



**Mike McSorley**  
**PARTNER AND**  
**HEAD HKA ABU**  
**DHABI**



**Imran Chaudhary**  
**ASSOCIATE**  
**DIRECTOR HKA**  
**ABU DHABI**

## Criticality in Construction Delay Claims

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### Introduction

In prosecuting or defending a claim for an extension of time in a construction contract, the word ‘critical’ is extensively debated.

What is meant by critical? At first blush, it appears a straightforward question demanding a simple answer but if posed to various professionals involved in construction – such as lawyers, contract managers, programming/control engineers, procurement, and construction managers etc. – each are likely to have their own perspective of the meaning of critical.

More importantly, the textbook definition of ‘critical path’<sup>1</sup> or ‘perceived critical path’<sup>2</sup> or ‘critical delay’<sup>3</sup> are not often helpful in formal dispute resolution due to many reasons.<sup>4</sup> Contractors, consulting engineers, project owners, witnesses of fact and technical experts mostly disagree with each other on what works were critical at a specific time. Therefore, the question posed – what is meant by critical? – requires to be understood from the perspective of arbitrators or judges who finally resolve construction disputes.

This article discusses the basis upon which criticality is determined by arbitrators or judges. Useful examples from United Kingdom court cases are provided to explain the point, however the references to such case law are not intended to provide legal position or legal analysis. Although this article is written from a common law (UK) perspective, the logic and rationale relating to criticality equally apply to other jurisdictions where currently such issues have not been developed to such an extent.

Many parties are involved in a construction project.<sup>5</sup> This article is written for any entity/party which carries the burden of proving what was critical.<sup>6</sup>

<sup>1</sup> Critical Path is defined as “the sequence of activities through a project network from start to finish, the sum of whose durations determines the overall project duration”, Andrew Burr, *Delay and Disruption in Construction Contracts*, 5th edition (Informa Law from Routledge, 2016), para 1-028.

<sup>2</sup> “...the scheduler needs to be able to recognize the real critical path and not be misled by peculiar idiosyncrasies of the logic. The critical path calculation will sometime indicate critical activities which experience says can never be critical...”, H. Murray Hons and Michael T. Callahan, *Construction Schedules*, 4th edition (USA: Juris), p.2-16.

<sup>3</sup> “...there is disagreement as to how one can determine whether a delay is critical. Many commentators would simply state, “it depends upon whether it was on the critical path.” But the issue is more complex than that – “how does one determine what is on the critical path...?””, Barry B Bramble and Michael T. Callahan, *Construction Delay Claims*, 4th edition (USA: Wolters Kluwer, 2011), p.1-13.

<sup>4</sup> For useful discussion on such reasons, reference chapter 10 [Standard of Proof for Contractor Time Delay Claims] and chapter 12 [Scheduling Issues in a Software Paradise] of, *Construction Scheduling: Preparation, Liability and Claims*, by Jon M. Wickwire, Thomas J Driscoll, Stephen B. Hurlbut and Mark J. Groff, 3rd edition (USA: Wolters Kluwer, 2010 & 2015 supplement).

<sup>5</sup> Such parties include developer or project owner, designer, architect, supervising engineer, main contractor, subcontractor, nominated subcontractor, suppliers, vendors etc.

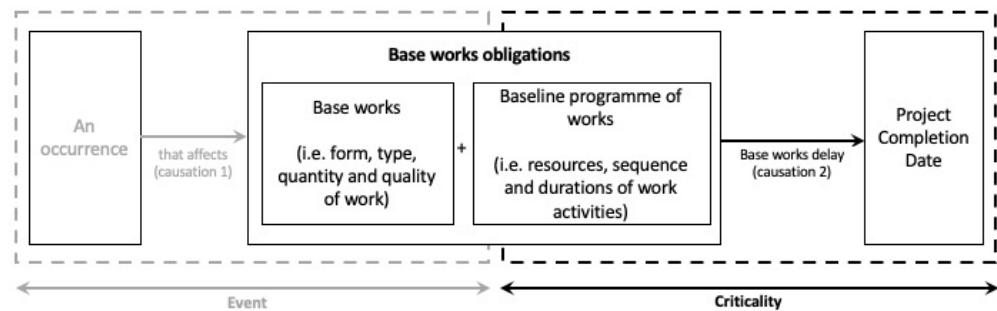
<sup>6</sup> BHP Billiton Petroleum Ltd and Others v Dalmine SpA [2003] BLR 271, at para 15 it is stated, “*Ei qui affirmat non ei qui negat incumbit probatio*” which means the burden of proof rests on him who affirms a fact not on him who denies.

On most occasions, that party is a contractor or a subcontractor, however it may well be a project owner.<sup>7</sup>

FIDIC Red Book 2017<sup>8</sup> is referenced whenever the contractor's/project owner's contractual rights and obligations are referred to in the article. However, a contractor/project owner should look to its governing contract terms for such matters.

## General Discussion

To establish entitlement to an extension of time, a contractor must establish two causations.<sup>9</sup> Firstly, an occurrence (an owner's risk event) affects the base work obligations and secondly, the base work so affected has/shall delay project completion (or completion of a milestone). The first causation defines the delay event.<sup>10</sup> The second causation, which is the subject of this article, defines the criticality as shown in the figure below:



**Figure 1: Two Causations, Event and Criticality**

Arbitration awards and court judgements indicate that an arbitrator or a judge determines criticality by reference largely to (1) the terms of contract, (2) evidence of fact ("factual evidence"), (3) critical path method ('CPM') network or construction programmes and (4) evidence of opinion ("expert opinion").

Terms of contract are, for the most part, expressed in a written contract. Factual evidence is produced through witnesses of fact<sup>11</sup> and contemporaneous project records.<sup>12</sup> CPM network or logical linked programme of works is a computer-based document which is often relied

<sup>7</sup> A project owner may also be required to advance a positive case and prove criticality, if required, in relation to its counter claims.

<sup>8</sup> FIDIC Conditions of Contract for Construction, Second Edition 2017 (Red Book).

