clause typically used by governmental entities: “Delay shall be substantiated by inputting the estimated consequences of the delay event into the current schedule and assessing the consequences which the delay event may have on achieving substantial completion.” This approach is contemporaneous and may have great value if delay claims are immediately resolved. What if the delay claim is not immediately resolved and is left to fester until the end of the project? In the latter instance, events may overtake the delay, e.g., acceleration or other delays on near critical paths that change the critical path of the project.
under either approach, the expert begins with a reasonable as-planned schedule and then statuses the as-planned schedule just prior to the onset of a delay. The activities related to the delay are incorporated into schedule. If there is an impact to the critical delay as a consequence, then a delay has been established. The modified schedule then becomes the new baseline for measuring subsequent delays using the preceding steps.

In a Windows Analysis, the as-planned schedule and updates are reviewed on a time interval basis to determine if a delay was experienced. This time interval basis is referred to as a window. Generally, the time interval chosen is the monthly period covered by the schedule update. The schedules are statused at the commencement of each window. The windows are then analyzed to determine if delays to the critical path occurred. The delays are analyzed further to determine the party responsible and whether a concurrency exists. The process continues in the same fashion going forward on a window by window basis. Care must be taken not to manipulate the periods chosen as windows so as to distort the results of the analysis.

B. Collapsed As-Built Methodology

This methodology begins with the creation of a detailed as-built schedule. Proponents of this approach argue that such a schedule is not theoretical and reflects what the contractor was able to achieve with its own labor force, supervision and equipment, rather than what it thought it might achieve when bidding the work. Once the as-built schedule has been prepared using contemporaneous job records, owner-caused delays are identified and then removed from the as-built schedule. The schedule then is collapsed to reflect how the work would have been performed, but for the owner’s delays. Collapsing the schedule introduces elements of judgment related to logic ties and other anomalies,
including whether a contractor might have performed other work more quickly, but for the owner-caused delay (i.e., so-called “pacing” delays).
C. How the Courts and Boards Perceive the Foregoing Methodologies

Assuming that the contract does not expressly mandate a different methodology for proving delay,\textsuperscript{47} the Windows\textsuperscript{48}, Time Impact Analysis\textsuperscript{49} and Collapsed As-Built Methodologies\textsuperscript{50} all have been accepted for use in proving delay. Nevertheless, despite general acceptance, these methods may not produce convincing results at trial.

In \textit{Old Dominion Electric Cooperative v. Ragnar Benson, Inc.},\textsuperscript{51} the project involved an engineer, procure and construct contract (“EPC Contract”) for a power generating facility. The EPC Contract required the contractor to prepare and maintain a detailed critical path method schedule, with updates and revisions as project conditions required. While the contractor prepared a baseline schedule, it was not accepted due to logic problems, missing milestone contract dates, including mechanical and substantial completion, and missing activities. Eight months into the project, a revised schedule was submitted that was conditionally accepted, although it did not show timely completion. The conditional acceptance of the baseline schedule then allowed the owner to request a Recovery Schedule. An acceptable Recovery Schedule was received one year into the project, which effectively became the baseline schedule. However, the contractor never adhered to this schedule and the project was substantially complete 233 days later than required by contract.

