A PRACTICAL APPROACH TO APAB

BETTER WAYS THAN TIA TO VISUALISE PROGRESS AND DELAY

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ABSTRACT

The construction planning and scheduling industry is awash with fancy computer modelling technologies developed to assist in day-to-day project management. With the relentless growth in personal computing power, construction programmes have become ever more sophisticated and increasingly complex. However, when faced with such complexity in project programmes, the processes for settling disputes around matters of delay are arguably in the doldrums.

Within the construction industry in particular, Contractors, Engineers and Contract Administrators almost exclusively drive delay analysis through the processes of Time Impact Analysis (TIA) applied retrospectively. In the writer's opinion, this is actually a misuse of the TIA methodology and contributes more to creating disputes, rather than settling them.

Turning to formal ADR, we instead see Tribunals and Experts rely more on a practical application of the As-Planned versus As-Built methodology, but still with a focus on durations, logic links and work sequences described within overly complex computer-based programmes. Whilst Experts at ADR can usually agree start and finish dates, on large disputes it is not uncommon for the bulk of delay – and the cause of those delays – to remain significant points of difference.

The writer is of the view that delay analysis should be focused more on the application of work teams and associated resources to particular work sequences within a project as a whole, rather than fixating on activity durations and programme logic links. This focus can be achieved through a process of assessing and comparing relative rates of production achieved by work teams in the delivery of specific works, then put together and assessed across a project as a whole. In the writer's opinion, this approach is supported by court cases calling for delay analysis to be objective, logical and practical in its determination of the 'Actual Critical Path'. This paper therefore proposes to look at simple and practical methods for reviewing and assessing delay through the use of 'productivity-based' charting techniques applied to the typical Contemporary Records available on construction projects. This process describes a more practical and logical approach to delay analysis utilising common tools ready to hand that is simpler to understand under the banner of the As-Planned v As-Built delay analysis method.

Keywords: Delay, Productivity, Progress

1. OVERVIEW

Construction is not an overly complex business. While the scale and breadth of projects can vary wildly – with new airport terminals costing in the order of US$1 billion – construction is simply the creation of useful structures through the combining of materials and components in a logical sequence, by the application of labour, machines and other appropriate resource.

Given construction's relative simplicity, any project can typically be described by no more than around 20 high level activities. For example, take the construction of a tower block. Work scope may simply be listed to around 9 main activities:

1. Excavate basement.
2. Construct substructure to podium.
3. Construct superstructure and core.
4. Install builders-work/blockwork.
5. Install MEP, install finishes.
6. Install facades.
7. Construct roof works.
8. Execute external works.
9. Test and commission.

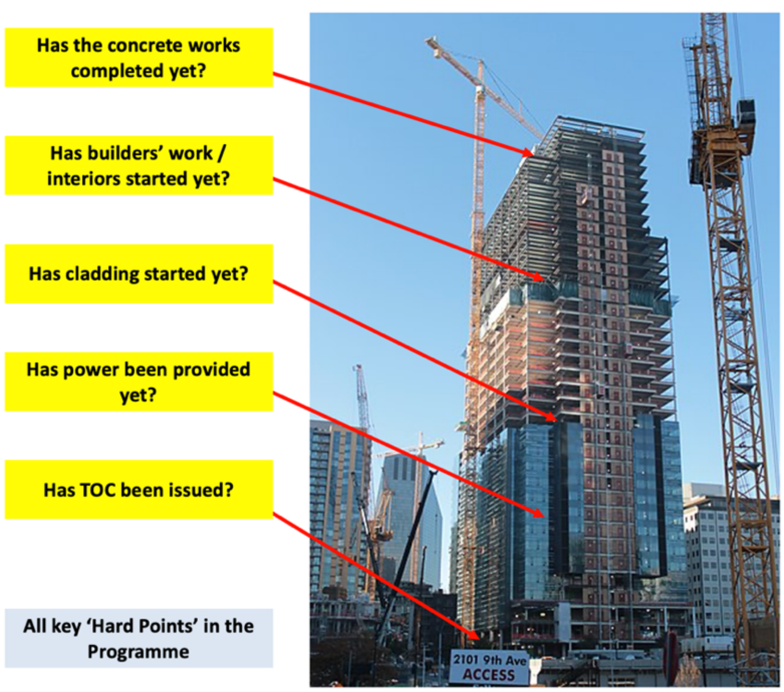

Figure 1 – typical tower block construction as described by a handful of high-level activities and identifying key **'hard points'** existing within the main sequence of construction (photo copyright: SounderBruce, Wikipedia, https://tinyurl.com/wpyhwzk8)

Given that construction is not particularly complex – compared, say, to brain surgery – it begs the question why matters of delay typically become substantial points of difference between parties and a major feature in the bulk of disputes reaching international arbitration[1].

In the writer's opinion, rather than assist in the avoidance of dispute, the delay analysis industry contributes more to dispute through the combined effects of:

1. A total reliance on analysis within detailed computer models,
2. Improvements in computing power allowing those detailed computer models to become ridiculously big,
3. A fixation on discrete logic links described within the computer models applied at component levels,[2]
4. A misapplication of specific delay analysis methodologies – most commonly time impact analysis (TIA)[3] applied retrospectively, and
5. A failure to apply common sense.

Given that TIA methodology dominates the between Contractors and Employers during the execution of live projects, this paper discusses issues with TIA that potentially leads to dispute and why the as-planned versus as-built (APAB) methodology is perhaps the most common methodology at formal dispute proceedings.[4] This paper then explores methods for visualizing wider sets of data in more practical ways, as part of an APAB approach to analysis, and in particular explores ways of analysing and visualizing data from contemporary records[5] that are not available through a strict reliance on common planning software platforms executing TIA.

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[1] '*Arcadis Annual Global Construction Disputes Reports'* year on year identifying delay being a significant issue at international arbitration. www.arcadis.com

[2] Too much 'granularity'

[3] Society of Construction Law Delay and Disruption Protocol 2nd Edition 2017 at Part 11.5 identifies TIA as a prospective methodology.

[4] The writer's personal experience of 18 disputes, with all experts (bar one) using APAB for delay analysis. TIA not seen as used at Arbitration.

[5] A FIDIC term for any type of record or data set captured contemporaneous to the execution of the works

2. THE ROLE OF THE DELAY ANALYST

Before looking at the details in this paper, it is perhaps useful to reflect on the primary roles or duties of a delay analyst. The primary duties are to:

1. First establish the location and extent of delay visible throughout a project, particularly with the determination of critical delay visible on the as-built critical path, and then
2. Identify the cause of those delays.

In exercising these duties, a delay analyst is to:

1. Make determinations by reference to contemporary records, and
2. Apply common sense[6] [7] to any determination made.

No reference is made above to any determination on liability. However the TIA methodology is reliant totally on a determination of liability as its first step[8]. In the Writer's opinion, the '*liability first then delay*' approach underlying the TIA methodology does not appear to be aligned with common sense. It questions how any determination on delay can be objective or realistic if a 'cherry picking' approach is applied to the delays to be determined. This is perhaps the primary reason why TIA is not frequently utilised at arbitration and is perhaps the primary reason behind the development of this paper.

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[6] Core Principle 5 – Society of Construction Law Delay and Disruption Protocol 2nd Edition 2017 (Society of Construction Law (UK), 2017)

[7] '*Causation for the purposes of a claim for damages must be determined by the application of common sense*' John Holland Construction and Engineering Pty Ltd v Kvaerner R J Brown Pty Ltd: 1996 (John Holland Construction and Engineering Pty Ltd v Kvaerner RJ Brown Pty Ltd, 1996)

[8] Agree accepted delay events first then insert as fragnets into the baseline program, but more typically the contractor inserting delay events he believes are to the employer's account.

3. BACKGROUND

A. How Do Contractors Plan to Execute Work?

At the tender stage, contractors primarily rely on key steps around the development of:

- A tender program, and
- Tender allowances.

I. Tender Program

The first plan or program for a project will usually be developed by a contractor during the tender period and is typically called a tender program. Whilst the employer will typically specify[9] a '*time for completion*'[10] for the project, the contractor will normally develop the tender program to address particular issues such as:

1. **Time for Completion** – Confirm to himself that the delivery of the works[11] is achievable within the prescribed time for completion through the development of a tender program.
2. **Work Sequence** – Establish the general approach and work sequence to be deployed by the team to deliver the works as a whole, such as crafting traffic management plans on a road project to develop the required work sequence and phasing for delivery of the works.
3. **Preliminaries**[12] – Determine the rate of progress required to deliver the works as a whole and use this to establish allowances for supervision. In other words, establish site establishment and preliminaries allowances.
4. **Tender Program Submission** – Should it be called for, develop the tender program into a preliminary program suitable for submission to the employer as part of any technical requirements accompanying the tender submission.

Contractors typically plan to deliver works in a general ordered sequence and describe those works most commonly through some form of program GANTT[13] [14] chart. At the basic level, contractors

[9] time for completion usually specified within the 'Appendix to the Form of Tender'
[10] FIDIC forms of contract typically define a Time for Completion as being the time period for delivery of the Works beyond which any delay in delivery may attract application of a liquidated damage or penalty
[11] 'Works' being the project as a whole and different to construction 'work'. Clause 1.1.5.8 FIDIC Red Book 2005 (FIDIC, May 2005)
[12] The Contractor's running costs – Project Manager, offices, cars, fuel, insurances etc
[13] Graphical depiction of a project schedule showing start dates, finish dates and project activities as horizontal bars
[14] For roads, tunnels or other 'longitudinal type projects, Contractors sometimes develop Time-Location (TILOs) charts

develop tender programs that identify the general plan and sequence of the execution of works, this being the application of an overall logic – rather than a detailed network logic – to work sequences and activities to drive the end-date milestone, usually using some form of common planning software.[15] More sophisticated contractors may develop the program further to include accompanying narratives, schedules of resources or resource loading,[16] but in developing the contract price for the works as a whole, the contractor's estimator typically applies a much more focused view, by dividing work into packages to be delivered by teams of specialist resource:

- Teams, or
- Gangs, or
- Specialist Subcontractors etc.

II. Tender Allowances

In developing the contract price for the works, the contractor's estimator will look to break down the works into work elements for particular teams or gangs, against which the estimator can apply production rates and prices. Over time, contractors' estimators develop 'little black books'[17] of typical rates and prices for common forms of construction works.[18] These rates and prices are usually supplemented and tested by the estimator by 'going out to the market' to establish market rates and prices for the works identified.[19]

Subcontracting has now become the dominant form of delivery in construction,[20] with specialist subcontractors executing very specific work scopes and effectively replacing traditional self-delivery. Subcontracting is considered to hold particular benefits, such as:

1. **Focused Delivery** – Specialist subcontractors are considered generally more cost-efficient as they deliver best value through being able to focus and refine their expertise in a particular field.

