Chapter

34

Disruption Analyses

We have emphasized that the term "delay" has a special meaning to a scheduler. Activities are subject not to "delay" but rather to "disruption." If the disruption is to an activity that is on the current critical path of the project at the time the disruption occurs, then the project is subjected to a delay. However, project correspondence and conversation among field personnel do not normally make such a distinction; even a scheduler may say, "the concrete pour was delayed by inclement weather."

The fact is that most of the delays on a project, even the ones most subject to dispute, do not delay the project. Some disruptions directly impact an activity that is currently upon the critical path. Other disruptions have an indirect impact, such as an emergency extra work order that diverts resources from an activity on the critical path. The vast majority of disruptions do not directly or indirectly cause delay. However, they do incur a cost to the project.

Previously noted is that the plan of the As-Planned logic network must be that of the person (or persons) directing the work to be performed. Also noted is that this plan may be one of many possible plans, but it was the one chosen, based upon both the assumptions recorded and unreported by the scheduler, to be the most efficient in terms of time and cost. The project manager may choose to work on the project from the north to the south or vice versa. It may be presumed that the choice was not random, and a disruption forcing a reversal will have some cost, even if only 15¢.

34.1 Traditional Methodologies

Traditional methodologies for measuring the cost impact of disruptions were much like those for measurement of delay prior to the advent of CPM. Often, a blunderbuss of alleged causative factors (deemed the responsibility of the "other" side) leading to disruptions was fired against a chart indicating planned versus actual costs. The defense was often the firing of a similar blunderbuss filled with the alleged causative factors deemed the responsibility of the initial claimant. Substitute an as-planned versus as-built bar chart for the cost curves, and we have a pre-CPM delay analysis.

A more refined methodology is to measure the difference between planned and actual productivity and costs during a period of calm (called the "measured mile") and compare it to the same difference during a period of disruption. Obviously, the circumstantial evidence of this analysis is greater, but still lacks a firm cause-and-effect relationship.

34.2 The Measured Mile Methodology

The use of the measured mile methodology to support a claim of loss of productivity has been accepted on numerous occasions. Authorship of the measured mile methodology is often attributed to Dwight A. Zink who discussed it in the April 1986 edition of the AACE journal *Cost Engineering*. It should be stressed that the legal basis for the measured mile methodology is based in tort rather than contract. The interference claimed is not a basis for compensation of itself; rather, the claimant must prove (1) liability, (2) causation, and (3) damages. Michael Finke (a professional engineer and attorney who was working on his doctorate at the time of his death in 2002) is quoted in another AACE publication:

> Unfortunately, many claimants and their experts do not put enough emphasis on proving causation of lost productivity. "Because of the widely accepted need to rely on expert opinion when presenting loss of productivity claims, there seems to be an unfortunate tendency for such claims to minimize the use of facts and maximize the use of opinions. This is typically done by employing approximate or generalized analyses and theories and making leaps of faith from liability to quantum, thereby glossing over the causation element." [Finke, Claims for Construction Productivity Losses, 26 Pub. Cont. L.J. 311, 334 (1997)]

To reiterate, many claims of the measured mile are strong on showing some interference (liability) and lost productivity or other costs (damages) but are weak or totally silent on showing a causal relationship. Compare to the delay analysis Chapter 33 where a fragnet must demonstrate a causal link from each causative factor or event to specific activities, and only then is the modified network subject to analysis to determine if damages relate to said causative factor. That fragnet is the key to showing causation and is most subject to disagreement among competing experts. The link claimed must be both reasonable and persuasive. Similarly for the measured mile, the link between claimed interference and claimed damages is the most vulnerable aspect of the analysis.

A proper measured mile analysis must focus upon several aspects, similar to the three-leg approach to the analysis for delay requiring a proper as-planned logic, as-built schedule and links from causative factors or events to the (initial or updated-to-window) as-planned logic. An initial focus should be a period of lower than anticipated productivity. This may be the productivity set by the initial estimate and schedule; or it may be less than that aspiration but yet impacted further by the interference; or it may be the superior productivity achieved on the project prior to interference. The three legs for the measured mile analysis are liability, causation, and damages. They should be presented in that order, but researched in reverse order.

Damages

All possible reasons for the loss of productivity should be determined and investigated. If the proponent expert does not do so, it will be done by the opponent. Determination of responsibility for the causes of loss is a secondary consideration. It may be nice as part of the presentation to suggest liability belongs to the opposing party. However, do be aware that there may be competing narratives on this issue. In many of the claim resolutions in which the authors of this text have participated, experts of both sides have agreed that a specific factor is properly linked to and the cause of specific damages, and yet disagreed on who is responsible.

