Time Impact Analysis (TIA): the Rosetta Stone for CPM Schedule Analysis

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Critical Path Method (CPM) schedules and formalized methods of analyzing schedule impacts started to enter mainstream construction management practice in the early 1980's. At that time, the industry recognized a need to accurately and scientifically measure schedule delays and conversely the affects of acceleration in real time during construction and also retrospectively after the work was completed. The ability to determine which party ultimately bore responsibility for schedule delays became the main focus on many projects as the assessment of liquidated damages or granting compensable time extensions became critically important to both owners and contractors. Just as the Rosetta Stone[1] provided scholars with a means to translate Egyptian hieroglyphics into Greek text, Time Impact Analysis (TIA)® provides users with the means to translate CPM activities into understandable schedule impacts.

CPM methods were originally developed using manual computations and later expanded with the augment of powerful, repetitive mainframe[2] computers. As CPM schedules matured into complex relationships a simple but unbiased method of measuring schedule delays was needed. Recognizing the shortcoming of many methods being applied at the time and based upon ongoing analytical experience with manual and computer driven schedule calculations, David M. Lee, a Vice President of **MDC***Systems*® published an article introducing the more rigorous schedule delay analysis concept of Time Impact Analysis (TIA) ®[3]. This article discussed the systematic application on a wide range of projects. Project complexity and availability of reliable documentation were identified as key features to be considered as the starting points in such analysis.

Later, in 1984, James J. O'Brien[4] introduced the concept of Time Impact Evaluations to evaluate and apportion responsibility for project delay in his book entitled *CPM in Construction Management*[5]. Mr. O'Brien's development of this method greatly depended upon the establishment of as-planned and as-built schedules for the work that was undertaken and upon the forensic engineering determinations of responsibility for the causative factors[6].

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[1] The Rosetta Stone is a dark granite stone (often incorrectly identified as "basalt") which provided modern researchers with translations of ancient text in Egyptian demotic script, Greek, and Egyptian hieroglyphs. Because Greek was well known, the stone was the key to deciphering the hieroglyphs in 1822 by Jean-François Champollion, and in 1823 by Thomas Young. The discovery facilitated translation of other hieroglyphic texts.

[2] Back in the 1970's and 80' the IBM mainframes were the precursors to the computers, servers, laptops and notebooks used today.

[3] "Time Impact Analysis- Forensic Scheduling" by David M. Lee, P.E. Presented American Society of Civil Engineers' Symposium Liability in Construction Management; Oct. 17-21, 1983.

[4] Mr. O'Brien was also the president of **MDC***Systems*® prior to forming O'Brien Kreitzberg Assoc.

[5] CPM in Construction Management, James J. O'Brien Third Edition 1983; McGraw Hill Book Company

[6] "When all the causative factors have been identified, a time impact evaluation (TIE) is prepared for each one. … 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 to the as-built one, and any major disparities between them should be examined to identify whether TIE's were incorrectly applied or whether there were additional causative factors not identified.

MDC*Systems*® subsequently developed computer software and hardware to meet the need for advanced schedule development. **MDC***Systems*® also further developed the concept of Time Impact Analysis (TIA)® services as an expert opinion concerning construction delay. MDC® also developed and applied related concepts of analysis such as Forensic Project Management (FPM)® and Capital Project Management Systems (CPMS)® techniques to supplement and reinforce the scheduling and TIA® services already being provided by **MDC***Systems*®. Succeeding advances in personal computers and scheduling software significantly affected the entire construction industry. This ultimately resulted in the development and use of more complex PC based construction schedules, multi-layered analysis of critical and near critical paths, and the need for more complete and insightful evaluation services utilizing personnel with experience in scope-of-work definition, schedule analysis and cost estimating.

Based upon over 40 years of project management experience, change order evaluations and contract negotiations in all venues for Mediation, Arbitration and both State and Federal Court cases, the Time Impact Analysis (TIA)® technique developed and practiced by **MDC***Systems*® is the most unbiased, neutral and reliable State-of-the-Art technique for CPM schedule analysis. **MDC***Systems*® developed the Time Impact Analysis (TIA)® technique to accurately apportion schedule delays that occur on a construction project. This unbiased and fact intensive service can only be properly applied by experienced project management professionals knowledgeable of the technical, schedule and cost issues for the project under examination. The experience and qualifications of the evaluator are key factors affecting the proper application of the available factual data to the project schedules in order to status, evaluate and determine the causal relationships and to accurately apportion responsibility for the delays that occurred.

In summarizing the basic TIA® schedule analysis approach, it is important to note that these principles apply universally across the entire scheduling spectrum from simple bar charts to the most advanced computer analysis routines including large (5000+ activity), complex, multi-critical path, resource loaded, cost tracking schedules. The following steps are repeated for each TIA® date point starting with the first and proceeding sequentially until the as-built schedule is realized in the last analysis.

a. Determine the baseline (as-planned) schedule for the analysis.
b. Establish the reasonableness of the baseline activity durations and logic, and revise as required. This results in a revised baseline.
c. Determine the source and reliability of as-built data.
d. Select the first Time Impact Analysis (TIA)® date and determine the progress of all activities, to that date.
e. Note any delaying events which occurred during the analysis period (late progress).
f. Update the revised baseline for progress during the analysis period (progress override).
g. Identify and insert new activities as necessary.
h. Revise remaining durations using Contractor’s projected schedule.

i. Note change in project completion date.
j. Determine cause and responsibility (owner, Contractor, etc.) for the change in project completion date (technical review of activity).
k. Inspect the network for controlling delays and note.
l. Repeat steps d-k for each analysis.
m. Develop successive Time Impact Analysis (TIA) ® around critical activity delays and controlling delays until the analysis reaches project completion, using as-built data.
n. Summarize the results of the analysis using simplified summary graphics.
o. Run comparative schedule analysis to ascertain all changes to the successive Time Impact Analysis (TIA) ® schedules and summarize.
p. Identify and highlight on the summary graphics, the controlling and critical delays.