[15] In the writer's experience, Primavera P6 being the most common form of planning software used within the construction industry. Other software includes Asta Power Project (common in UK), Microsoft Project etc

[16] Application of both resource and/or cost/value to bars within the computer model

[17] The estimator's accumulation of knowledge of pricing works, gained over years of working in the industry

[18] Cost of works rates and prices also available through annual publications such as '*Spon's Architects' and Builders' Price Book 2022*' (AECOM, 2022)

[19] If an estimator cannot identify market rates, he will be forced to develop 'Plug Rates' – basically an educated guess

[20] As opposed to self-delivery with your own teams of men and machines. Main Contractors avoiding the cost and expense of carrying the cost of labour and plant between projects.

2. **Sharing Risk** – Subcontracting allows the contractor to shed project risk through their supply chain to those specialists best suited to carry that risk.
3. **Unproductive Resource Cost** – Subcontracting allows contractors to avoid the cost (and liability) of carrying unproductive resources on their books through the lean periods between projects.

Figure 2 – typical driven concrete piles pitched using a crane and hammer (photo copyright: Argyriou https://tinyurl.com/yc4a4v8x,)

Using a highway infrastructure project as an example, a contractor may identify work packages split between specialist subcontractors as follows:

1. **Piling** – Specialist subcontractor operating the specialist equipment needed to install piles.
2. **Bridge Structures** – Concrete specialists who may deliver one of many structures encountered on a large highway. A specialist in rebar, formwork, placing of concrete etc.
3. **Drainage** – Specialist subcontractor operating equipment suitable for trenching and installation of drainage systems.
4. **Surfacing** – Specialist subcontractor with access to the appropriate equipment for the placing of road base, basecourse and wearing course across the whole site.

So, at the tender stage and in developing a plan for the execution of construction works, the contractor focuses on the identification of teams or gangs[21] – made up of collections of resource, labour and plant etc – that converts components and materials into portions of the permanent works. The project then consists of multiple teams or gangs working away to combine those multiple portions of works into the final permanent works.

Figure 3 – Team or gang executing road surfacing works. (Photo copyright: Mypix, Wikipedia, https://tinyurl.com/23yx95uw)

B. How Do Contractors Deliver Work?

After successfully tendering and securing a project, the contractor then has to mobilise resources, further develop a plan to deliver the works and then implement that plan. In doing so, a project delivery team will:

1. Refine the overall strategy for delivery,
2. Develop and ideally agree a contract program compliant with the contract requirements,
3. Implement that plan, and
4. Record progress against that contract program through monthly progress reports[22] (MPRs).

[21] A gang of workers led by the Foreman, called a Ganger (Merriam Webster, n.d.)
[22] Contractors typically report progress to their client monthly and report formally through the Monthly Progress Report on multiple key indicators such as safety, cost, time, procurement, design etc.

Overall Strategy

Contractors will typically plan – certainly at the outset – to deliver the works in line with the plans and strategies developed through the tender and pre-contract periods. Keeping in mind that the contractor's project delivery team is usually not the team that developed the tender plan, a starting point would be for the delivery team to identify their tender program, check it and develop it into what would hopefully become an agreed baseline program. This will typically see contractors refine their tender strategies around:

1. **Contract Program (Baseline Program)** – develop the tender program into a more detailed program or baseline program[23] for agreement with the employer, reflecting any requirements for submission called for by the contract agreement that was not addressed at the tender stage.
2. **Preliminaries** – establish the requirements for the project execution team and establish objectives for delivery of the works.
3. **Works Packages (Subcontractors)** – go back out to the market and begin to procure the delivery teams and resources to be utilised in the construction of the works. This is most commonly via the use of the supply chain and again principally through the use of specialist subcontractors.

The Contract Program (Baseline Program)

The contractor is often required to submit a baseline program[24] for agreement. This program is incredibly important. It should reflect the contractor's intent at the outset in terms of their general plan, sequence and methodology of how they intend to deliver the contract works.[25] This program should then be accepted by the employer and then become the benchmark against which program performance is measured. Unsurprisingly, the development of these baseline programs can become problematic for a number of reasons.

Back in the writer's early career, computers were not widespread tools and project management software was rare. Baseline programs were often developed by hand and would remain at a

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[23] Baseline Program usually being a plan and sequence describing the delivery of the Works – FIDIC Clause 8.3 calling for a detailed program within 28 days of commencement (FIDIC, May 2005)

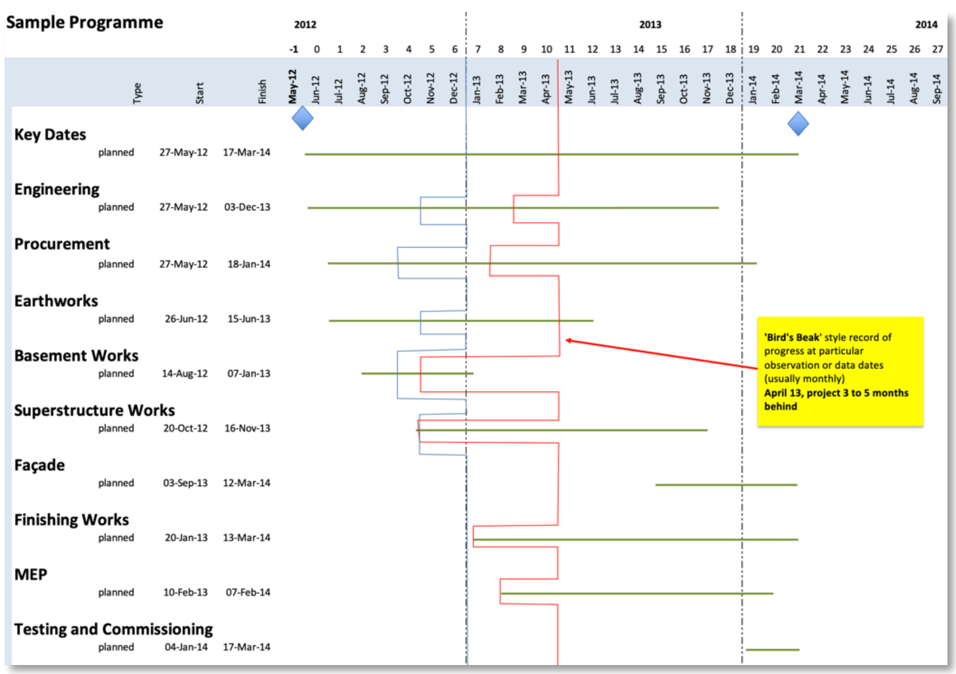
[24] Sometimes called a Baseline Program, Contract Program (FIDIC (FIDIC, May 2005) Clause 8.3), Clause 14 Program etc.

[25] FIDIC 1987, Clause 14.1 '*The Contractor shall … provide in writing … a general description of the arrangements and methods which the Contractor proposes to adopt for the execution of the Works'* (FIDIC, 1992)

relatively high level of detail, principally dealing with key items only (1 bridge, 1 road etc). Separate sub-programs and look-ahead programs would then be developed to describe particular portions of the work in more detail, but the baseline program would generally remain at a high level, be printable to a single (although vast) sheet of paper and it would often be stuck to the wall of the site office to allow for frequent review.

Whilst these types of manually developed baseline programs would not look to be particularly sophisticated today, they were actually very good tools because:

1. **Thoughtful Development** – The process of developing the program logic by hand often resulted in sensible and practical program logic for the delivery of the Works as a whole. Put simply, the manual process of developing the program forced the project team to think with more clarity about how, when and in what sequence they were going to deliver the works.
2. **Easy Reference** – Being able to stick a program on the wall in the office would mean that it was easily understood and readily on hand for review. This was particularly useful for marking-up progress on the program at regular intervals.[26]



[26] Marking up a program by hand at particular time intervals would identify a graphical measure of relative progress. This would often be called applying a 'bird's beak' to the program

Figure 4 – Program being marked up periodically by hand with a Staggered Progress Line or 'bird's beak' to make an assessment of the level of delay observable at any particular time. Example above showing the project 3 to 5 months behind plan.

With the advent of modern computers and sophisticated planning software, the development of electronic baseline programs has become problematic. Key issues observed with baseline programs today are:

1. **Programs Too Big** – The increase in computing power allowing baseline programs to become too big and too detailed, leading to programs becoming non-CPM compliant.[27] It is not unusual for the writer to come across programs that have anywhere between 5,000 and 50,000 (or more) activities, with programs pushing the limits of the hardware available[28].
2. **Author Too Remote** – Whilst the project director would be the strategic lead, the development of the baseline program can often left to less senior technical planning personnel. This can lead to the development of the baseline program:
    a. Simply being fitted into the employer's key dates,
    b. Not being properly aligned with tender – now contract – strategies,
    c. Not being tested for 'reasonableness' to confirm the program deliverables are achievable, and
    d. Not being vetted by the project director at all.
3. **Too Much 'Cut and Paste'** – Computer-based software makes it too easy to generate unwieldy programs, simply by cutting and pasting copious sections of activities and logic. Even though through their sheer size these programs may look impressive, this type of approach to planning can lead the planner to neglect fundamental issues such as identifying the correct work sequence, considering resource allocation and looking at issues of resource demand and resource levelling.[29]
4. **Unreasonable Employer Requirements** – The employer's team driving unreasonable requirements for too much detail within baseline programs[30].

[27] Incorrect logic links, open-ended activities and over-use of program constraints
[28] Database loading times measured in hours
[29] Rather than exhibit peaks and troughs in resource demand, organize groups of activities to drive more uniform requirements for resource demand
[30] '… a programme, in such form and detail as the Engineer shall reasonably prescribe …' FIDIC 87 Reprint 1992 Clause 14.1 (FIDIC, 1992)

C. How Do Contractors Record Progress (MPRs)?

Contractors primarily record progress by marking-up the baseline program with records of actual progress observed at particular data dates. This leads to the creation of what are called 'progressed' baseline programs or 'progressed' programs.

Using the functionality of modern planning software, this typically sees progress captured on a monthly basis[31] through marking-up a record of 'percentage complete' at the chosen data-date. By updating the record of progress percentage complete for each and every activity on an electronic program, the software will then provide a forecast for the completion date, based upon an assessment of the remaining durations for the work left to be executed and the logic links contained within the baseline program. Comparing this forecast completion date[32] with the forecast completion date contained within the original baseline program therefore gives the planner a '**measure of delay'** at that particular point in time.

Whilst executing analysis based on the baseline program and the 'progressed' program updates, the delay analyst is not utilising all of the progress data available. Contractors record progress utilizing a multi-level approach, driven by the requirement to formally report progress to the employer at monthly progress meetings – usually in the form of monthly progress reports (MPRs). MPRs typically aggregate a wide range of the contractor's progress indicators or KPIs, including:

1. **Progress by Program (Progressed Programs)** – Report on the movement of the forecast completion date giving, on a month-by-month basis, a measure of delay suffered in the window period versus the size of the window passed through.
2. **IPA/IPCs**[33] – the application for payment process also captures an agreed measure of progress reporting for any project based on earned value. Set against the initial project cash flow agreed with the employer at the outset,[34] the IPA/IPC process also captures, on a month-by-month basis, a measure of progress of the delivery of the works as a whole. In particular it identifies:
    a. A value and measure of progress identified by the contractor, and in reply.
    b. A corresponding measure of the progress as assessed by the employer.