Determination of the measured mile or forsaken attainable but-for-the-interference productivity is the second leg. The easiest level of persuasion is for similar scopes of work. “Pipe” is not just any pipe; “paving” is not just any paving. The productivity of a long run of 48-in. RCP in virgin soils is probably not a good comparable to an installation of a storm sewer in an urban setting with laterals every few feet. The productivity of a long run of paving in virgin conditions is probably not a good comparable to paving around manholes and meter lids in an urban setting. While each may be impacted by unanticipated subsurface conditions (such as undocumented pipes and conduits) or traffic restrictions (such as closing of an adjacent street now, requiring doing only one lane at a time), the productivity achieved with the straight and clean run probably would not be achieved in the urban setting, even without interference.

We hope to find a best "Granny Smith apples to Granny Smith apples" comparable. Perhaps we must do with a "Mackintosh apple to Granny Smith apple" or 48-in. RCP to 36-in. RCP or even 24-in. RCP pipe. As the two classes of scope diverge, counsel's job to persuade becomes more difficult. Note the burden is upon the claimant to persuade.

Moving further afield, we may attempt to compare apples to pears, say, 24-in. RCP to 12-in. ductile iron pipe or even to 12 × 24 in. prefabricated electrical duct bank. The burden is upon the claimant to persuade, but the argument may be made that actual versus estimated productivity of one scope may be transferable to the other scope. By the time we reach apples to antelopes, the comparison is difficult to establish, but not impossible. If during year 1 of a project all work was performed at or better than estimated under the reign of inspector #1, and in year 2 all work is being performed at lower productivity under the reign of inspector #2, we may have our measured mile and impacted period baselines.

The next hurdle in persuasion is to choose a period of time of "good" performance, that is, the measured mile. The conclusion to Dwight Zink's 1986 article states:

> The "measured mile" approach to isolating the disruption costs of acceleration is generally accepted by the courts as being a reasonable way of determining the damages incurred over and above those which should have been expected. However, the size of the sample must also be reasonable—i.e., extrapolating two percent of progress into 80 percent of expected costs would hardly be reasonable.

We are looking for a measured mile, not a measured inch, a general measure of productivity, not merely a "golden afternoon." Duration is a key but not the sole component for selection. A golden spring, summer, and fall without impact is not necessarily the best comparable to an impacted winter. Obviously, the opposing expert may select an alternate measured mile, leaving a clear choice for the ultimate fact finder or more seriously creating a basis for dismissing one or both as being too partisan.

But what if issues began at the outset of the project and there does not exist an impacted mile or significant period of time on the project to use as an exemplar? It may be possible to suggest a similar project from a similar locale, similar labor pool and having similar supervision. By using industry estimating tools, it may be possible to suggest using a dissimilar locale or labor pool subject to an adjustment factor. However, the burden of persuasion is upon the claimant. It may then be far better to consider an alternate argument such that the project contract has been materially changed from lump-sum to a cost-plus basis, and then focus upon determination of the proper "plus" to be requested.

Causation

Two buses collide in north Philadelphia. A man falls to the ground with a broken leg in south Philadelphia. While the driver of at least one of the buses may have liability for a tortuous action, and the man has incurred damages, the two do not appear to be related, and the north Philadelphia event does not appear to have caused the south Philadelphia injury. The most common defense to a claim of disruption is that the interference asserted is not related to the injury asserted.

Where excavation encounters a subsurface interference, or a single change order requires work to stop, regroup, and proceed, the project contract documents will usually provide a protocol for recovery of damages. In such a case the link of causation between the causative factor and impact is clear. Less clear is where an "emergency" change order draws a crew away from other productive work, requiring a reset when they return. Even less clear is where a number of change orders or other interferences are claimed to cause a general malaise and systemic loss of productivity. The contractor may say, "But look, we had five concurrent change orders and productivity of activities not directly impacted dropped." The response may well be relating the north and south Philadelphia events as above.

Liability

Liability is a claim in tort, not contract or criminal law. Proof does not require notice or adherence to risk-shifting clauses or presentation "beyond a reasonable doubt." The obligation is merely to persuade that a direct and proximate causal link is more probable than not. Since much of the proof will involve who knew what and when, this may require extensive review of contemporaneously prepared documentation.