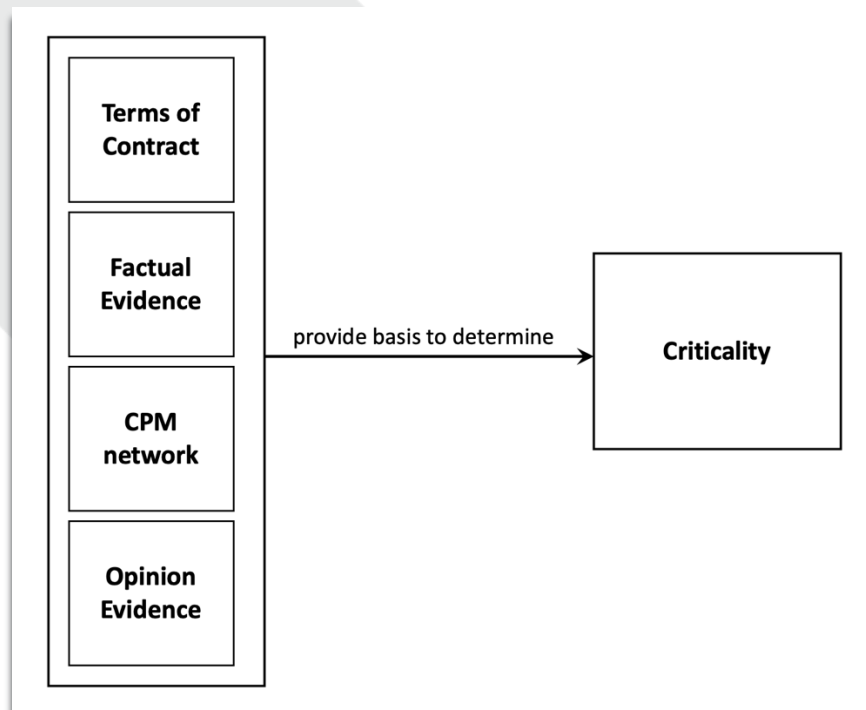
<sup>9</sup> Keith Pickavance, "Extensions of Time – An Arbitrator's perspective", International Construction Law Review, 2003, p.367.

<sup>10</sup> For detailed discussion on first causation, reference Timothy Whealy and Muhammad Imran Chaudhary, "Delay Events in Construction Delay Claim, Const. L.J. Issue 1 2022.

<sup>11</sup> "...witness [of facts] can give evidence only on facts of which he has personal knowledge-something which he has perceived with one of his five senses.," Robert Fenwick Elliott, "Building Contract Disputes: Practice and Precedents", 13th edition (London: Sweet & Maxwell, Thomson), para 10-3.

<sup>12</sup> Contemporaneous project records include communications which were issued at the time such as letters, emails, minutes of meetings, progress photographs, progress of works reports, daily manpower reports, site inspection requests, request for information, request for approval, registers for procurement/progress of works/interim payment applications and certificates, drawings, instructions etc.

upon by the parties in dispute.<sup>13</sup> Opinion evidence is produced by experts in the field to which the dispute relates,<sup>14</sup> which generally relates to technically complex matters that are beyond a judge's and/or arbitrator's sphere of expertise. The foregoing is shown in the figure below:



**Figure 2: Four aspects of determining criticality**

The four aspects mentioned above, upon which criticality is determined, are now discussed below.

### **First Basis: Criticality in Contract (Terms of contract)**

It is important to initially check the meaning of criticality under the contract. Even if a work activity is critical in fact, or critical based on CPM network or critical in the opinion of an expert, the work activity will not be considered critical in the context of the veracity of an extension of time claim if the terms of contract suggest otherwise.

For example, in *Glenlion*,<sup>15</sup> the contractor's approved programme of works provided for a completion date before the prescribed date for completion included in the contract.<sup>16</sup> The contractor was entitled, under the contract, to carry out the works in accordance with the programme. One of the disputes between the parties was whether a term was implied into the contract that would oblige the owner or its agents to perform the contract in such a way that would facilitate the contractor achieving the early completion date indicated in its approved programme. In other words,

<sup>13</sup> "Critical Path Method (CPM). The methodology or management technique that, through the use of calculation rules (usually automatically carried out by programming software), determines the critical path and calculates float.", The Society of Construction Law (SCL), 2nd edition Delay and Disruption Protocol, p.62.

<sup>14</sup> Richard Wilmot-Smith QC, *Wilmot-Smith on Construction Contracts*, 3rd edition(Oxford: OUP, 2014), para 23.125 at p.686.

<sup>15</sup> *Glenlion Construction Ltd v The Guinness Trust* (1987) 39 BLR 89.

<sup>16</sup> Standard Form of Building Contract, 1963 edition, with quantities, Joint Contracts Tribunal.

which completion date was to be used to determine criticality of works – the early completion date as shown in the programme, or the completion date stated in contract. The obvious point being from which date would entitlement to an extension of time commence.

HHJ Fox-Andrews QC held that there was no such implied term, or in other words the early completion date could not be used as a reference point to determine criticality of works and therefore would not be the starting point for the award of an extension of time. The judge stated:

*“...It is not suggested by Glenlion [contractor] that they were both entitled and obliged to finish by the earlier completion date. If there is such an implied term it imposed obligation on the Trust [owner] but none on Glenlion.....A fair and reasonable extension of time for completion of the works beyond the date for completion stated in [contract] might be an unfair and unreasonable extension from an earlier date... The unilateral imposition of a different completion date [i.e. early completion date as per programme] would result in the whole balance of the contract being lost...”<sup>17</sup>*

In programming, float<sup>18</sup> is calculated during backward pass calculations.<sup>19</sup> A backward pass starts from the end date of a network and calculates ‘free float’<sup>20</sup> and ‘total float’<sup>21</sup>. However, in circumstances where the planned completion date as per CPM network is before the contractually

prescribed completion date, a third type of float, “terminal float”<sup>22</sup>, will be created between the end date of CPM network and contractually prescribed completion date. In such a scenario, programming, and construction professionals may view criticality from the end date of CPM network which would not be a correct view of criticality as per *Glenlion*.

However, the situation as to early completion date may be different if the terms of contract are different from those governing the *Glenlion* case. For example, entitlement to an extension of time under FIDIC Red Book 2017 states the following:<sup>23</sup>

*“The Contractor shall be entitled subject to Sub-Clause 20.2 [Claims For Payment and/or EOT] to Extension of*

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<sup>17</sup> Ibid. pp.103-104.

<sup>18</sup> The Society of Construction Law (SCL), 2nd edition Delay and Disruption Protocol, at p.64, defines ‘float’ as follows: “The time available for an activity in addition to its planned duration.”

<sup>19</sup> James J. O’Brien and Fredric L. Plotnick, *CPM in Construction Management*, 8th edition (USA: McGraw Hill Education), pp.118-120.

<sup>20</sup> The Society of Construction Law (SCL), 2nd edition Delay and Disruption Protocol, at p.64, defines ‘free float’ as follows: “The amount of time that an activity can be delayed beyond its early start/early finish dates without delaying the early start or early finish of any immediately following activity.”

<sup>21</sup> Ibid, at p.71, defines ‘total float’ as follows: “The amount of time that an activity may be delayed beyond its early start/early finish dates without delaying the contract completion date.”

<sup>22</sup> Terminal float is defined as “the period between when the Contractor plans to achieve completion and the time for completion” Ellis Baker, Ben Mellors, Scott Chalmers, Anthony Lavers, *FIDIC Contracts: Law and Practice*, 5th edition (Routledge Taylor & Francis Group, 2009), para 8.271 at p.469.