[31] But can be at any discrete time slice decided by the planner
[32] At the data date within that particular Progressed Baseline Program
[33] Interim Payment Application. Interim Payment Certificate. The process for applying for and agreeing interim payment releases to the contractor
[34] FIDIC 'Red Book' 2005 Clause 14.1 b), '*The Contractor shall submit to the Engineer within 28 days after the commencement date a proposed breakdown of each lump sum price …*'

3. **Inspection Requests (IRs)** – as part of a typical QAQC procedure, projects will typically deploy inspection and sign-off processes whereby the employer is invited to inspect and sign-off on the status of works prior to that work being accepted.[35] Chains of inspection requests therefore chart out the progress of works, certainly through all the stages the parties consider important enough to warrant as 'hold points' prior to commencing further works.
4. **Activity Databases (for example weld databases, engineering submission logs)** – complicated projects, such as oil refineries, may develop and manage Inspection Request processes through the deployment of specific databases related to specific portions of categories of work. Such databases contain significant engineering-specific information and typically identify when activities were undertaken (welding databases covering weld types, who executed the welds and on what day they were executed etc). Such databases are therefore a great way of identifying time periods and performance data for the execution of particular groups of activities, and certainly identify 'hard points' such as when particular activities may have stopped or have reached a completion.
5. **Daily Allocation Sheets** – commonly kept by specialist sub-contractors,[36] daily allocation sheets are very good at tracking the deployment of a resource and how that resource delivered work. Again, these records are good at identifying 'hard points' for when activities commence or stop, as well as identifying the resource deployment for the execution of such works.

On closer inspection, the development and reporting of the MPRs is actually a form of delay analysis in itself. The process of compiling the MPR on a monthly basis and formally reporting progress (time lost) to the Employer enables the contractor to:

- Identify a period for analysis – the month usually covered by the reporting period,
- Pull various strands of contemporary records together to analyse and form an opinion on the extent of delay evident in the period, and
- Express an opinion on the cause of the delay observed.

[35] Either accepted either prior to covering-up or accepted as complete
[36] Subcontractors who may typically be single trade specialists such as piling subcontractors or drilling specialists who record on a daily basis what their men and machines are doing

As a result, in executing delay analysis, the delay analyst has a significantly more detailed range of data sets available for charting progress than just the progress data contained within the 'progressed' computer baseline programs. For example, the delay analyst has access to:

1. **Inspection Requests (IRs)** – often hosted in online electronic databases,[37] records of individual inspections, and the results of those inspections, captured specific to specific time frames and specific works or trades.
2. **Submission Logs** – logs typically retained for drawing submissions, design submissions, materials submissions etc.
3. **Material Deliveries (for example concrete delivery tickets)** – delivery tickets that can be reconciled to work locations and again specific timeframes.
4. **Specific Work Databases, Weld Databases –** specific databases retained for QAQC purposes tracking particular critical work activities. For example, oil refineries and weld logs tracking the execution and completion of different types of welds.
5. **Photographic Records** – not only formal monthly progress photos accompanying MPRs, but also many photos captured daily by the workforce that can reconcile a work location to a status of build at a particular point in time.

4. DELAY ANALYSIS FOR CLAIMS AND TIA – WHY IS TIA PROBLEMATIC?

'Why use a prospective delay analysis methodology to forecast what actually happened in the past?'

It sounds nonsense, but in the writer's opinion this is effectively what TIA delay analysis is.[38] [39] So why are we surprised that TIA is problematic in the industry and seems to cause more arguments over delay than it solves?

In promoting the adoption of the TIA methodology, the industry initially had good intentions. It was a 'prospective' methodology, intended to be an effective way for parties to proactively agree

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[37] In the Writer's experience, the most common system is the Aconex online web-based document collaboration system developed by Oracle.

[38] Decide on liability first (accepted delay event) followed by insertion into the baseline programme – but with this analysis process typically executed substantially after the event has usually occurred.

[39] TIA identified as a 'prospective' or 'looking forward' methodology. See Society of Construction Law Delay and Disruption Protocol 2nd Edition 2017 Part B 11.5 (Society of Construction Law (UK), 2017). TIA in Windows identified as the prospective methodology applied retrospectively. See AACE MIP 3.7.

revised baseline programs that reflected an instructed change **at the time the change was raised**.[40] This approach – to agree changes as and when they occur – can possibly be traced back to the 1990s when the UK adopted more collaborative forms of contract agreements.[41] [42] It can certainly be seen as an ethos described in the Society of Construction Law Delay and Disruption Protocol 1st Edition from 2002 (Society of Construction Law (UK), 2002).

A. Typical Employer Strategy

In hindsight, such an approach was potentially misguided as – certainly in the wider international community – not all employers are open to the idea of agreeing increases in both time – and particularly cost – for changes during the currency of a contract. The hard reality is that most employers do not wish to provide contractors with any additional relief, unless there is absolutely clear and unavoidable reason to do so. This gives rise to employers wishing to avoid or at least defer dealing with liability for cost and time – and employers demanding the deployment of the TIA methodology applied retrospectively feeds directly into that strategy. This can be summarized as follows:

	Employer Strategy	Employer's End Game
1	Contract agreements include a notice and time bar process.[43]	The employer wishes only to consider delay events around which: • Notice has been given, and • The employer accepts some liability. The employer takes advantage of the time bar provision to limit ultimate levels of employer liability.
2	TIA is a methodology based upon analysis of discrete delay events inserted into a program.	This ties in with the notice and time bar provisions of common contract agreements. The TIA delay analysis attempts to analyse specific liability for specific delay events notified,[44]

40 Change in program to be agreed contemporaneously to the event or change occurring
41 Latham Report of 1994 (Latham, 1994) and subsequent Egan Report of 1998 (Egan, 1998) became influential reports in the UK promoting more collaboration between Employers and Contractors in a drive to promote efficiency within the construction industry, spurring the development of new contract forms such as the NEC Suite (NEC, 2023)
42 The Egan Report identifying 'production' as one of four key development areas. Executive Summary Point 7 (Egan, 1998)
43 Very common, particularly is the Contract is developed from any of the FIDIC standard forms
44 Rather than establish the extent of the As-Built Critical Path first

	Employer Strategy	Employer's End Game
		with any balance of delay automatically falling to the contractor's account.
3	TIA analysis deviating or not aligning with what actually happened on site.	The delay analysis no longer aligning with what actually happened on site, arising from the combined effects of: • the methodology being a selective modelling technique, and • the contractor starting to work out-of-sequence against the logic described within the model.[45] As soon as this deviation occurs, it provides the employer opportunity to: • Argue that the delay analysis is incorrect, and • Defer addressing any formal determination on the matter.
4	Defer final determinations on entitlement to beyond completion.	The further in time the project moves on, the further the results of the TIA deviate from reality, thereby providing the employer with more excuse to defer or avoid any interim agreement on EOT entitlements until the works reach completion.[46] This further feeds into the employer's strategy to leave any EOT/prolongation settlement until scope of all potential liabilities is known and the works have been taken over (TOC).
5	Settlement of final account with the contractor's account suppressed.	As the works finally reach completion it is the contractor who will have been put to all the expense:

[45] SCL Protocol 2nd Edition 2017 Part B 11.2 2 (Society of Construction Law (UK), 2017) risk of anomalous results from logic links, calendars, remaining durations etc

[46] The more unscrupulous Employers will also physically take over portions of the work but argue that the Works remain incomplete – the worst case seen by the writer is a water treatment plant operated by the Contractor for two years, still without any formal TOC in place

	Employer Strategy	Employer's End Game
		• Financed the cost of any overrun – no (or little) interim compensation for preliminaries, variations and claims, whilst constructing the permanent works to the employer's '**final Requirements**'. • Incurred the time overrun and thereby facing the imposition of penalties, and • Employer raising counterclaims for poor performance, rights to terminate and threat to call on performance bonds. At final account, it is the employer who takes on the position of strength in account settlement talks, as the contractor's account is suppressed as much as possible prior to any negotiations commencing.

B. Technical Issues with TIA

Perhaps in light of the observations on the employer's strategy discussed above, the TIA methodology is used frequently on live construction projects and predominantly retrospectively.[47] In the writer's experience, this predominant reliance on the TIA methodology gives rise to some particular technical issues identified as below:

1. **Too much detail** – Despite projects being reasonably described by a handful of activities, the industry tends to develop massive programs for use as baseline programs. The advent of cheap computing power has led to baseline programs becoming unnecessarily big.[48] It is also common[49] for the scale of the programs developed to push computers to the limit of computing power available. The level of detail in the baseline program versus the handful of issues that

[47] In the writer's experience, the majority of Employers, irrespective of country or jurisdiction, demand TIA Methodology for delay analysis, but not specifically the TIA in Windows methodology as described by AACE MIPs 3.7.
[48] Programs seem to be getting bigger because the improvements in computing power allows them to get bigger
[49] In the Writer's opinion

may be inserted as fragnets therefore leads to a dilution of impact[50] for the events being modelled within the analysis.

2. **The 'Infinite Blue Bar' Syndrome** – once an activity is recorded as being commenced, the bar turns blue. But it is then very difficult to establish reasonably: a) when that activity properly commenced (false start), or equally b) when that activity reasonably completes. This is because contractors are not very good at making proper starts and then are not very good at reaching 100% completion.[51] For example, for completion and if a contractor leaves a hole in a floor for access, the floor is 'effectively' complete to facilitate the follow-on trade but may never be recorded in the 'progressed' baseline program as actually being 100% complete. Similarly for commencement, the planner records an activity as commenced (because planners are always keen to show progress), but then the contractor takes time in ramping up his resources.