\textsuperscript{47}E.g., in \textit{P.J. Dick Incorporated v. Principi}, 324 F.3d 1364, 1369 (2003), the United States Court of Appeals for the Federal Circuit found that where the contract mandated the use of a specific methodology, this methodology became “the only way of determining the effect of the changes.”
\textsuperscript{49}See \textit{Bell BCI Company v. United States}, Id. at p. 640; \textit{Appeal of Fletcher & Sons, Inc.}, VABCA-2502, 88-2 BCA ¶20,677; \textit{George Sollitt Construction Co. v. United States}, 64 Fed.Cl. 229, 252 (2005); \textit{Appeal of SAE/Americon-Mid Atlantic, Inc.} GSBCA Nos. 12294, 12523, 12690, 12710, 12841, 12842, 12907, 98-2 BCA ¶30,084, pp. 148,898-99.
\textsuperscript{51}2006 WL 2854444 (E.D.Va.)
Two scheduling experts were retained by the contractor. The first expert addressed delays for the first half of the project during a period deemed by the expert to have been benefited by sufficient and reliable schedules. The expert’s testimony was rejected entirely due to the fact that he had no experience with the power plant industry or with scheduling power plant construction projects, and he attempted to utilize the originally submitted baseline schedule that had been submitted, rejected and replaced. The second expert used a windows analysis to determine delays during the second half of the project. The court expressly noted that in this methodology, windows are selected on a subjective basis, with the outcome potentially being affected by the selection of these windows. The opinions reached by the expert then were rejected by the court for a variety of reasons, including: (1) reliance on inaccurate scheduling information; (2) selection of windows intended to mask the impact of contractor-caused delays; (3) failure by the expert to consider all delays in each window; and (4) the court’s conclusion that certain delays were not owner-caused as determined by the expert.

In *George Sollitt Construction Co. v. United States*, 52 where the court accepted the expert’s time impact analysis as an appropriate method for proving delay, certain opinions nevertheless were rejected. For example, on a claim alleging that owner-caused delay to electrical service for a chiller servicing a new building delayed the building which was on the critical path, the expert’s opinion in support of the claim was rejected because the evidence showed that the building had been accepted before the electrical wiring was completed. The acceptance of the building controlled the assessment of liquidated damages that the expert alleged was improper. 53 On another claim related to

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52 Supra, note 48.
53 Id. at 255.
changes and unforeseen conditions encountered at another building, the expert’s conclusions were rejected because they did not consider contractor-caused delays to the schedule.\textsuperscript{54} In its consideration of each claim for delay, the court’s considerable analysis focused on whether the evidence supported the conclusions of the expert reached through the time impact analysis.

\textit{Metric Const. Co., Inc. v. United States}\textsuperscript{55} involved a delay claim made by a contractor against the Navy. The contractor’s expert prepared a collapsed as-built schedule to quantify the delay due to certain changes. The expert attempted through this process to account for delays attributable to the starting and stopping of work due to delayed material deliveries caused by the Navy’s changes. The claimed delay was 310 days. Although the court did not criticize the methodology used, it allowed only a 65 day time extension after concluding that the expert did not take into account delays attributable to the contractor (e.g., equipment breakdowns, mechanical problems, failure to achieve scheduled production rates for asphalt placement, and the impact of a fire at the asphalt plant).

Similarly, in the \textit{Appeal of Donohoe Construction Company},\textsuperscript{56} the contractor’s windows analysis technique was accepted by the Board, but the conclusions of the expert largely were rejected. In this regard, the Board criticized the expert’s conclusion that the as-planned schedule was reasonable and achievable despite some imperfections. This finding impacted the Board’s analysis of the delays in each window. Next, the Board reviewed the expert’s conclusions regarding the delays in each window and scrutinized the assessment of delays based on the evidence of record. Of the 101 work days of delay

\textsuperscript{54} \textit{Id.} at 256-57.
\textsuperscript{55} 81 Fed.Cl. 804 (2008).
\textsuperscript{56} 98-2 BCA \#30,076.
recognized by the Board, the Board concluded that 11 were allocable to the Owner, 12 were excusable, and 78 days were attributable to the contractor. The contractor had sought a compensable time extension of 168 calendar days.

It is noteworthy that each of the foregoing cases turned on the evidence presented in support of the contractor’s claims for either excusable or compensable time extensions and not on the methodology chosen to calculate delay. The expert is not the arbiter of entitlement, which remains in the purview of the finder of fact.

As mentioned above, the sophistication of CPM software also permits manipulation of the schedules to shape desired results. For example, in Sauer Inc. v. Secr. of Navy, the expert concluded that the contractor’s progress as of the commencement of the first window of delay reflected no delay to the contract completion date. This conclusion conveniently allowed the expert to opine that all delay incurred on the project was experienced either in the first window or subsequent windows. However, the schedule updates did not support the expert’s conclusion, which he rationalized by arguing that the schedule update prior to the first window had used the P3 “Progress Override” feature, rather than “Retained Logic,” thus distorting the status of the work. Nevertheless, based on the evidence of record, the Board concluded that the Project was behind at the commencement of the first window and that the expert’s analysis of delay going forward was tainted by his conclusion that no delay had preceded the first window.