<sup>23</sup> Refer to Sub-Clause 8.5 of FIDIC Conditions of Contract for Construction, 2nd edition 2017.



*Time if and to the extent that completion for the purposes of Sub-Clause 10.1 [Taking Over the Works and Sections] is or will be delayed by any of the following causes..”*

It is interesting to note that the planned date for Taking Over the Works may pre-date the time specified as the Time for Completion. In such circumstances, if one of the listed events arises and critically delays the planned date for Taking Over the Works, the contractor shall be entitled to an extension of time, even if the projected/delayed date for Taking Over does not extend the Time for Completion.

The *Glenlion* and FIDIC Red Book 2017, as stated above, highlight that the terms of contract are paramount in determining criticality and the resultant affect.

### **Second Basis: Criticality in Fact (Factual evidence)**

The Critical Path Method (CPM) network was first developed in 1956.<sup>24</sup> CPM network is generally prepared and monitored using computer aided programmes such as Primavera. It is sometimes said in practice that the critical status of an activity cannot be known without a CPM network. Whereas the UK courts have resolved construction delay disputes for decades prior to 1956. Therefore, it is important to appreciate how criticality was analysed and resolved by the courts, prior to 1956, i.e., without the aid of CPM networks and computer-based programmes.

In determining criticality without the aid of computer-based CPM networks, the process adopted by UK courts, based on understanding of pre-1956 judgements, had been to (1) examine testimony from witnesses of fact, and contemporaneous project records with the aim of establishing the actual construction sequence and logic, (2) ascertain the requirement for client provided information and/or contractor provided resources required at the time of the delay (the “need element”), (3) understand the parties’ contemporaneous conduct and (4) to establish any inconsistencies in evidence presented. These factual techniques are applied in modern UK court cases as well. In the Scottish case of *City Inn*<sup>25</sup> Lord Drummond Young stated:

*“I think it necessary to revert to the methods that were in use before computer software came to be used extensively in the programming of complex construction contracts... Those older methods are still plainly valid, and if computer-based techniques cannot be used accurately there is no alternative to using older, non-computer-based techniques.”<sup>26</sup>*

The non-computer based factual techniques are explained below aided with reference to old and modern UK court cases.

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<sup>24</sup> James J. O’Brien and Fredric L. Plotnick, *CPM in Construction Management*, 8th edition (USA: McGraw Hill Education), p.9.

<sup>25</sup> *City Inn Limited v Shepherd Construction Limited* [2008] B.L.R. 269; (2008) 24 Const. LJ 590.

<sup>26</sup> *Ibid.* Paragraph 29.

## (1) Construction Sequence and Logic

The following cases demonstrate that courts have relied on construction logic as a main basis of determining criticality of works simply because it is a common-sense approach.

### Freeman and Son v Hensler<sup>27</sup>

A contractor agreed to demolish 15 houses and erect 12 new houses on the site for the developer within six months from the date of contract. By agreement, the commencement and date of completion were postponed for two weeks. Following that, possession of site was not provided holistically as intended, but in a piecemeal manner with possession of the area for the last house only being given one month before the contract completion date.

The site for the last house should have been given much earlier if the construction works for the last house were critical with respect to the overall contract completion date. The trial judge held that an implied term in the contract was that possession of the site was to be given within a reasonable time and the developer had complied with that. In other words, the Judge did not consider that completion of the last house was critical at the time when possession was actually given.

The Court of Appeal reversed the trial judge's judgement. Lord Justice A.L. Smith established the overall construction logic to determine criticality of the works relating to the final house and hence the requirement for timeous site possession for that final plot of land. LJ Smith quoted a term from the contract "*The brickwork is to be carried up simultaneously all around: no portion to be more than five feet in advance of any other at any time*". Lord Justice Romer stated "*...the fact that they were to be built practically as one house is borne out by the provision as to the bricklaying...*". Accordingly, LJ Smith stated that the reasonable time within which possession of the whole site was required ended on the expiry of the fortnight period of postponement; thereafter any late possession would be deemed critical. In other words, the works associated with the final house were critical immediately upon expiry of the period of postponement.

### Wells v Army and Navy Co-operative Society<sup>28</sup>

If the construction logic is – joinery works can start after brick masonry – it does not necessarily mean that joinery works cannot be critical until brick masonry is finished. In fact, a contractor must prepare shop drawings and start joinery shop works before the brick masonry is finished.

In *Wells*, Lord Justice Vaughan Williams stated the construction logic and criticality of joinery works in relation to house construction was as follows:

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<sup>27</sup> *Freeman and Son v Hensler* [1900] Hudson Fourth Edition (Volume 2) (London: Sweet & Maxwell, 1914 reprinted 2001), pp.292-297.

<sup>28</sup> *Wells v Army and Navy Co-operative Society* (1902) Hudson Fourth Edition (Volume 2) (London: Sweet & Maxwell, 1914 reprinted 2001), pp.354-361.

*“...common sense would tell anyone that, if you have a big job of this sort to carry out, the contractor will start his shops almost immediately, including his joinery shop, and if the joinery is to be properly executed with seasoned stuff, it is idle to suggest that he is not to begin his joinery work until the time when his building, his plastering, and all the rest of it has been done.”<sup>29</sup>*

Walter Lilly v Mackay<sup>30</sup>

In *Walter Lilly*, Mr Justice Akenhead emphasised that logic is one of the most powerful factors when determining criticality of works:

*“... This was a wholly logical approach... The logic is simply that if there are, say, two outstanding items of work, A and B, and A is always going to take 20 weeks to complete but B is only going to take 10 weeks, it is A which is delaying the work because B is going to finish earlier; overall completion is therefore dictated by the length of time needed for A. Put another way, it does not matter if B takes 19 weeks, it will be the completion of A which has prevented completion...”<sup>31</sup>*

The above cases demonstrate that construction logic in fact has been an important factor when determining criticality.

**(2) “Need Element”**

Late release of design or instruction or of an area of work or late approval are commonly submitted as critical events in most extension of time claims. Arbitrators are keen in finding “...whether the information was only late by reference to an early programme or by reference to a specific request in writing which asked for information long before it was needed”.<sup>32</sup> If something was needed at the time to proceed with the execution of works, and it was not provided, it is highly probable that such information was critical. The undernoted case, as explained below, highlights the importance of the “need element”.

Sattin v Poole<sup>33</sup>

Justice Phillimore when analysing the factual evidence emphasised that if something was not needed at site by a specific date, it was not critical until it was really required at site:

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<sup>29</sup> Ibid, p.358

<sup>30</sup> *Walter Lilly & Company Limited v Giles Patrick Cyril Mackay, DMW Developments Limited v Army and Navy Co-operative Society* [2012] EWHC 1773 (TCC); [2012] B.L.R. 503.