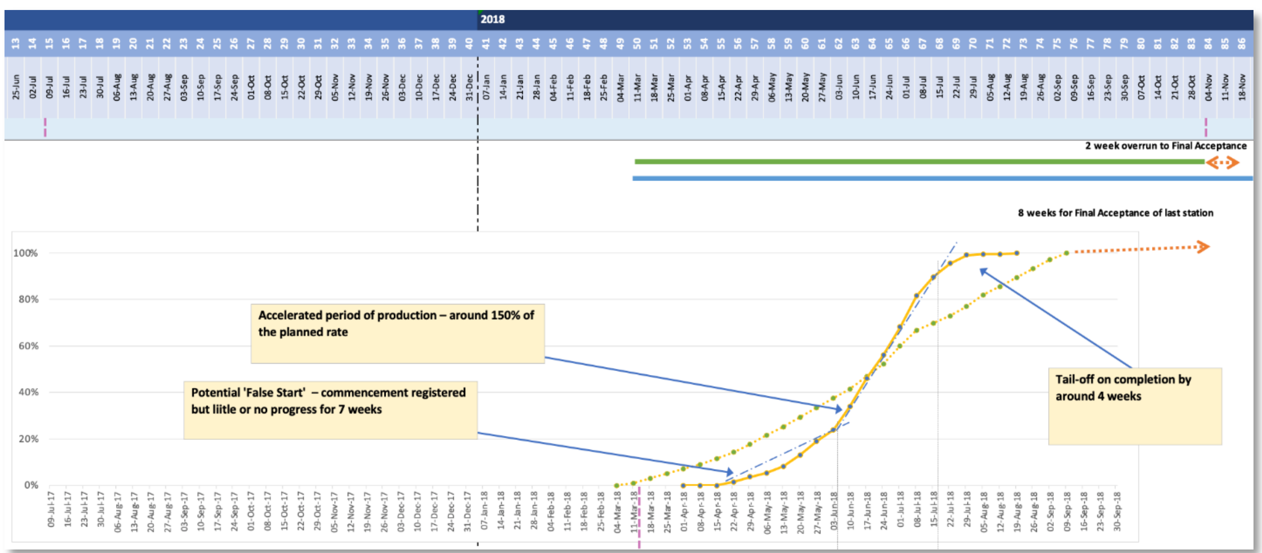

Figure 5 – Progress S-Curve for 'actual progress' showing: a) commencement made on time but then little or no progress for 7 weeks signifying a 'false start', and b) a completion tail at 99% relating to the possible location of actual completion before recording of progress stops

3. **Logic links not reflecting actual execution** – by their nature, contractors are keen to execute activities in the most efficient way possible. This means contractors will readily change works sequences at any time to suit the most cost-effective approach to execute the works. This means that the work sequences will often deviate from the precise sequence that may be described

[50] Ratio of Activity count to Delay Event count dropping, the bigger the Baseline Program gets
[51] In the Writer's opinion

within the logic links of the baseline program. Similarly, programs can be manipulated with additional logic links to create false critical paths.

In light of these issues, it would appear that tribunals do not readily accept that the retrospective application of the TIA methodology as an appropriate way to execute a retrospective delay analysis. In the writer's opinion these observations go some way to explain why – certainly at international arbitration – the APAB methodology is almost universally adopted.

5. AS-PLANNED V AS-BUILT (APAB) – AND A PRACTICAL APPROACH TO DELAY ANALYSIS

A. Introduction

From the writer's experience, the APAB methodology is by far the most popular methodology deployed at arbitration. The approach appears to be embedded deep within tribunals' armoury of tools for assessing delay, as it complies easily with the case law advice that delay analysis should be common-sense based, search for dominant causes and establish causative potency.[52]

In the following section, this paper discusses the APAB methodology in some detail but specifically looks at key issues and supplemental approaches that the delay analyst can use in the determination of the as-built critical path beyond the methods limited to analysis of progress data and logic links typically contained simply within electronic baseline programs. In particular, this paper looks at real-time examples of graphical and production-based methods that the delay analyst can deploy in the exploration of a range of contemporary records. This section looks at particular issues identified as follows:

1. Software for delay analysis.
2. Separating design and procurement from construction activities.
3. Basic program information – high level data.
4. What is completion? Is It 95%, 97% or 100%?
5. Program information split into more detail – grouping to trades or activities.
6. Supplementing progress data with other data – heat maps.

52 Society of Construction Law Delay and Disruption Protocol 2nd Edition 2017 2017 (Society of Construction Law (UK), 2017)and case law such as Henry Boot (UK) Ltd v Malmaison Hotel (Manchester) Ltd (Henry Boot Construction (UK) Limited v Malmaison Hotel (Manchester) Limited [2000] EWCA Civ 175, 2000) and Saga Cruises BDF Limited v Fincantieri SPA (Saga Cruises BDF Limited v Fincantieri SPA [2016] EWHC 1875, 2016)

7. Determining the as-Built critical path without planning software.
8. Summarizing the Determination of the As-Built Critical Path.

B. Software for Delay Analysis

Planning software is highly sophisticated and widely adopted on construction projects. It is however important to remember that the bulk of planning software is designed for 'planning' and 'forecasting' the execution of works. To this end, planning software is highly useful and good at its job for planning, but that does not necessarily make it a suitable tool for delay analysis.

It is the job of the delay analyst to determine the as-built critical path for the project,[53] a job that requires the analyst to execute skill and common sense. If there is any over-reliance on planning software, then the delay analyst can fall into the trap of relying on the planning software to determine the as-built critical path for him, rather than determine that critical path for himself.

In the writer's opinion, typical planning software and a focus on TIA gets into difficulties with executing reasonable delay analysis. The Writer identifies key areas of difficulty with software based analysis as follows:

1. **Over-Reliance on Logic Links** – The software relies on the logic links and sequences programmed into the plan and therefore does not readily map out or represent changes in the work sequence the contractor may have actually executed on site. The AACE recommends the delay analyst should go back and reflect on changes in logic,[54] but in the Writer's opinion this is not always possible because:
    a. The employer usually views any modification made to the baseline programme with suspicion, and as a consequence
    b. Contractors rarely offer modified programs, and employers certainly do not readily accept them.
2. **No Review of Productivity** – The software does not analyse or show clearly how performance or production varies over time (the infinite blue bar syndrome). Neither the AACE[55] or SCL[56]

[53] SCL Protocol 2nd Edition 2017, Analysis time-distant from delay event, Part B 11.6 d) (Society of Construction Law (UK), 2017)
[54] AACE SVP 2.2 (Update Validation) and SVP 2.3 (As-Built Validation).
[55] AACE SVP 2.2 and SVP 2.3 recommends looking at data in monthly updates.
[56] Society of Construction Law Delay and Disruption Protocol 2nd Edition 2017, Part B 11.4 c) calling for wider approach to delay analysis (Society of Construction Law (UK), 2017)

provide clear guidance on the use of productivity data. In any case, TIA simply focuses on performance of the critical path items only.

3. **False Start and False Completion Issues** – The software does not clearly identify the existence of any false-start or 'token start' to any activity and equally does not clearly identify when an activity has come to a sufficient completion to allow follow-on trades to commence. Again, neither the AACE or the SCL protocol give clear guidance on how to address these start and finish issues in TIA beyond looking at the data in monthly[57] slices.

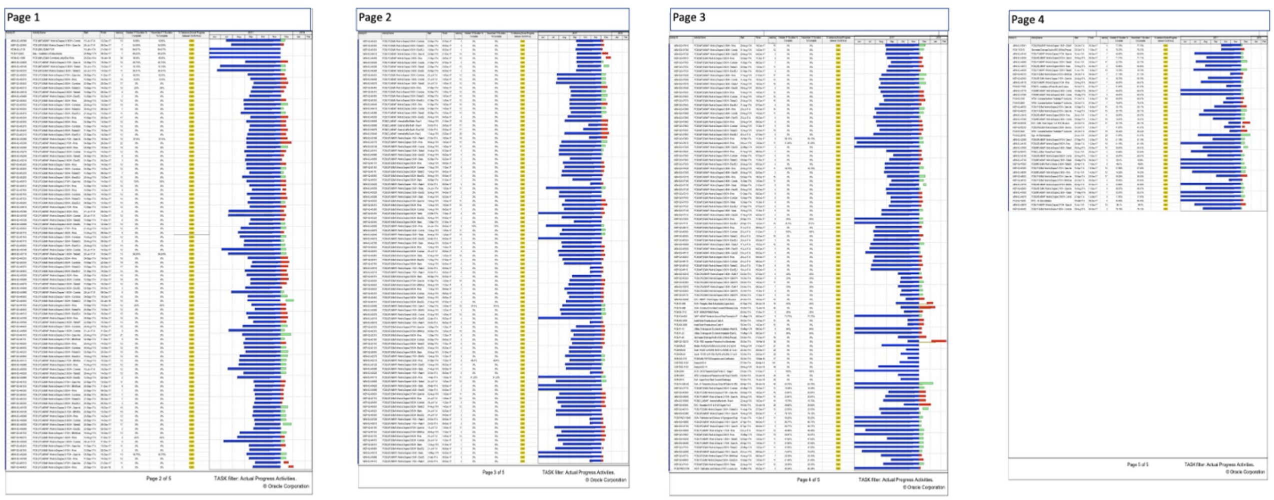

Figure 6 – 'Progressed' Program of around 3,000 activities showing 400 activities filtered and exhibiting progress, but bars becoming infinitely long as the activities do not reach a strict 100% completion. The 'Infinite Blue Bar Syndrome.'

4. **Garbage in Garbage Out** – The planning software is not resilient to 'garbage-in-garbage out' issues, by being totally reliant on the skill of the planner to correctly define the baseline logic and then correctly input the record of progress, rather than being based on facts.

5. **Remoteness from Contemporary Records** – The software is a step away from the typical contemporary records that actually capture the records of progress[58]. This remoteness then leads to delay analysis tending to be focused solely on: a) the underlying logic links built into the baseline programme, b) records of progress inputted into the programme over time and c) any changes to programme logic made along the way. Without verification, the software – and

[57] Or other reasonable time periods
[58] the photos, inspection requests (IRs), records of progress, approvals etc.

the progress data contained therein – may not actually represent the progress of the works being analysed in the delay analysis being executed.

Planning software typically limits charting to variations of GANTT bars only. It does not allow for inclusion of other forms of data sets or charting (S-Curves, photos etc) and does not readily allow for inclusion of analysis commentary to accompany the determination of a critical path.

Readily available spreadsheet software provides an easy alternative to re-process and analyse the data. Yes, the planning software is good at capturing the progress data, but for determining the actual critical path, spreadsheets hold additional capabilities as described below:

1. **Blank Canvas** – Spreadsheets are effectively blank canvases over which flexible delay analysis can be executed. Spreadsheets can provide the space to marshal and draw together multiple strands of analysis to support aspects of the determination of the critical path in one place. This can be particularly useful when bringing together multiple data sets and explanation of the analysis being executed.
2. **Charting Tools** – Spreadsheets provide access to a wide selection of charting tools such as line charts, bar charts, heat maps, histograms and graphing tools. This then allows data sets to be combined in support of the development of particular opinions on delay. For example, the graphical objects allow vertical lines to be drawn very easily to allow a delay analyst to infer logic links and determine the critical path across such multiple data sets.