In the Appeal of Hensel Phelps Construction Company, part of the work involved the installation of PEF duct work, which was first shown on the CPM schedule as critical in August 1990. The activity remained critical through the Fall. However, in

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58 99-2 BCA ¶30,531.
December 1990, the schedule changed the predecessor-successor relationship of the PEF duct lines and showed much of the work proceeding at the same time. The cumulative duration of this work was changed from 36 weeks to three weeks, creating some 132 days of float for this work. The Government’s expert witness asserted that the contractor’s CPM schedule had been manipulated to mask critical path work that could not be completed by the December 6, 1991 date on which the contractor asserts it was substantially complete.

The contractor submitted a delay and disruption claim alleging that a significant number of RFIs and contract modifications impacted its performance, delaying substantial completion by nine months. The Board denied the contractor’s claim, finding that contract work, including the PEF duct lines, continued to be performed during the nine month period after December 6, 1991, contrary to the conclusions reached by the contractor’s expert.

IV. AACEI Recommended Practice No. 29R-03 - Forensic Schedule Analysis

In August 2003, the Claims and Dispute Resolution Committee of the Association for the Advancement of Cost Engineering International (“AACEI”) commenced a project aimed at developing a “Recommended Practice” for forensic schedule analysis. As defined by AACEI in its November 2010 draft of the Recommended Practice:

forensic schedule analysis refers to the study and investigation of events using CPM or other recognized schedule calculation methods. It is recognized that such analyses may potentially be used in a legal proceeding. It is the study of how actual events interacted in the context of a complex model for the purpose of understanding the significance of a specific deviation or series of deviations from some baseline model and their role in determining the sequence of tasks within the complex network.\textsuperscript{59}

\textsuperscript{59} See AACE International, AACE International Recommended Practice No. 29R-03, Forensic Schedule Analysis (2007) at p. 10 of 147.
Forensic schedule analysis is inherently retrospective in nature, as contrasted to the use of scheduling for planning purposes, which is prospective.\(^6^0\)

After four years of development, including extensive peer review, the AACEI adopted and published a “Recommended Practice: Forensic Schedule Analysis,” at its annual meeting in June 2007.\(^6^1\) The intent of the Recommended Practice is to provide a unifying technical reference for the forensic application of the critical path method of scheduling. The Recommended Practice is divided into the following five sections:

1. Organization and Scope – An introduction to its concept and structure.
2. Source Validation – This addresses the accuracy and usability of the major sources of schedule information (i.e., the baseline schedule, the updates, the as-built schedule, and the impact/delay events).
3. Method Implementation – Describes nine methods of forensic delay analysis, including their strengths and weaknesses.
4. Analysis Evaluation – Included in this section is a discussion of excusable and compensable delays; technical standards for determining concurrent delay; whether pacing delays occurred; what is the critical path and the importance of analyzing near critical paths; manipulation of the critical path; and acceleration or mitigation of delay.
5. Choosing a Methodology – The Recommended Practice does not mandate the use of a single methodology. The various methodologies identified earlier in the

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\(^6^0\) John C. Livengood, *The New AACEI Recommended Practice for Forensic Schedule Analysis (Part 1 of 2)*, 18:1 Construct (Summer/Fall 2008).

\(^6^1\) For an excellent recitation of the history of the Recommended Practice, see Kenji Hoshino and John Livengood, *A Defense of the AACE Recommended Practice for Forensic Schedule Analysis*, 30:1 Constr. Lawyer (Winter 2010).
Recommended Practice each may be appropriate depending on the contractual requirements, the purpose of the analysis, data availability and reliability, the complexity of the dispute, budget, time constraints and the audience for whom the analysis is intended.\textsuperscript{62}

The original draft of the Recommended Practice was subjected to peer review, both solicited and unsolicited.\textsuperscript{63} In response to issues raised through this peer review process, the AACEI issued a Revision 1 to the Recommended Practice on June 26, 2009.\textsuperscript{64} This draft likewise resulted in further comment and criticisms.\textsuperscript{65} Certain of the criticisms and suggestions now have been addressed in a revised draft issued to the public for comment in November 2010.