<sup>31</sup> Ibid, para. 378.

<sup>32</sup> Richard Wilmot-Smith QC, *Wilmot-Smith on Construction Contracts*, 3rd edition (Oxford: OUP, 2014), para 14.46 at p.370.

<sup>33</sup> *Sattin v Poole* [1901] Hudson Fourth Edition (Volume 2) (London: Sweet & Maxwell, 1914 reprinted 2001), pp.306-316.

*“...builder gets behind and vastly behind. Then some instruction...some order...some supply of an article...is delayed. It is useless to give a builder an order for something till he has got a certain stage in his work. Probably the order has been kept back because until the building has reached a certain stage...certainly it is undesirable to send some delicate piece of work to lie about the works till it is really wanted.”<sup>34</sup>*

Adyard Abu Dhabi v SD Marine<sup>35</sup>

Justice Hamblen when analysing expert evidence gave a useful example and emphasised that the ‘need’ for an instruction should be considered at the time.

*“Assuming (as is in fact appropriate in the present case) that the Contractor is many months in delay by reason of its own default. The Employer decides a week before the (original unextended) contract completion date that he wishes a wall to be painted blue instead of the contractually specified red. At the time of the instruction, because of the Contractor’s delays, the wall is not even built yet. The paint will take 5 weeks to procure, but will still arrive before the completion of the wall and the date upon which the Contractor would require the paint in line with his delayed progress. Mr. Swan’s [Claimant’s delay expert’s] analysis would appear to entitle the Contractor to 4 weeks’ extension of time (by adding 5 weeks to the date of impact, and comparing with the original contract completion date). However, I would suggest that common sense tells the observer that such an extension was neither fair nor reasonable, where the employer’s action have not actually delayed the progress of the Contractor by a single day.”<sup>36</sup>*

In each case – whether something was really needed at site at the time – is a fact sensitive matter which is decided on balance of probabilities. Therefore, the need element is another important factor that determines factual criticality.

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<sup>34</sup> Ibid. p.314.

<sup>35</sup> Adyard Abu Dhabi v SD Marine Services [2011] EWHC 848 (Comm); [2011] B.L.R. 384.

<sup>36</sup> Ibid. Para 262.



### (3) Parties Contemporaneous Conduct

It is more probable that approval of a design drawing or a variation instruction was critical at the time if a party had repeatedly requested receipt of such information. In other words, it is difficult to believe that the necessary information etc. could be treated as critical whereby the party that sought such information was completely silent at the time it was required. Therefore, the parties' contemporaneous actions are another important factor in determining criticality of works.

#### Wells v Army and Navy Co-operative Society<sup>37</sup>

Justice Wright referred to project contemporaneous records and stated that if a party submits repeated requests for the issuance of information etc., it demonstrates its importance:

*"...other [details] urgently required on the 11th March, 14th March, and 7th and 20th April were not received until June or July or even later, and in each of these instances the details required seem to have been necessary and important. Remonstrances by the plaintiffs [contractor] on the 11th March, 30th April, 8th July, 22nd July, indicate their importance."*<sup>38</sup>

#### Great Eastern Hotel Company Ltd v John Laing Construction<sup>39</sup>

If both parties agree that certain work was critical at the time, it is more probable than not that such works were critical. Judges, when weighing evidence on the balance or probabilities, also consider criticality in the same way.

Judge Wilcox stated:

*"The parties accept that the temporary roof was critical to the whole Project and agree that the delays to the procurement and erection of the temporary roof caused a substantial delay to the project."*<sup>40</sup>

#### SABIC v Punj Lloyd<sup>41</sup>

In SABIC, Justice Stuart-Smith also decided criticality of works based on the parties' contemporaneous conduct:

*"The evidence that PFP [Passive Fire Protection] was regarded by all as critical during the Warning Period is overwhelming...SCL [defendant] report identified PFP and insulation as "on topmost critical path". SABIC [claimant] held the same view which continued through the month. By the end of the month it was Mr. Martin's [defendant's construction manager] view that application of PFP at current rates would keep PFP on the critical path and delay would result...On this evidence, I find that the parties believed PFP to be critical..."*<sup>42</sup>

The aforementioned cases suggest that the parties' contemporaneous actions (or inactions) are an important factor that influence the determination of factual criticality.

#### **(4) Inconsistent Evidence**

Like any other evidence, the evidence relating to criticality of works is also decided on the balance of probabilities. Therefore, inconsistent evidence can undermine the veracity of the submitting party's case.

In *Saga Cruises*,<sup>43</sup> a vessel owner engaged a contractor for certain repair and refurbishment works to the vessel. The contractor delivered the vessel late (contract date for completion being 2 March 2012), on 16 March 2012. The owner sued the contractor for delayed delivery of the vessel for the period between 2 and 16 March 2012. During this period, one aspect of the works, which was critical in the owner's opinion, were incomplete 'Bolidt Decking' which was to be installed in three stages: pouring, curing and finishing. The contractor's opinion was that these works were not critical. Judge Sara Cockerill disregarded the contractor's evidence relating to criticality as it was inconsistent:

*"The Owner's case was that pouring and curing could not have been done on the transfer voyage. Mr. Magnani [contractor's witness] suggested that all stages could have been done on the voyage...As regards pouring, I do not accept Mr. Magnani's evidence on this point, which was inconsistent not just with the evidence of Messrs Duguid and Shaw for the Owners, but more importantly with...(ii) his own acceptance that pouring can only be done in calm surroundings..."*<sup>44</sup>

In summary, criticality in fact is determined by reference to the construction logic, need, parties' contemporaneous actions (or inactions) and consistency of evidence.

#### **Third Basis: Criticality in CPM Network**

The CPM network is a unique planning and programming method because all activities from start to the end of the project are inter-related with logical relationships. These logical relationships inject life into the network and the network reacts dynamically when it is changed or updated with progress. Through the forward and backward passes,<sup>45</sup> the

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<sup>37</sup> *Wells v Army and Navy Co-operative Society* [1902] Hudson Fourth Edition (Volume 2) (London: Sweet & Maxwell, 1914 reprinted 2001), pp.346-361.

<sup>38</sup> *Ibid.* pp.351-352.

<sup>39</sup> *Great Eastern Hotel Co Ltd v John Laing Construction Ltd* [2005] EWHC 181 (TCC).

<sup>40</sup> *Ibid.* Para. 64.

<sup>41</sup> *SABIC UK Petrochemicals Limited v Punj Lloyd Limited and others* [2013] EWHC 2916 (QB).

<sup>42</sup> *Ibid.*, at para. 171.