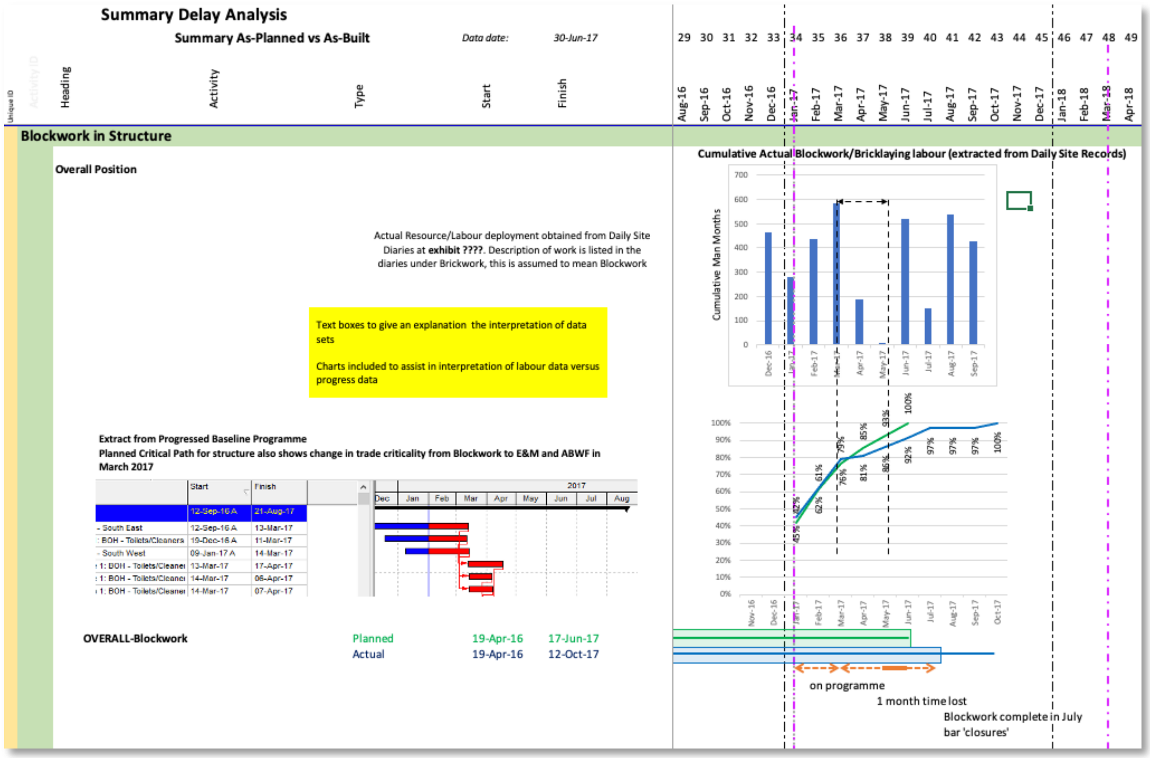

Figure 7 – Screen grab of Spreadsheet used for delay analysis showing: a) grouping colours to segregate portion of the program (and the analysis), b) inclusion of histograms and s-curves to provide additional analysis of progress data and contemporary records, c) inclusion of screen grabs from the baseline program to support the analysis and d) commentary boxes explaining the findings explaining the interpretation of data as the analysis moves to the determination of the As-Built Critical Path.

C. Separating Design and Procurement from the Construction Activities

With the development of baseline programs for construction activities, contractors have a tendency to develop a single program that would encompass all activities, such as design, approvals and procurement. Whilst interlinked with construction, these activities are actually significantly different from each other and should not be analysed with construction activities within the same unified program[59]. Otherwise, any delay analysis will show anomalous results. To put this simply, it is common for approvals on engineering not to reach a 100% completion until the end of a project, but contractors may execute the works, with portions of engineering approval remaining to be completed. Delay analysis on such combined programs would therefore show design as being the primary driving delay, when the requirement is usually to analyse the delay in the construction.

[59] In the Writer's opinion

The reality is that the delay analyst should first focus on establishing the extent of delay through construction activities only, particularly to establish the extent of delay exhibited through construction from commencement to TOC. It would then be for the delay analyst to explore separately whether activities such as lack of engineering, design or procurement were actually **causes of delay** to the construction activities. This is particularly important where the Contractor again may have mitigated through changes in his work sequence, such as proceeding with construction without having reasonable approvals for designs in place.

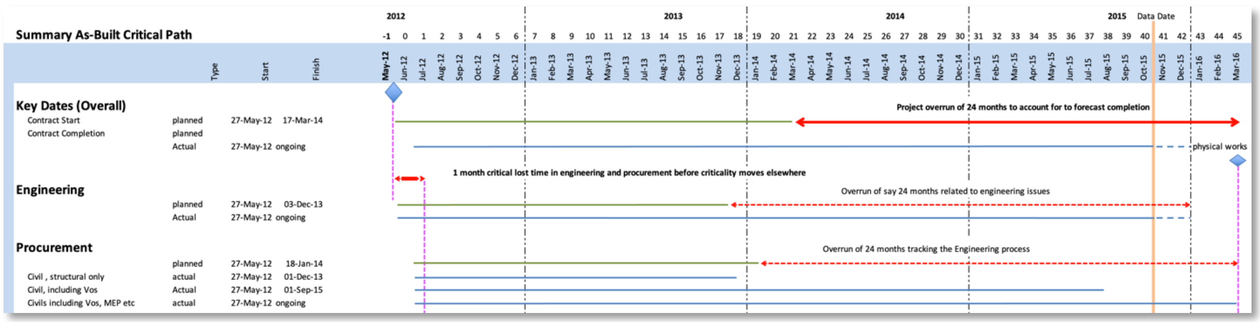

Figure 8 – High level data for a project showing the Engineering (Design) and Procurement typically running for the full length of a project with a significant chance of reporting anomalous results for the construction activities. Logic links in electronic programs tend to show these activities as critical, when the actual critical path is more likely to be passing through the construction activities.

D. Basic Program Information – High Level Data

Through the process of recording progress within marked up or 'progressed' programs, contractors capture basic progress information, typically presented in the GANTT format chart. Such charts show the planned progress as a green bar and then show the actual progress typically represented by a blue bar. As the project marches on, the data date moves to the right and ultimately the 'progressed' baseline program captures a full record of progress from commencement to final TOC:

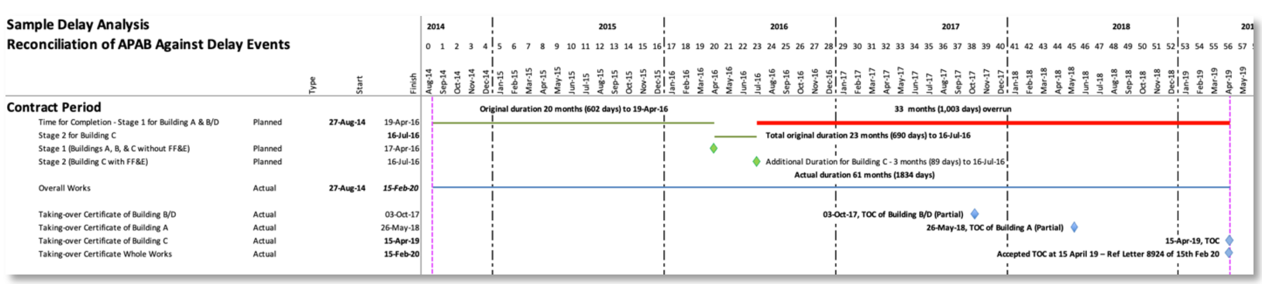

Figure 9 – typical record of a summary of the overall planned period versus the actual construction period showing: 1) progress to particular milestones (green bars versus blue bars) 2) a date for completion to TOC (the purple line) and 3) a measure of the project overrun (33 months).

As the progress has been captured over time – and to particular time slices – the 'progressed' baseline programs contain useful data to show relative rates of progress over time. This 'progressed' progress data across the project is not usually used in normal TIA delay analysis[60], but it can be abstracted and presented as performance S-Curves as shown below:

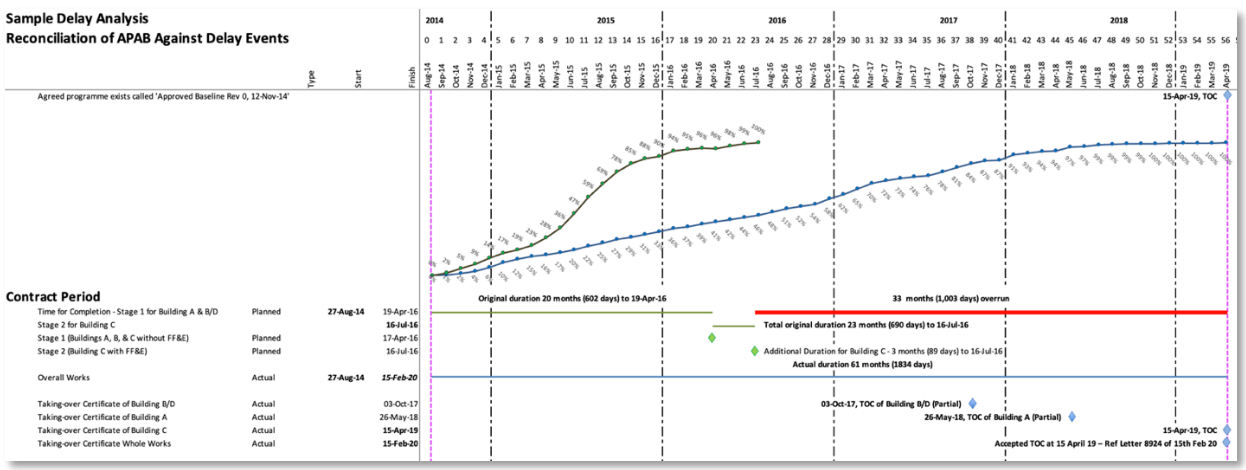

Figure 10 – progress data for 'overall progress' abstracted and presented as S-Curves. S-Curves now providing context to the relative rates of progress of the project over time.

The introduction of the S-Curves now provides significantly more context to data for interpretation in any delay analysis. Even at the high level of 'overall project performance', key observations can be made that would not necessarily be available from a delay analysis limited to GANTT charts with logic links. Looking at the example above, additional observations could be:

1. **Commencement** – Whilst progress was generally in line with the plan in late 2014, why did the contractor not 'ramp-up' performance in line with the plan in 2015?
2. **Constant Progress** – With the exception of early 2017, performance appears to be relatively constant from 2015 to end 2017 (as shown by a straight gradient).
3. **Completion possibly mid-2018** – Whilst TOC is identified at April 2019, the project reaches 99% complete certainly by July 2018. Was it more likely the permanent works complete in mid-2018 and the TOC was unreasonably withheld for a period of 9 months?