The general approach discussed below is the breakdown of these discrete steps:

In the beginning it's simple – the as-planned schedule[7] is the starting point. The definition of a schedule needs to be established because some believe that simply having milestone dates in the contract constitutes a schedule. For our purposes it does not. The as-planned schedule means a CPM schedule with normal logic (custom and practice) ties that demonstrate the engineers' or contractors' work approach and utilizes the anticipated means and methods of construction to accomplish the contracted scope of work in the allotted time. During the analysis phase, the TIA® approach will ultimately reveal the flaws, if any, of assumed efficiency, logic and methods from the outset.

On most projects, the schedule will change and evolve as events unfold. The schedule is a management tool which, if used properly, will assist the decision makers to manage the project in the most efficient and cost effective manner possible. Generally, schedules are updated at least once per month[8]. The update should record those activities that have already occurred as actual dates (A in Primavera). Both start and finish dates for every activity should be recorded accurately. The remaining durations should be reviewed in light of the work accomplished and resources used for the completed work. Revised logic durations and resources should be entered into the schedule and the schedule re-run or calculated to ascertain the longest or critical path forward. Further adjustments should be made, if necessary, to maintain critical milestones and coordination dates with the work of others and an updated schedule should then be published to the owner and other related project parties.

[7] If none was developed in the normal course of the work, the consultant must be extremely cautious in imposing a schedule which could be interpreted as containing a bias toward either party. This schedule is best developed in conjunction with the other party to the dispute and agreed upon before beginning any analysis. Consultants have been severely criticized by courts for imposing their unilateral determination of a reasonable as-planned schedule.
[8] Special schedules e.g. Shut Down-Turn Around Schedules, in some cases are updated hourly.

The procedure discussed above is repeated at each selected TIA® date point over the duration of the work. At the completion of the project, the final schedule update should, in fact, be the actual, as-built project schedule for the work, provided all previously recorded work activities are imported into it. It is simply a matter of the normal course of following good scheduling procedures to eventually wind up with both the as-planned and as-built schedules in electronic format as part of the project records. It is so simple to develop this basic information during the life of the project and yet painstaking to re-create after substantial completion, particularly when a dispute ensues and the typical adversarial discovery process entrenches the parties into their respective positions.

Now comes the hard part. Assuming that the project was well documented in the manner discussed above, where do you start to unravel and simplify the conflicting arguments on CPM scheduling issues such as delay, acceleration, liquidated damages, and compensable and non-compensable extensions of time?

Most often, the first clue to identifying an appropriate starting point is obtained during a Forensic Project Management® examination of the schedule revisions, change orders, material deliveries, critical milestones, environmental factors, and outside influences (force majure events) on the project. The ultimate determination of compensable/non-compensable delay; acceleration/inefficiency costs, liquidated damages and other time related entitlements are heavily reliant upon the proper application of both FPM® and TIA® analyses on the as-planned and as-built project schedules.

Using the insights gained from the FPM® analysis, the TIA® date points are established by focusing on the significant events that occurred during the life of the project.
At each TIA® date point, an adjusted as-built and as-planned schedule is developed. The adjusted schedules are intended to reveal the competing effects and responsibility for delays at that point in the life of the project. A table showing a running total of the days of delay/acceleration attributable to each party can be developed and updated at each TIA® date point.

A complete understanding of the techniques and processes necessary to reliably determine and apportion delay is beyond the scope of this brief introduction to CPM schedule analysis and can only be developed over time by applying the above principles to real project situations.

MDC*Systems*® provides this level of detailed CPM schedule analysis to clients in the construction and manufacturing industries and conducts training for organizations which need to develop, update, review, approve or analyze CPM schedules for their respective projects. Feel free to visit the **MDC***Systems*® website for additional information concerning this and other services offered by **MDC***Systems*®.

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Key Definitions

Float Time – The result of the mathematical calculation of the time between the late finish and early finish dates for an activity. The question inevitably asked is "who owns the float" and the answer is: it depends upon the situation. Inside the contractor's schedule, any extra time is normally considered to belong to the contractor. Extra time between milestone dates for parallel or sequential contracts established by the owner would likewise belong to the owner. In practice, it is never this clear and in general float is available to the party that first needs it for its scheduled activities. If the contractor and owner are using the above discussed scheduling procedure then at the time of the need it should be apparent if the change or incident requires the float and it can so be allocated. Overhead rates for change orders should include time related costs whether float is being used or additional project time for completion is necessary.

Concurrent Delay – In a CPM schedule, delay time that is occurring on two parallel paths at the same time, either of which would delay the project completion.

Controlling Delay – In a CPM schedule the delaying activitiy or activities that form a technical and schedule perspective are the main drivers of project delayed completion. These types of delays may result in new float being available to other previously critical path activities.

Scheduler – An experienced individual who understands the sequence and duration of activities necessary to complete the finished project. Normally the individual who constructs the schedule uses computer programs to perform rote functions. However, he may override computer generated answers in favor of the preferred means and methods, most likely sequences and durations given the project site, anticipated material deliveries and resources available.

Supercritical Schedules – CPM schedules wherein the original or as-planned schedule has more than twenty-five percent of the total activities on the critical path. Once this occurs then the schedule serves only as a record of work planned and performed because the essential planning function of determining alternatives and most efficient means is no longer possible.