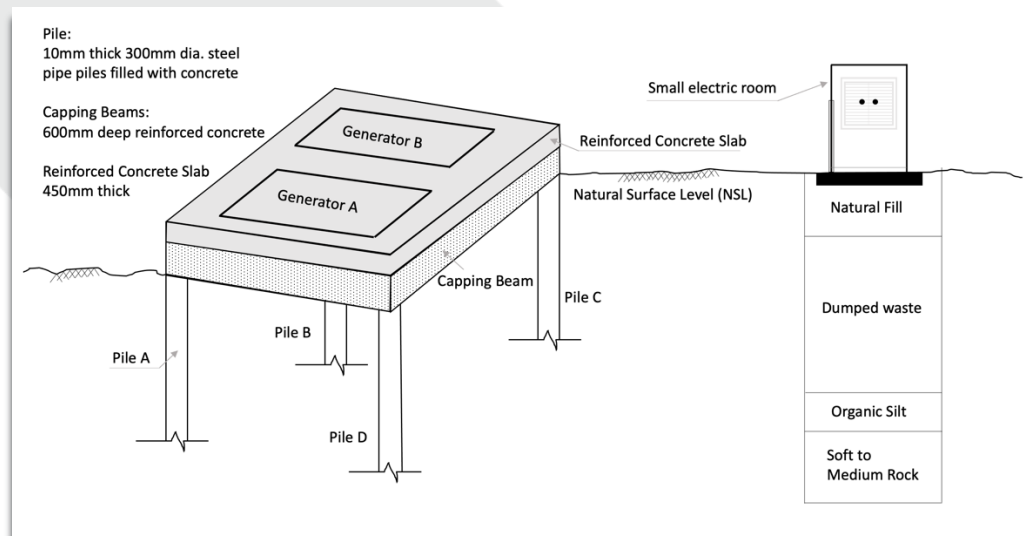
<sup>43</sup> *Saga Cruises BDF Limited v Fincantieri SPA* [2016] EWHC 1875 (Comm).

<sup>44</sup> *Ibid.*, at para 269.

<sup>45</sup> For further details, refer to: James J. O'Brien and Fredric L. Plotnick, *CPM in Construction Management*, 8th edition (USA: McGraw Hill Education), pp.117-120.

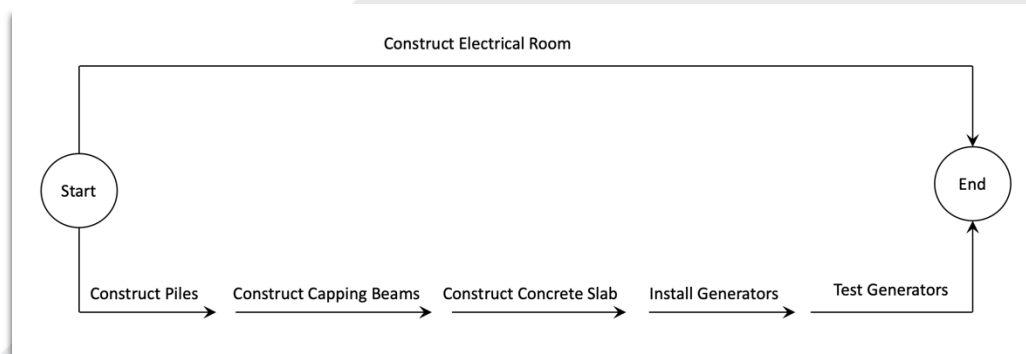
network creates float which is an important feature of CPM. The logic diagram is the most important single feature of CPM network.<sup>46</sup>

Take a very simple project example to understand CPM network and criticality. A contractor is required to construct foundation (piles, capping beams, and a slab) and procure, install and commission two generators in addition to the construction of a small electrical room as shown below:



**Figure 3: High level details of example project**

A pure logic diagram is developed first to understand which activity will precede or follow various activities.<sup>47</sup> Logic diagram of the example project is as follows:



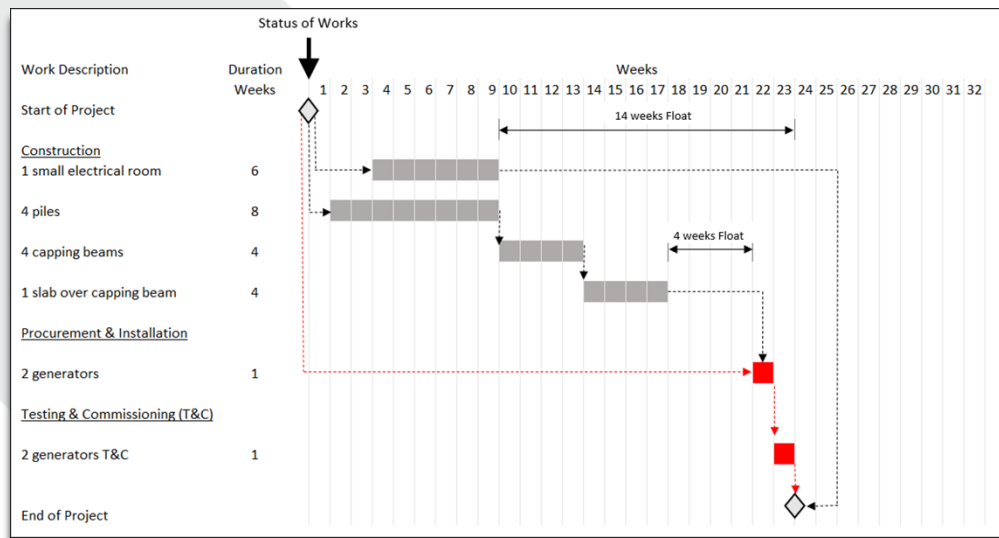
**Figure 4: Logic diagram of example project**

The logic diagram above shows that the electrical room works are stand-alone and unrelated to piles, capping beams, slab, and generators works. Whereas piles, capping beams, slab and installation and testing of generators are interlinked with finish-to-start relationships. For instance, capping beams cannot be cast unless piles are driven first and so on. A

<sup>46</sup> James J. O'Brien and Fredric L. Plotnick, *CPM in Construction Management*, 8th edition (USA: McGraw Hill Education), p.25.

<sup>47</sup> James J. O'Brien and Fredric L. Plotnick, *CPM in Construction Management*, 8th edition (USA: McGraw Hill Education), p.22.

project can be built in many ways.<sup>48</sup> One way to construct the example project as shown above, is as follows:



**Figure 5: As planned status of example project works**

Let us assume generators are long lead items and shall not be delivered to site before week 21 – this is a procurement constraint. Consequently, the foundation/concrete activities will have 4 weeks float. Project will finish at the end of week 23 as shown in the figure above.

The example project is procurement driven and the critical path from the start until week 21 passes through the procurement of generators and then installation to testing and commissioning of the generators.