[60] As TIA focuses on critical activities only arising from the network logic links within the programme logic

E. What Is Completion? Is It 95%, 97% or 100%, or 600%?

For what appears to be a relatively simple question, the answer may be a little more nuanced and certainly dependent on circumstances. This question can only be answered with an '*it depends*', but it is certainly for the delay analyst to make a judgement on what constitutes completion, based upon the factual data to hand. If one is executing delay analysis within computer software, then the software will only accept completion at 100%, but some more likely scenarios important for a delay analyst to consider are as follows:

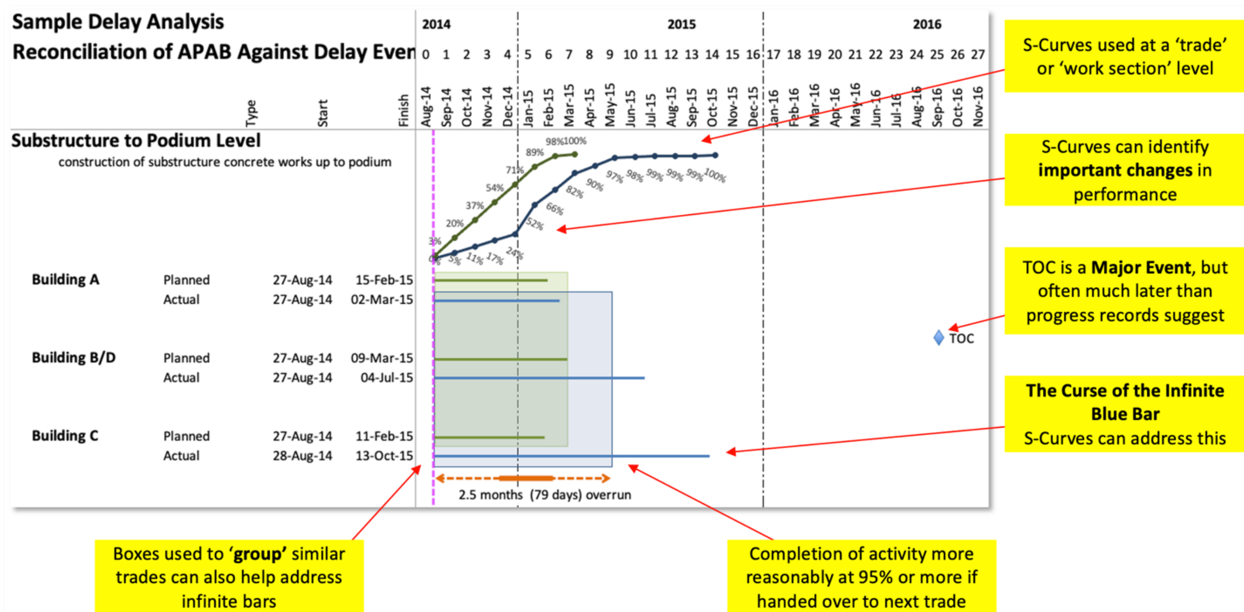

Figure 11 – issues around what may constitute a 'Completion' and how completion needs to be judged based upon the circumstances at hand. Completion is not just 100%

1. **Substantial Completion (Standard Contracts)** – A term arising from certain standard contract forms, but interpreted to mean the completion of the bulk of the construction activities, with activities remaining limited to snagging-type[61] works. From a program point of view, substantial completion does not have to be recorded at 100%.
2. **Completion (EPIC Contracts)** – Completion will usually be understood to be completion of **100%** of the construction works with the facility constructed moving into an '*operational phase*.'

[61] Slang construction term for minor outstanding works. Also sometimes described as Punch List type works

3. **TOC (Take Over Certificate)** – a point at which the employer certifies the works as sufficiently complete, or if they refuse to provide any formal certificate, it is understood to be the point at which the employer has occupied and taken beneficial use of a facility.
4. **95% to 97%** – A reasonable assessment of completion of a portion of works sufficient to allow the follow-on trades to commence. In the writer's opinion, if the employer releases 5% retention upon completion, then logic says anything above 95% must be a reasonable measure of completion – certainly for groups of activities.
5. **Completion at 600%** – Should an activity incur some change, then the actual quantities executed may represent maybe not a completion at 100%, but at some other figure. Take for example, engineering submissions. If the contractor planned for around 600 submissions, but to reach completion they ultimately executed 3,600 submissions then arguably the contractor may have executed six times more engineering work than they planned. If the contractor executed the engineering at their planned rate of production then the activity would take six times longer to reach a completion. This can be seen in the example below:

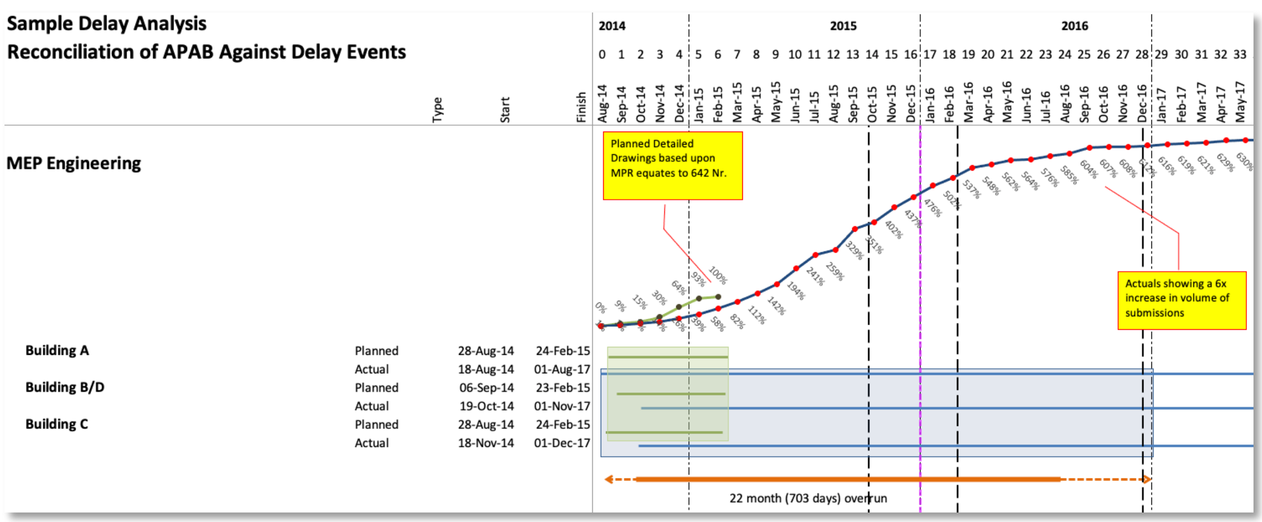

Figure 12 – Engineering planned for 100% but executed to 600%. Rate of progress observed at the planned rate, but with the activity taking 6 times longer to execute

Whether looking at either a judgement as to whether the works are complete, or what portions of work are complete sufficient for the next trade to proceed, completion is not necessarily 100%. Based on the information they have to hand it is for the delay analyst to apply common sense and make their determination.

F. Program Information Split into More Detail – Grouping to Trades or Activities

Whilst the examples above show how the S-Curves can be applied to the overall data available, to refine and focus-in, the process can then be stepped down and applied to particular groups of work activities or trades. This can be achieved by extracting the data from the planning software or contemporary records and re-processing the data in a form that is more practical for analysis. Again, using a building analysis as an example, the delay analyst may want to explore progress in the construction of substructure to a basement across a site containing three structures. This could be analysed in the data and shown as below.

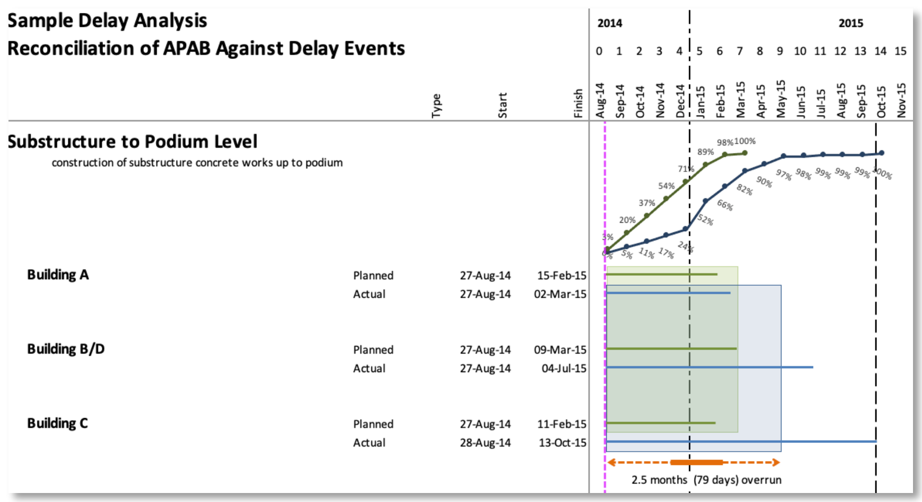

Figure 13 – Delay analysis stepped down to explore the progress and delay with a particular aspect of a project (Substructure to Podium Level). Overrun of the substructure identified at 2.5 months, with particularly poor progress for the first 4 months.

This portion of an analysis now identifies some key information useful in the determination of an as-built critical path:

1. **Grouping of Activities** – Reflecting on how contractors construct sections of work, as the works can be lassoed and grouped (the green and blue boxes in the chart) to help identify where groups of activities will be executed with predominantly one similar group of teams or gangs, giving an overall level of performance for the delivery of the substructure works.
2. **Commencement on time** – The data shows that the activities commenced on time, but once commenced, suffered delay.
3. **Completion at the 97%** – The provision of the S-Curve helps to identify where the works have reached a reasonable completion (97%) rather than a strict 100% completion. This assists

the delay analyst in addressing the ‘infinite blue bar’ issue of identifying where works have become reasonably complete. For example, the podium construction could be sufficiently complete for follow-on trades to commence, even though access holes remain in the podium (accounting for the missing 3% completion in the data).

4. **Changes in Productivity** – The S-Curve data in this example now clearly shows an initial delay through slow production (a three-month delay on the slack portion of the curve) but then a recovery and mitigation (performance ramping-up from January) which ultimately sees the podium reach a reasonable completion to 97% only two months late. The S-Curve therefore allows the delay analyst to explore the contemporary records further to:
    a. Identify the cause of the initial three-month delay, and then
    b. Identify the actions that allowed for the recovery in the works prior to completion.

G. Supplementing Progress Data with Other Data – Heat Maps

The APAB methodology supports a delay analyst in analysing a multitude of sources of data in any way that they consider is suitable, rather than just limiting them to the strict logic links and accompanying record of progress described in the electronic ‘progressed’ programs. This allows the delay analyst to interrogate multiple and differing data sets, overlay them and then explore the correlations.