Imagine an alternate scenario to the bus accident example. The bus strikes the man. There is apparent liability. The dash camera on the bus shows the man running out in front of the bus from between parked cars. So perhaps there is not liability? Additional footage from both the dash cam and the ATM across the street shows the bus stopping, the driver waving for the man to cross, and then again the driver starting to move (either deliberately or because the driver's foot slid off the brake).

34.3 CPM Out-of-Sequence Methodology

Use of the as-planned logic network adds a great deal of objectivity and reproducibility to the disruption analysis. Obviously, project records of actual costs are never complete enough for the lawyers and forensic consultants, and even if they were, there is always the question of the accuracy of the initial estimates (cost and time) for the activities disrupted. However, like the value of CPM in breaking down large ballpark estimates of time into estimates of discrete activities—some high, others low—that cumulatively are more accurate, a similar value is imparted by the CPM relating to the estimated costs of discrete activities and the costs of disruption.

If masonry on the upper level of a two-story structure is stopped while the owner determines if he or she desires a larger or smaller window opening, it is clear that there will be some additional cost in remobilization and ramping up to speed after a restart; and if the scaffolding is left standing, there will be costs associated with the rental of the scaffold. If the scaffolding is removed to permit other trades to have access to the interior of the building (thus working Out-of-Sequence from the as-planned logic), there will be the additional costs of removal and re-erection. There may also be additional costs of less than complete access by the other trades working around stacks of block, which is hopefully (but is not guaranteed) less than the double handling of the mason completely clearing the area. Although the quantifying of such costs may still be an estimate, the use of the measured mile approach at the activity or task level is less subject to variation and dispute than for entire areas or time periods of the project.

A project manager who is involved in the preparation of the original as-planned logic network will truly attempt to meet that schedule. One of the finest compliments given to a scheduler is when, after all the work of preparing the CPM is completed, the project manager says, “That is exactly the way I intend to build the project. What did I need you for?” If a project manager encounters a disruption that can freeze the project in its tracks, she or he may attempt to work around it. However, the project manager is certainly hoping to minimize the distortion to the “most efficient plan” and intends to return to the plan as soon as practicable. Only on the worst of projects, where the project manager is constantly running into roadblocks to the plan and even to the work-arounds put in place, may the plan be abandoned and resources assigned wherever there appears to be a task to perform without interruption.

Thus, it is possible to track the disruptions to the project by analysis of progress of work performed Out-of-Sequence from time period to time period. Building upon the windows methodology discussed previously, the scheduler should note the instances of new and continuing work performed Out-of-Sequence for each status evaluation or update. As noted in the windows methodology, the data dates for such updates may be a function of major causative factors or may be periodic if the number of causative factors makes such an exercise unwieldy.

Primavera's P3 Project Planner software's schedule diagnostic is an excellent tool for such an analysis. Each time an activity is started or finished Out-of-Sequence, it is reported. P3's diagnostic distinguishes between eight types of work being performed Out-of-Sequence (Figure 34.3.1). A similar diagnostic is provided in P6 but unfortunately focuses more on whether entered data meet the needs of enterprise coding systems than on the technical quality of the plan behind the calculated schedule.

The diagnostic allows the scheduler to distinguish between work performed Out-of-Sequence that may indicate either a crew getting a head start on the next activity or the start of a disruption (activity started, predecessor has not finished) from that more clearly indicating a lingering obstruction (activity finished, predecessor has not finished). Not included in the Primavera diagnostic but of potential use might be a code for "activity finished, predecessor not started" to distinguish between disruptions that skip to the next activity when progress on a started activity is obstructed from those when an activity in a planned sequence is skipped over entirely. Similarly, the code "activity finished, predecessor has not finished" is not issued by the P3 diagnostic for breaching a FS relationship, although it might be useful for this application.

1. "Activity started before its predecessor finished." — used to note actual dates reported this period may indicate problem within this period
2. "Activity started, predecessor has not finished." — used for FS and FF relationships, with or without lag
3. "Activity started before its predecessor's lag would allow." — used for FS and SS relationships with lag
4. "Activity started, predecessor has not started." — used for SS relationships, with or without lag
5. "Activity finished, predecessor has not finished." — used for FF relationships, with or without lag
6. "Activity finished before its predecessor's lag would allow." — used for FF relationships with lag
7. "Activity started too early to allow it to finish on or after its predecessor's finish." — used for FF relationships without lag
8. "Activity started too early to allow it to finish after the expiration of its predecessor's lag." — used for FF relationships with lag

Figure 34.3.1 Types of work being performed Out-of-Sequence.