The important points to note in the above programme are as follows:

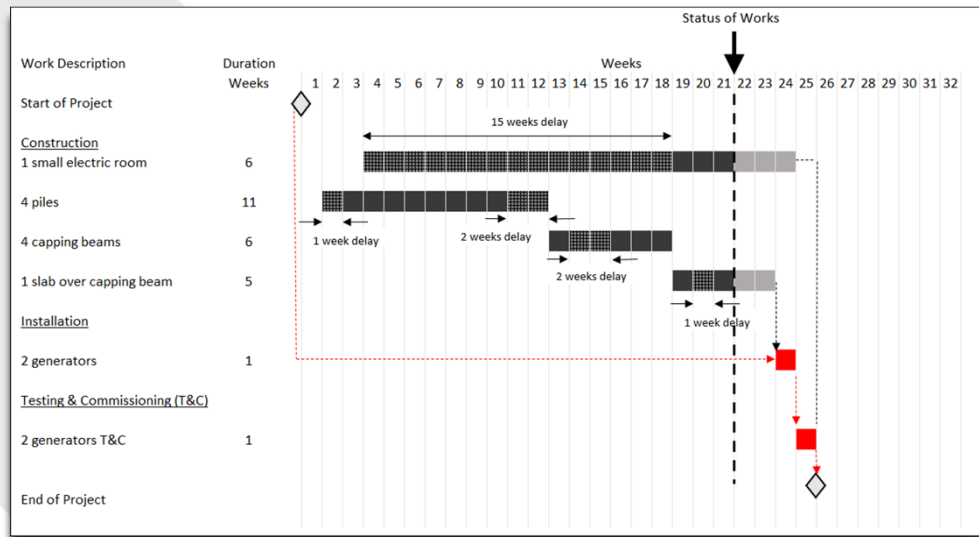
- (1) Procurement of generators is on the longest path, therefore critical during the first 21 weeks.<sup>49</sup>
- (2) The electrical room has a construction period of 6 weeks with 14 weeks float, therefore non-critical.<sup>50</sup>
- (3) Foundation works (piles, capping beams & slab) have 4 weeks float, therefore non-critical.

The project is progressed, and status of the project works at the end of week 21 is as follows:

<sup>48</sup> “There is no one correct way to sequence any construction project. Different sequences may be equally possible, logical and reasonable. There are many ways to complete any project. Personal choices of various managers play an important role in sequencing. Differences between two schedules thus do not necessarily make one incorrect...” Michael T. Callahan, Daniel G. Quackenbush and James E. Rowing, “Construction Project Scheduling” (USA: McGraw-Hill Series in Construction and Engineering and Project Management, 1992), p.55.

<sup>49</sup> The Society of Construction Law (SCL), 2nd edition Delay and Disruption Protocol, at p.62, defines critical path as follows: “The longest sequence of activities through a project network from start to finish, the sum of whose durations determines the overall project duration. There may be more than one critical path depending on workflow logic. A delay to progress of any activity on the critical path will, without acceleration or re-sequencing, cause the overall project duration to be extended, and is therefore referred to as a ‘critical delay’.”

<sup>50</sup> Electrical room works have float therefore non-critical.



**Figure 6: Actual status of example project works at week 21**

The status of the project at week 21 indicates that electrical room and foundation works are late by 15 and 6 weeks respectively, and overall completion of project is delayed by 2 weeks, from week 23 to 25.

At week 21, following questions arise:

- (1) Is electrical room critical?
- (2) Is slab over capping beam critical?
- (3) Is procurement of generator critical?
- (4) What is the route of critical path?

In reality, construction projects are complex with thousands of programme activities involved.<sup>51</sup> Therefore, programming experts are required in formal dispute resolution process to provide their expert opinion on the questions similar, but more complex, to the example above.

#### **Fourth Basis: Criticality in an Expert's Opinion (Opinion evidence)**

Expert evidence or expert opinion is needed on a matter which a judge or an arbitrator cannot normally inform itself,<sup>52</sup> due to lack of expertise/knowledge in such specialist subject. Opinion evidence is not evidence of fact but an opinion on the facts and may entail assumptions based on personal experience and expertise. In construction disputes, expert opinion is generally provided by engineers of various disciplines, surveyors, accountants, programming experts, project managers etc.

The start/finish dates, activities duration, constraints on activities, working hours, relationships between activities, percentage progress complete, remaining duration of activities, causes of delay to individual activities and completion of work as a whole are all issues of facts. These facts are established through the contemporaneous project records and witnesses

<sup>51</sup> The project in *Vivergo* case consisted of more than 13,000 activities. *Vivergo Fuels Limited v Redhall Engineering Solutions Limited* [2013] EWHC 4030 (TCC) at paragraph [291].

<sup>52</sup> Richard Wilmot-Smith QC, *Wilmot-Smith on Construction Contracts*, 3rd edition (Oxford: OUP, 2014), paragraph 23.125 at p.686.



of fact; therefore, expert evidence may be inadmissible on such matters.<sup>53</sup> Likewise, criticality is a factual issue, and an expert opinion in itself does not determine if an activity is critical.

*“The key opinion evidence produced by a programming expert is usually the location or route of the critical path.”*<sup>54</sup> Location or route of the critical path means the chain of critical works in a given timeframe or window in a programme. In providing expert opinion on criticality, an expert generally focuses on various aspect such as (1) longest sequence of outstanding works, (2) logic, (3) complexity and geographical position of the works and (4) break in chain of criticality. These aspects, and judges’ view on them, are explained below with the assistance of, and reliance on case law.

### Longest Sequence of Outstanding Works

The experts consider those outstanding works critical if they form the longest sequence of project activities at a given time.

*In Walter Lilly*,<sup>55</sup> Mr Justice Robert Akenhead explained the conventional approach used by programming experts to determine what was delaying the works at a point in time (i.e., criticality) and thereafter also provided his own opinion, as follows:

*“Mr. Robinson [claimant’s programming expert] had regard to the likely longest sequence of the outstanding work on a monthly basis as being the primary pointer to what was delaying the work at any one time. This was a wholly logical approach and, indeed is the approach used by most delay experts when there is a usable baseline programme from which ...”*<sup>56</sup>

Mr Justice Robert Akenhead in determining if “Leather works in Library” were critical in one-month window, stated:

*“Mr. Robinson’s view...with which I concur, is that on any proper analysis the Works were being critically delayed by the delayed instructions in relation to the design, procurement and installation of the Leather in the Library. This was a significant item of work and it had the longest sequence as at that stage; all things being equal, if there had been no problem either with the procurement of the Leather or with anything else, the Works would not and could not have been practically complete before the Leather work in the Library had been completed...”*<sup>57</sup>

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<sup>53</sup> Stephen Furst QC and Sir Vivian Ramsey, *Keating on Construction Contracts*, 11th edition (London: Sweet & Maxwell, 2021), paragraph 8-059.