A useful tool available within spreadsheets is the ‘heat map’ function that allows a chart to be developed to show an intensity of colour to represent an intensity of an activity over time. This can be applied to a multitude of data sets, with some examples below:

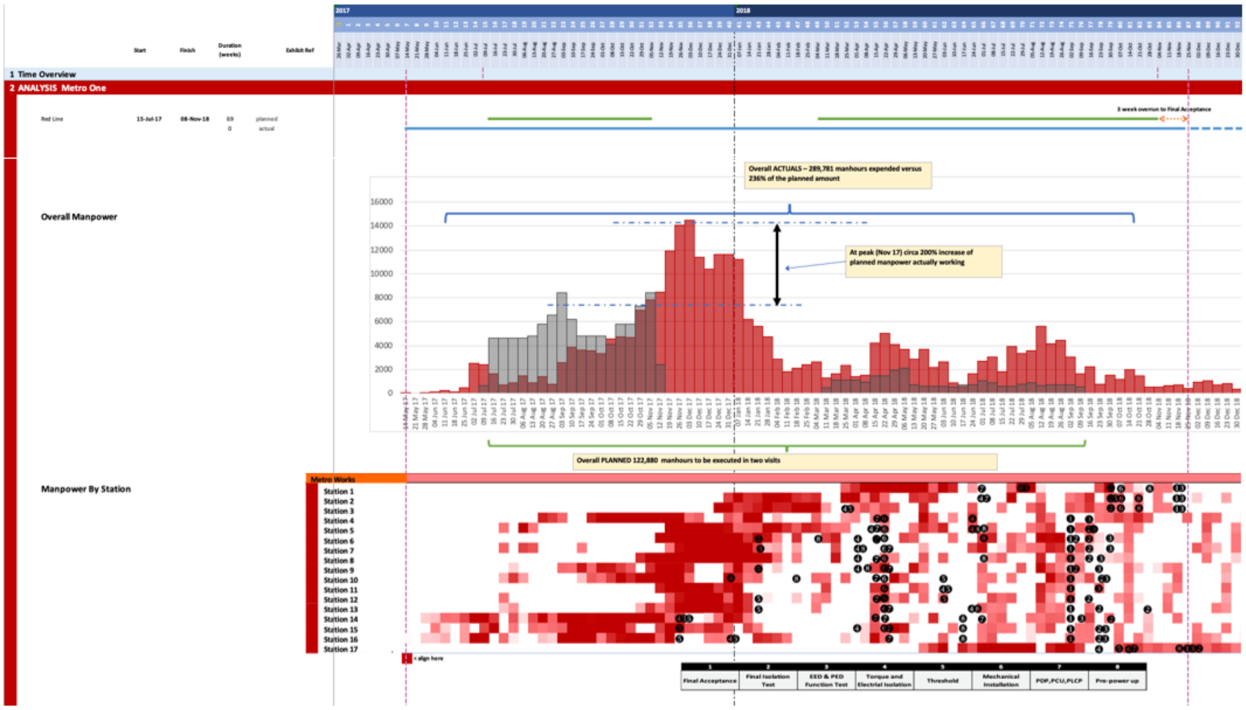

Figure 14 – heat map applied to labour allocation to explore the correlation of total labour (histogram) versus the allocation of labour to particular stations (the heat map) and activity against inspection requests for crossing QAQC hold points (black dots). Chart shows the labour deployed and with that labour now the works reached various stages including (6) Mechanical Installation and (1) Final Acceptance.

The example above identifies a distribution of labour to particular activities over time and identifies:

1. GANTT chart bars at the top placing the ‘plan’ and ‘actual’ into context over time.
2. Histogram showing the overall ‘plan’ (grey) and ‘actual’ (red) for labour over time relative to program.
3. Heatmap showing the intensity of the distribution of labour across the 17 active stations over time.
4. Inspection request hold points (black circles) mapped over the heatmap showing how the works passed through completion gateways over time – particularly mechanical installation and final acceptance.
5. Correlations between labour distribution and inspection request gateways giving a better indication of the completion of the works to a ‘mechanical completion’ and ‘final acceptance’ than could reasonably be inferred from a logic-linked GANTT chart.

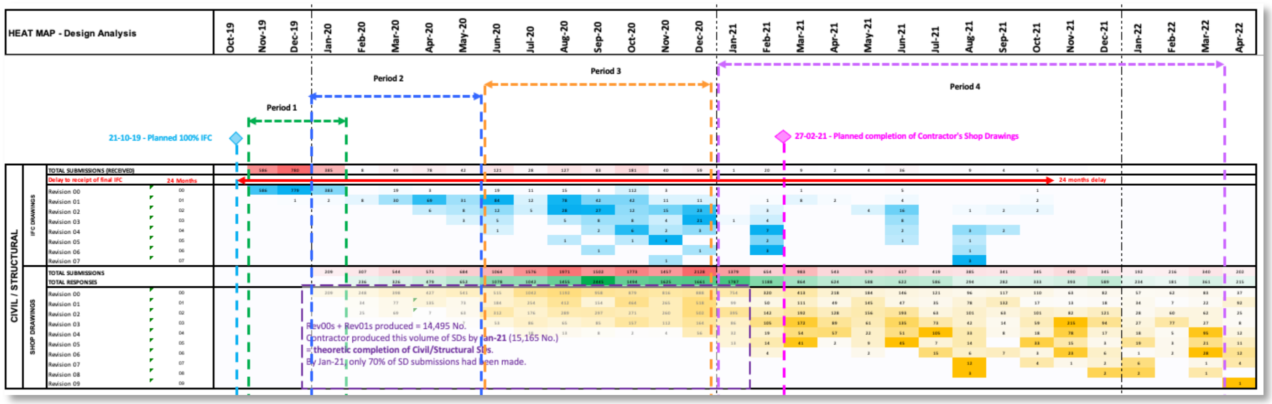

Figure 15 – Heat Map Analysis for Civils/Structural Engineering showing: 1) Drawings IFC drawing release (Blue) being significantly prolonged beyond the Period 1, 2) Shop drawings being developed in return (orange), but then 3) the Shop Drawing process being further prolonged by re-submission up to 8 times through to Period 4. 24 month delay in Employer's completion of drawings IFC, with Shop drawings dragged by the re-submission process as the Employer completes the design.

The example above maps the development of a contractor's repeated submission of engineering 'shop drawings' over time for civils/structure works (yellow) relative to the employer's release of civils/structure drawings issued for construction (IFC) (blue). The chart identifies:

1. The employer's drawings IFC passing through 7 revisions spread over a 24-month period beyond which the drawings IFC were supposed to be complete.
2. The contractor's 'shop drawing' submissions spread over a 29-month period, with shop drawings submitted in response to the release of the employer's drawings IFC.
3. Significant number of re-submissions being executed (9 revisions) as the employer changed the design. Whilst the submissions were at the planned rate of progress, the increase in submissions delayed the overall completion.
4. Completion finally reached and identified by the substantial level of submission (the darker orange boxes) towards the end of the period 4.
5. 'Shop drawing' submissions coming to an end around 4 months after the employer's last IFC revision, but engineering completed around 10 months later than the original plan.

H. Determining the As-Built Critical Path Without Planning Software

When executing TIA delay analysis within the planning software, it is the planning software that determines the location and extent of the as-built critical path. It does this by:

- resolving the progress reported against the activity bars against
- the network logic contained within the programme, to determine the longest path through the program, and then
- displaying this longest path as red bars.

Planning software can then complicate matters by stating that multiple critical paths exist within a program. Planning software can achieve this by setting the program with a ‘must complete by’ date. Any logic paths that then push beyond the ‘must complete by’ date display as red or critical within the software.

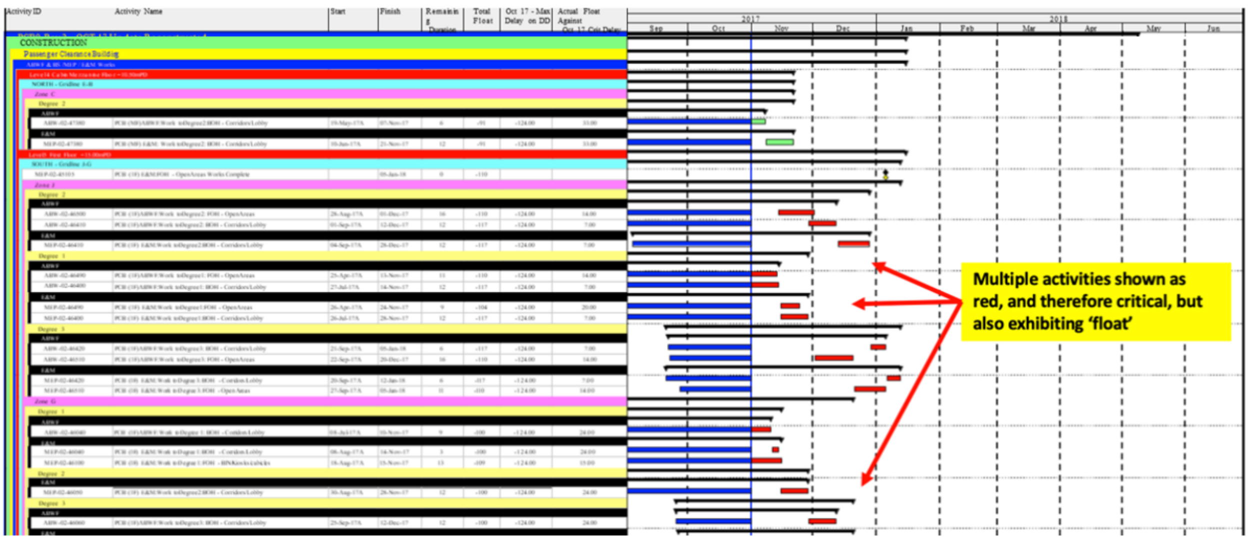

Figure 16 – Planning Software outputs displaying multiple critical paths where activities actually exhibit float, courtesy of multiple network paths crossing a ‘must complete by’ date set in the software.

This however can become problematic, not least because it is for the delay analyst to determine the critical path, but because:

1. There can only be one logical longest path or critical path through a project, unless the delay analyst identifies areas of concurrent delay.[62]
2. Works may be executed out of sequence, giving rise to the network logic generating anomalous results.

[62] Two or more delay events of ‘equal causative potency’ residing on the critical path against which their effects are coming together and converging to the extent that they are indistinguishable. See Society of Construction Law Delay and Disruption Protocol 2nd Edition 2017 Core Principle 10 10 (Society of Construction Law (UK), 2017) and case law such as Saga Cruises BDF Limited v Fincantieri SPA [2016] EWHC 1875.

3. As the TIA analysis is simply a computer model, the planning software will not apply any 'common sense' to any anomalous results it may generate.

As the APAB methodology is a more manual and flexible approach that allows for the parallel review multiple data sets[63], the methodology itself forces the delay analyst to apply common sense to the determination of the critical path and support that determination with a factual matrix and analysis. Particular care needs to be taken to identify where the critical path hands-over from one key trade to the next. This is where S-Curves looking at rates of production can be more informative than simply relying on the logic links in a computer model. Take for example two S-Curves exploring the relationship between tunnel heading works and follow-on back end works for secondary lining as below.