At this point, the reason for each instance of Out-of-Sequence performance may now be noted. Reasons can range from "superintendent's choice" or "equipment failure" to "change in condition discovered" or "stop work order issued" to "unresolved RFI" or "C.O. pending" to "too much mud, sent crew elsewhere." Determining the party responsible for each cause would be next. If a log record (of the reason why a planned activity was not started or was started and then stopped) was not kept, a detailed review of the daily diaries of the project may be required to determine the cause of the disruption. This process is greatly aided if the previously prepared list of causative factors includes all and not only the most noteworthy incidents that have occurred.

Once a disruption and its impact to a specific activity or flow of activities have occurred, a cost can be assigned to the specific disruption. This may involve some level of subjectivity, but the level of disagreements should be small if each side renders an opinion in good faith for these small amounts. After all, remobilization of a drill rig for one piling initially skipped because of the discovery of an undocumented pipe is unlikely to cost either $100,000 or zero. In fact, if there are but a few such disruptions, a contractor can expect to be laughed out of court as some reasonable level of disruption is expected in any endeavor.

However, if the level of disruption is greater than that of reasonableness, the total impact of "1000 bee stings" begins to look like real money. Where the totals of the disruption analysis are similar to those of traditional methodologies, a very strong case can be made for compensation.

34.4 Adoption by the Industry

The methodology noted in this chapter was first published in the 6th edition of this text, although it had been included in presentations given by the authors at the annual conferences at Primavera and other venues for several years prior. As this 7th edition is being prepared, note that at least one member of the wider consultant software industry has chosen to expand and enhance the diagnostics of P3 and P6. Ron Winter Consulting, LLC (http://www.ronwinterconsulting.com), provides a number of diagnostic software tools, ranging from a simple, yet elegant, day/date calculator (calculating the number of days between two dates, or date *X* plus *Y* days = date *Z* calculations), to additional diagnostics for one schedule, to comparison of two (or more) schedules or updates of a schedule. The latest release of Ron's Schedule Analyzer Forensic software now includes an enhanced Out-of-Sequence diagnostic, designed to work with either P3 or P6 files. Figure 34.4.1 provides a comparison of the three diagnostics (P3, P6, and SA) as published by Ron Winter Consulting.

The P3™ out-of-sequence progress listing

```
Out-of-Sequence Progress Listing

Activity   Predecessor Rel   Lag  Description
---------- ----------- ---- ----- ------------------------------------
---

finished.
13-13.2    11-08.2b     FS      0 Activity started, predecessor has not
```

The P6™ out-of-sequence progress listing

```
Out-of-sequence activities......................................1
      Project:    BASE-110208 16Dec08      Activity:   13-13.2
      Install trombone support hanger
```

The Schedule Analyzer™ SAe Fo rensic Out-of-Sequence Report listing

```
Proj                OOS      Pred           Date       Description
------------------ -------- -------- --------------- ----------------
----------------
BASE-110208 16Dec08 13-13.2        S = 29Oct08 07:00A Install trombone
support hanger
BASE-110708 16Dec08          11-08.2b F = 03Nov08 17:00  Erect Burner
Deck 1A
------------------ -------- -------- --------------- ----------------
----------------
Rel/Lag = FS/0, WorkDays-Early=4.00, CalendarDays-Early = 6.00
Problem: Activity started, predecessor has not finished.

Legend: Proj = Project (omitted if only one project was analyzed)
        OOS = Out-of-sequence (successor) activity
        Pred = Predecessor activity (with possible delay/interruption)
        F = Finish Date and Time, S = Start Date and Time (A = Actual)
        Description = Activity description (title)
        Rel/Lag = Relationship/Lag Duration
        WorkDays-Early = WorkDays successor activity started early
        CalendarDays-Early = CalendarDays successor started early
```

Figure 34.4.1 Comparison of three diagnostics.

34.5 Summary

The as-planned logic represents the project manager's plan of execution and, presumably, the most expedient and cost-effective means to perform the scope of work of the project. When the project manager is hindered from performing work according to this plan, additional costs can be expected, even if the disruptions incurred do not impact the current critical path of the project. Review of selected updates to determine which activities were performed Out-of-Sequence, and why, can be used to prepare or defend a claim of disruption.