<sup>54</sup> *Ibid.*

<sup>55</sup> *Walter Lilly & Company Limited v Giles Patrick Cyril Mackay, DMW Developments Limited v Army and Navy Co-operative Society* [2012] EWHC 1773 (TCC); [2012] B.L.R. 503.

<sup>56</sup> *Ibid.* Para.[378].

<sup>57</sup> *Ibid.* Para.[397].

In *City Inn*<sup>58</sup>, Lord Drummond Young highlighted the importance of outstanding works at a given point in time in relation to criticality:

*“In my opinion...at that stage any work that is still outstanding if it is essential for the usable occupation of the building, must necessarily be critical...”*<sup>59</sup>

The above cases suggest that the outstanding activities that fall on the longest sequence of works at any point in time are considered critical. Applying this rationale to our example project provided above, at week 21, outstanding works are 3 weeks for electric room and 4 weeks for generators. Therefore, it appears that concrete slab and installation/testing of generator works form longest chain of outstanding works, hence critical.

### Logic

An expert opinion, which is premised on sensible and persuasive logic, carry more weight than if such opinion is founded on an illogical base.

In *City Inn*<sup>60</sup>, Lord Drummond Young emphasised that incorrect logic links between activities in CPM network could affect criticality and if there are several such errors it could possibly destroy or impair the legal basis of the whole programme:

*“It is in my opinion clear that such a programme is critically dependent upon the logic links between different activities...I am of opinion that Mr Whitaker [defender’s programming expert] must be correct when he states that an error in one logic link can vitiate the whole programme, and errors in a number of links will almost inevitably vitiate the programme...Mr Lowe [pursuer’s programming expert] was asked about the link between line 17 and line 57...In cross-examination he had accepted that the link should have been start-start rather finish-finish, and accepted that that could render line 17 non-critical...”*<sup>61</sup>

In *Walter Lilly*<sup>62</sup>, Mr. Robinson and Dr. Aldridge were the programming experts for the claimant and defendant, respectively. Mr Justice Robert Akenhead emphasised the importance of correct logic while comparing the expert reports:

*“...I preferred Mr Robinson in almost every respect. He, broadly, logically and conventionally, adopted the approach of establishing critical delay by reference to the “logical sequence(s) of events which marked the longest path through the project”...Dr Aldridge’s*

<sup>58</sup> *City Inn Limited v Shepherd Construction Limited* [2008] B.L.R [269]; (2008) 24 Const. LJ 590.

<sup>59</sup> *Ibid.* Para [124].

<sup>60</sup> *City Inn Limited v Shepherd Construction Limited* [2008] B.L.R [269]; (2008) 24 Const. LJ 590.

<sup>61</sup> *Ibid.* Para [38].

<sup>62</sup> *Walter Lilly & Company Limited v Giles Patrick Cyril Mackay, DMW Developments Limited v Army and Navy Co-operative Society* [2012] EWHC 1773 (TCC); [2012] B.L.R. 503.

*report...is littered with this type of remark that WLC [claimant] has failed to prove or demonstrate this or that or to make out its case; it is not for an expert to suggest this type of things. He proceeds on an obvious logical misapprehension that if works are finished before Practical Completion, they cannot have delayed completion. His suggestion that plastering defects delays could realistically have contributed to the overall delay is simply unsustainable in circumstances in which there was ultimately a limited amount of remedial work actually done...*<sup>63</sup>

Mr Justice Robert Akenhead further stated:

*“...Another serious flaw in the approach adopted by Dr Aldridge was his willingness to proceed on the basis that one could ignore a number of the possible causes of delay in so far as they affected work which might have been (but which was not) omitted by DMW [owner] or its Architect. By doing this, he...undermine various possible causes of delay as being causative because he could say that, if a particular item of work could or might be omitted, it could not be causing a delay. This was wholly illogical...”*<sup>64</sup>

In *Obrascon*<sup>65</sup>, Justice Robert Akenhead emphasised the importance of logic in expert reports:

*“Programming experts, at least the good ones, help the Court to concentrate on the logic not only of the original (baseline) programme to which the contractor in question was working but also what was driving progress or a lack of it on key parts of the work at key times.”*<sup>66</sup>

Take a scenario, a critical activity B can only start when activity A is finished, and activity A has float:

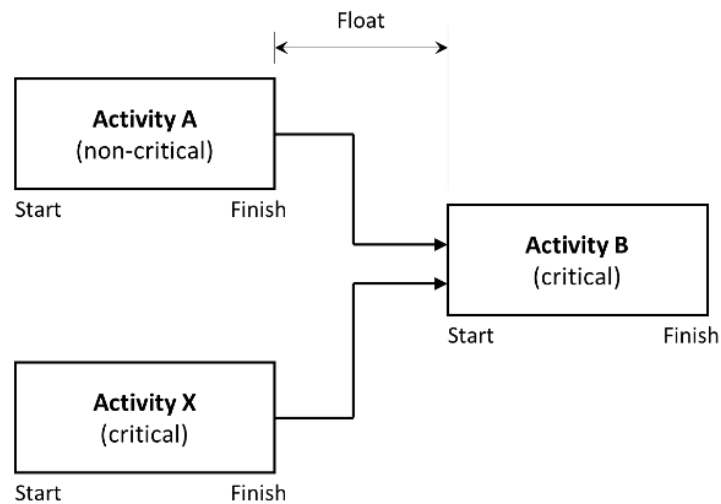
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<sup>63</sup> Ibid. Para [98] and [99].

<sup>64</sup> Ibid. Para. [375].

<sup>65</sup> *Obrascon Huarte Lain SA v Attorney General For Gibraltar* [2014] EWHC 1028 (TCC).

<sup>66</sup> Ibid. Para.[272].



**Figure 7: Relationship of Activities A and B**

From a planning and programming perspective, we need to start critical activity B by the start date – early or late start, both of which are the same because the activity is critical. However, we *do not* want to complete non-critical activity A by late finish date thus pushing that work to a new critical path, but we *want* activity A to be complete by early finish date.<sup>67</sup> In circumstances, where activity A was delayed beyond the available float and activity B was not ready to start in any event regardless of completion of activity A, parties to contract take the position which suits them after the fact. The party responsible for delay to activity A would argue that the delay to commencement of activity B has in fact created further float for activity A. Whereas party responsible for the delay in commencement of activity B would argue that delay to activity B does not matter because activity B cannot start in any case until activity A is finished first as per the logic.

The above scenario is a fact sensitive matter and requires close examination of the facts and requires expert opinion. The contemporaneous evidence, a party's ability to complete activity A/B and actual progress achieved on activity A/B would provide useful background to determine which activity was actually critical when activity A exceeded the initial float between commencement of activity B.