In sum, the major criticisms predating the November 2010 Recommended Practice were as follows:

- The Recommended Practice does not constitute a standard and is mislabeled.
- The Recommended Practice recognizes nine methodologies rather than a single recommended method.
- The Recommended Practice does not rank methodologies in Order of Preference.
- The Recommended Practice does not contain legal citations and includes at least one methodology that has been rejected by the courts and boards.

\textsuperscript{62} Sections 1, 2 and 3 are summarized in the article identified in Footnote 2. Sections 4 and 5 are summarized in John C. Livengood, \textit{The New AACEI Recommended Practice for Forensic Schedule Analysis (Part 2 of 2)}, 18:2 Construct (Winter 2009).
\textsuperscript{63} The Recommended Practice was critiqued during a presentation made at the 2008 Construction Super Conference in San Francisco. A number of letters also were received by the AACE from forensic schedule experts expressing concerns or criticisms.
\textsuperscript{64} AACE International, AACE International Recommended Practice No. 29-03, \textit{Forensic Schedule Analysis} (2009), www.aacei.org/technical/tps/29R-03.pdf.
• The Recommended Practice introduces new taxonomy and nomenclature that is not used in the industry.

• The Recommended Practice is not fully endorsed by forensic schedulers, but may now be used as a weapon in cross-examining experts who testify before judges who are not experienced in addressing schedule issues.

These objections have been further amplified and responded to in published articles.\textsuperscript{66}

At this point, the significance of the Recommended Practice is less than clear. The most common concern registered prior to the November 2010 draft was that the Recommended Practice may be misunderstood as a standard by courts. However, the November 2010 draft now states as follows: “[t]he RP/FSAPG [Recommended Practice/Forensic Schedule Analysis Practice Guide] is not intended to establish a standard of practice, nor is it intended to be a prescriptive document applied without exception. Therefore, a departure from the recommended protocols should not be automatically treated as an error or a deficiency as long as such departure is based on a conscious and sound application of schedule analysis principles.”\textsuperscript{67}

In sum, by its own admission, the Recommended Practice is not a standard. If the purpose of the Recommended Practice, as set forth in Section 1.1 of the current draft, is to provide a unifying reference of basic technical principles and guidelines for the application of critical path method (CPM) scheduling in Forensic Schedule Analysis, it will take time, peer recognition, and acceptance by judges and arbitrators for this to occur. Nevertheless, lawyers preparing scheduling experts to testify, or preparing

\textsuperscript{66} \textit{Id.} See also Footnote 3 for a response to these criticisms by Kenji Hoshino and John Livengood.

\textsuperscript{67} \textit{Supra} at note 36.
themselves for cross examination, should be aware of the protocols set forth in the Recommended Practice as it may prove to be a sword for either side.

V. Conclusion

While parties have relied upon CPM analyses in construction litigation for nearly 40 years, with available software and personal computers increasing the sophistication and cost effectiveness of their use, a computer does not assure credibility. As evidenced above, an accepted methodology for analysis is only one element essential to the proof of delay on a construction project. To assure the reliability of the analysis, the baseline CPM schedule must be logical, include all necessary work activities, adopt appropriate durations and constitute a reasonable plan for accomplishing the work within the time parameters set forth in the contract. Further, to analyze subsequent delay, the schedule must be properly and accurately updated to reflect work actually performed on the project.

Courts and Boards, with the assistance of competent counsel and experts, have demonstrated the patience and ethic necessary to ferret out inconsistencies in any conclusions reached by experts, requiring that the evidence match in all respects the opinions adduced by the experts. The failure by an expert to fully rely on all of the facts, consider all delays, and avoid strained conclusions will surely doom the acceptance of his or her conclusions regardless of the methodology chosen.