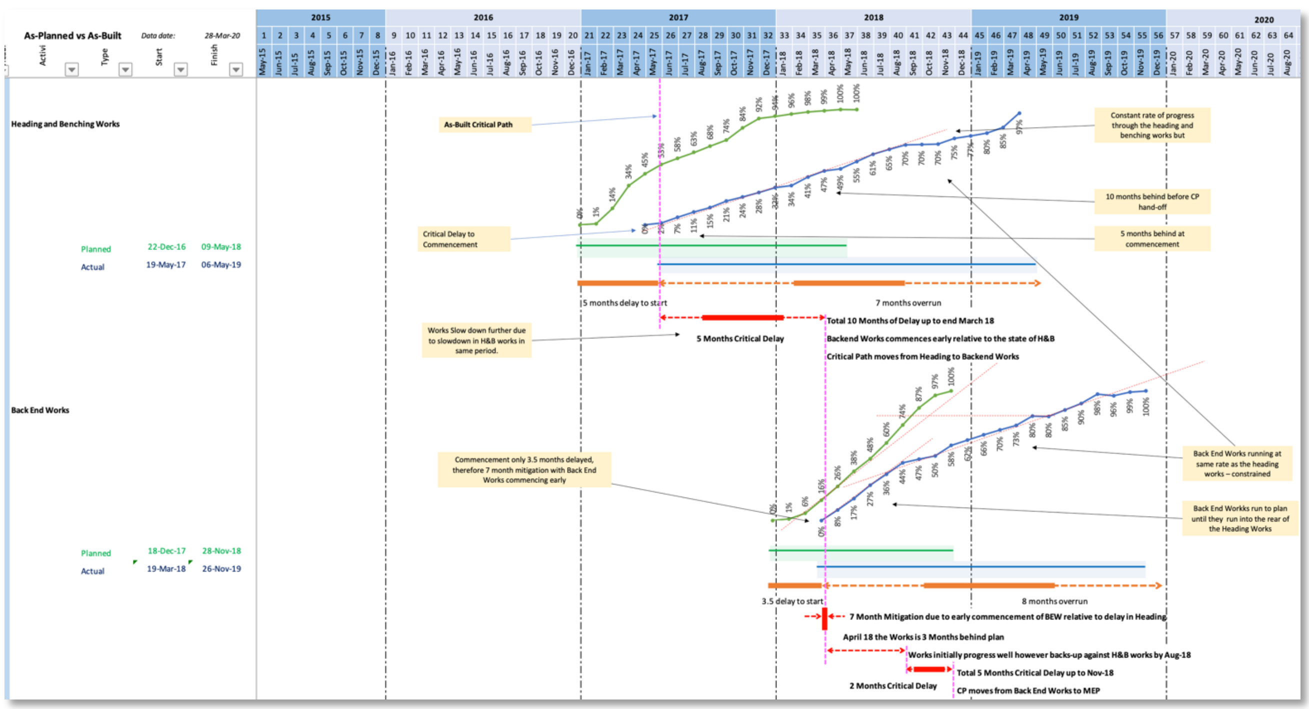

Figure 17 – Determination of the As-Built Critical Path from the comparison of the S-Curves for adjacent trades

The combination of the S-Curves for the two adjacent activities can identify a significant amount of information from the data that can help support a delay analyst's opinion of where the true critical path is to be found:

[63] Progress data compared to Inspection Requests, compared to Photographs etc

1. **Underlying Logic** – The application of common sense first of all establishes that the heading and benching of the tunnel must be executed before the follow-on back end works for the secondary lining.[64]
2. **Lead Activity** – Commencement of the heading and benching works can be identified, with a 5-month delay, followed by the rate of progress with headings being constant, but perhaps at 60% of the planned rate of production.[65]
3. **Follow-On Activity** – Back end works commence only 3 months late, but at the point of commencement the Heading works are 10 months behind plan. The 3-month-late commencement to the back end works means that there is a 7-month mitigation to the 10-month delay in the heading works. Put simply, the back end works are being executed physically closer to the preceding heading works up the tunnel being constructed.
4. **Follow-On Activity 'Driven' by the Lead Activity** – Once commenced, whilst it appears that the contractor was able to progress the back end works in line with his original planned rate of production (slope matches the plan) for a 5-month period, the slow rate of production with the preceding heading works ultimately constrains the back end works. From August 2018, the back end works run at a reduced rate matching the heading works.
5. **Determination of the Critical Path** – determination of the critical path identified as:
    a. Critical path first residing in heading works but suffering a 5-month delay.
    b. Critical path handed off to the back end works around March 18, and with a mitigation – back end works being executed physically closer up the tunnel to Heading works – possibly logistics issue.
    c. Back end works at first progress well. Production in line with plan for a 5-month period.
    d. Back end works then slow because of interference with the heading works. Back end works suffer 2-month delay before reaching 60% completion.

I. Summarising the Determination of the As-Built Critical Path

With the development of the APAB analysis within the spreadsheet environment, the delay analyst is then able to develop more informative charts that provide a summary of the findings and the

[64] Inspection of the underlying logic in the baseline program should support this view.
[65] Percentage rate of progress can be established from the slopes of the S-Curves.

determinations they have made. When not constrained by particular forms of software,[66] the delay analyst can focus on clearly showing what window periods they have identified within their delay analysis and what level of delay is identified in each window, particularly where windows may show mitigation and recovery arising from either changes to the sequence of the execution of the works, or deployment of more resource. An example summary chart to explain the findings of a delay analysis is shown below:

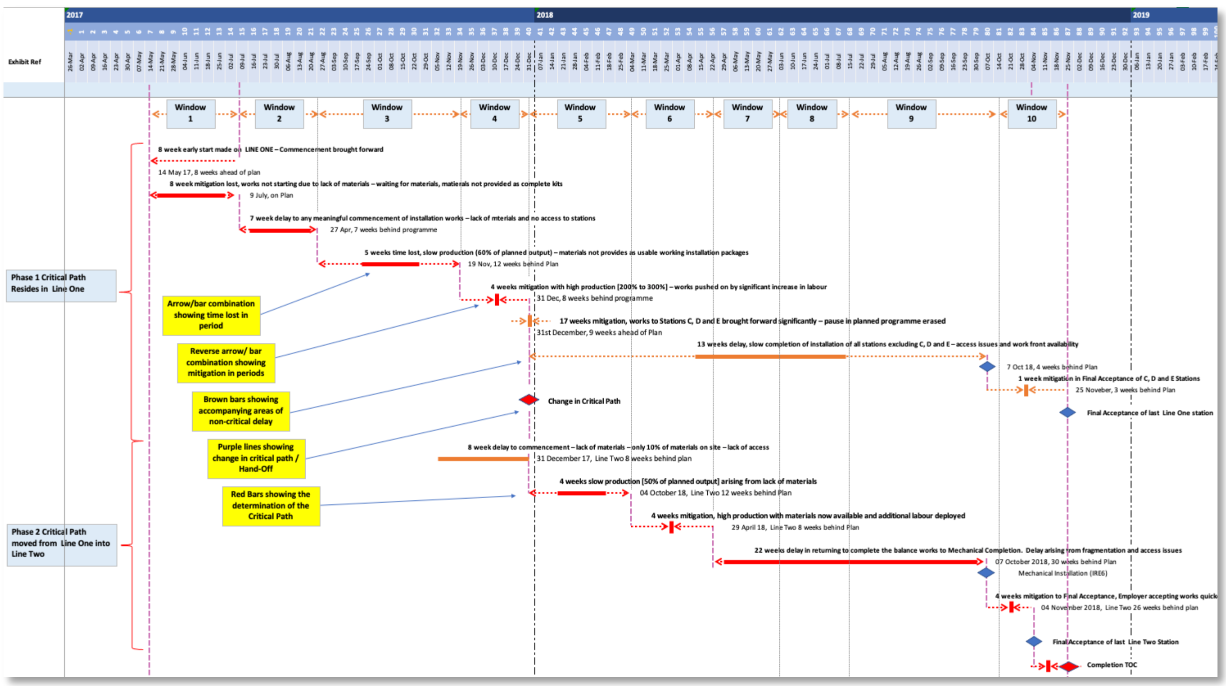

Figure 18 – Chart summarizing a delay analysis and showing what levels of delay and mitigation are evident in what particular window periods. Brown bars for showing non-critical delay to parallel longest paths whereas critical delay shown in red on the critical path

Key features of this type of summary are identified as follows:

1. **Windows Time-Slices** – Whilst the delay analysis is executed on data captured on a monthly basis, the summary identifies windows time slices during which the critical path resides within a particular portion of works. At the end of each time-slice, the critical path hands-off to another portion of the work.

[66] Where delay analysts appear to rely on print-outs of consisting of significant pages that are needed to cover the thousands of activities a programme may contain

2. **Adjacent Longest Paths** – The summary can be used to show the movement of delay across parallel longest paths, which can be useful if the project has to account for multiple completion milestones.
3. **Change in Critical Path** – As well as identifying the hand-off between adjacent portions work, the summary also allows for the identification of the change in critical path between adjacent longest paths. This then allows the delay analyst to differentiate between critical delay on the overall critical path (shown in red) and non-critical delay on adjacent longest paths (shown in brown), which is non-critical relative to the overall delivery of the works.
4. **Differentiating between Delay and Mitigation/Recovery** – the summary also allows the delay analyst to clearly show areas of mitigation and recovery within the windows time-slices and how that differs to areas of delay. This can be particularly useful when differentiating between mitigation arising from the works simply being executed more quickly than planned in the alternative to mitigation arising from a change in the sequence and execution of the works.

Figure 19 – Mitigation on the critical path in a window period & Figure 20 – Critical Delay in a window period

6. CONCLUSIONS

TIA is an incredibly useful methodology for agreeing adjustments and amendments to baseline programs at the points in time when changes and VOs arise. For both employers and contractors who are proactive and embrace the methodology, significant benefits can be achieved in terms of defining certainty around issues of cost and time risk, at the time the parties benefit most from that certainty.[67] This was certainly recommended within the construction industry as an appropriate way forward within the first Delay and Disruption Protocol of 2002.

It however has to be accepted that in certain circumstances, employers do not want to agree interim deals on matters of EOT and equally, contractors can be opaque with their claims as they attempt

[67] Employer buying contract performance for the change, with the contractor carrying the risk of delivering that performance agreed

to secure recovery on their own deficiencies. In light of this, the TIA methodology has perhaps contributed more to the creation of disputes rather than settlement of disputes.

It is clear that in the wider dispute profession, tribunals wholeheartedly embrace the APAB methodology. Tribunals do not want to be limited to analysis based on a single set of progress data, but instead want to see a dissection of the facts on the ground based on a multitude of contemporary records. Put simply, they want to see the development of compelling story of events supported by facts.

With this in mind, the writer suggests some key action points for delay analysts to consider in their delay analysis as follows:

1. **Delay Analysis Methodology** – Don't blindly rely on retrospective TIA for your primary delay analysis methodology. Look to see what would be more appropriate. Remember, for good reason tribunals rely more on APAB.
2. **Progress Data** – Don't rely exclusively on planning software, logic links and 'progressed' program data as the sole progress data for delay analysis. Cast a wider net and look for correlations across the multiple data sets available – MPRs, inspection requests, submission logs, weld databases, photos etc.
3. **Infinite Blue Bar Syndrome** – Don't just accept that activity bars are not complete if they are not at 100% completion. Apply reasonable judgment to the assessment of both the commencement and the completion of activities, reflecting on what commencement and completion actually means. Completion certainly does not have to be at 100%.
4. **S-Curves and Productivity** – Chart out the progress data into S-Curves. Doing so will provide a much better indication of how the works progressed over time, how rates of progress (production) have changed and again give much clearer indications of when works started, stopped or reached a completion.
5. **Graphical Summaries** – Make best use of the charting and graphic tools available to support the delay analysis. Pictures and diagrams will always speak louder than words.
6. **Apply Common Sense** – It is the delay analyst's role to determine the course of the as-built critical path by reference to all appropriate contemporary records. But only by using common sense to weed out any anomalous results can the delay analyst determine a true critical path.

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