Going back to our example project, the question – whether slab over capping beam was critical or procurement of generators – is a similar scenario as discussed for activity A/B in the preceding paragraph, therefore this is a fact sensitive matter which may also require an expert opinion .

#### Complexity and Geographical Position

Sometimes, a simple review of a programme of works reveals that an aspect or area of the works requires focussed attention from a planning, execution, and control perspective due to its complexity and/or

<sup>67</sup> This logic is taken from: James J. O'Brien and Fredric L. Plotnick, *CPM in Construction Management*, 8th edition (USA: McGraw Hill Education), p.114.

geographical position in the overall works. For example, in an auditorium project, although many halls, exhibition areas, roads and car parks are required, the auditorium hall itself is the most complex area of work due to complexity of constructing a theatre, its unique lighting, sound control systems, building management system, various levels, sitting arrangements, zones-wise seating arrangements, unique HVAC features, iconic internal architecture, internal height and its less symmetrical areas of works.

In determining criticality, experts and judges keenly observe such features of a project. In *Obrascon*<sup>68</sup>, the experts and Mr Justice Robert Akenhead noted these elements as well:

*“The programming experts are agreed that the completion of the tunnel design and the subsequent tunnel construction were the critical areas of work for programming purposes... This is obvious not just from the durations shown on the baseline programme. It was the single most complex area of work and its geographical position right in the center of the twin carriageway on the relatively narrow site was such that unless and until it was substantially and sufficiently complete it would be difficult to progress to completion much of the rest of the work...”*<sup>69</sup>

Therefore, the complexity of a certain aspect of a project may indicate that such works were critical.

### Break in Chain of Criticality

Just like a break in chain of causation, there may be a break in chain of criticality as well. When an activity loses its critical status during progress of works, it is treated as non-critical from that point onward.

*“The basic concept of CPM is that each activity may start only at a point in time after the finish, or 100 percent completion of all predecessors to that activity”.*<sup>70</sup> Therefore, once a critical activity is 100% complete, the criticality will shift to its successor critical activity. However, experience suggests that a successor activity usually starts when predecessor activity is not 100% complete. Therefore, from a scheduler’s perspective, an activity is 100% complete when its successor activity is capable to have a meaningful start.<sup>71</sup>

For example, logic in a programme is that brick masonry will start when the foundation for whole of zone A is completed. In reality, brick masonry may start in zone A even if foundation works at some corners of zone A were not finished. Facts and common-sense supersede the logic and basic concept of CPM as well, as stated above. In such a scenario, following logic blindly and ignoring the facts could be seen as illogical and

<sup>68</sup> *Obrascon Huarte Lain SA v Her Majesty’s Attorney General For Gibraltar* [2014] EWHC 1028 (TCC).

<sup>69</sup> *Ibid.* Para. [276].

<sup>70</sup> James J. O’Brien and Fredric L. Plotnick, *CPM in Construction Management*, 8th edition (USA: McGraw Hill Education), p.173.

<sup>71</sup> *Ibid.* p.153.



lacking common-sense. In formal dispute resolution, programming experts generally do not agree on a point in time when criticality shifts from one activity to other.

In *Obrascon*<sup>72</sup>, Justice Robert Akenhead highlighted the break in chain of criticality as follows:

*“The experts then divide as to whether the critical path ran through the northern part (Mr. Crane’s view) or the southern part (Mr. Palles-Clark’s view). Mr. Palles-Clark says broadly that because there was more work in the southern section and more panels in the airside section and these would finish later than the northern section, the south must be more critical. I disagree and accept the logic of Mr. Crane’s view which is that it was never going to be necessary to complete all the diaphragm wall panels in either the northern or southern section before starting with the next critical item of work, known as the “Pavement Exposed Excavation” (“PEE”)...I agree that PEE could have started on about 24 September 2010... The fact that the PEE work could not proceed then does not mean that this area of the work was not critical. This points to the northern section of the tunnel diaphragm wall panels being critical in the result.”*<sup>73</sup>

Therefore, break in chain of criticality is another important factor that influence the critical status of activities.

#### Inconsistent Expert Opinion

In circumstances where experts change their opinion on criticality during proceedings, judges afford little weight to such expert opinion because of the change in position.

In *Great Eastern Hotel*,<sup>74</sup> Judge Wilcox stated:

*“Mr. Celetka ultimately, in cross-examination, as he had to, revised his opinion as to the criticality of the protection of the Railtrack services to the project. His failure to consider the contemporary documentary evidence photographs...led me to the conclusion that little weight can be attached to his evidence...I sadly conclude that he has no concept of his duty to the court as an independent expert...”*<sup>75</sup>

In summary, a programming expert provides his opinion on criticality of works by reference to the longest sequence of outstanding works, logic, complexity and geographical position of the works and break in chain of

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<sup>72</sup> *Obrascon Huarte Lain SA v Her Majesty’s Attorney General For Gibraltar* [2014] EWHC 1028 (TCC).

<sup>73</sup> *Ibid.* Para. [286].

<sup>74</sup> *Great Eastern Hotel Company Ltd v John Laing Construction* [2005] EWHC 181 (TCC).

<sup>75</sup> *Ibid.* Para. [128].

criticality. Revision of opinion during cross-examination is likely to undermine the credibility of the expert's report and of its findings.

### **Conclusion**

In analysing what delayed project completion, it is of utmost importance to know what activities were critical. Criticality of elements of work/activities is a factual matter. Therefore, a CPM network or computer-based programme or an expert opinion do not in themselves determine that certain activities were critical. Rather, the facts or an expert's opinion on the facts inform a tribunal what works were critical at the time.

The textbook definitions or mathematical explanation of critical works are often not helpful in a formal dispute resolution process. Parties to contract, witnesses of facts and programming experts often disagree on what activities were critical at the time that the delaying impact was experienced.

The answer to the question – what is meant by critical? – should be approached from four different angles – criticality in contract, criticality in fact, criticality in CPM network and criticality in an expert's opinion.

Criticality in contract is determined by reference to the terms of contract. Criticality in fact is determined by weighing up and considering the contemporaneous project records and witnesses of fact with respect to logic, need, parties' contemporaneous actions and consistency of evidence. Criticality in a CPM network or computer-based programme is determined by reference to the such CPM network or computer-based programme. Criticality in an expert's opinion is an opinion on the route of the critical path and/or break in chain of criticality.

It must be borne in mind that a CPM network or a computer-based programme is as reliable as the factual data inserted into such programme. Similarly, the weight afforded an expert's opinion is dependent upon the facts upon which it is founded.

As criticality is a factual issue, therefore one should not forget that facts are determined on balance of probabilities. Any inconsistency "fact" or opinion will be detrimental to the party that relies on such facts.