CONSTRUCTION LAW INTERNATIONAL

FROM THE IBA INTERNATIONAL CONSTRUCTION PROJECTS COMMITTEE OF THE ENERGY ENVIRONMENT, NATURAL RESOURCES AND INFRASTRUCTURE LAW SECTION (SEERIL)

Vol 13 ISSUE 3 **ISSN 1819-1371** **NOVEMBER 2018**

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Forensic schedule analysis methods

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November 2018

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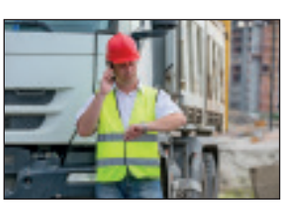

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Cover: A skyscraper boom in the City of London, which includes the 278 m (912 ft) 22 Bishopsgate, the tallest building ever to be constructed in the Square Mile. Credit: Joe Dunckley Shutterstock.

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FROM THE EDITORS

The third edition of *Construction Law International (CLInt)* 2018 includes, in addition to Country Updates and FIDIC Questionnaires, several feature articles analysing issues relating to schedule, delays and acceleration in construction projects.

Two articles were presented at the International Construction Projects (ICP) Working Weekend held in May 2018 in the Netherlands: one by John Livengood and Patrick M Kelly, who compare the use of different methodologies in forensic schedule analyses; and one by Douglas Stuart Oles, who comments on the lawyers' point of view of delay analyses.

In addition to the above, Rob D'Onofrio, Shona Frame and Laura McEwen examine the laws applicable to delay issues in the United Kingdom and the United States. Alexander Voigt, Moneer Khalaf, Adam Clements and Sam Mattar compare two of the most reliable lost productivity quantifying methods, which are the 'measured mile' method and the 'system dynamics' method in relation to disruption damages claims. Finally, Thomas Long discusses methods to ensure continuity in analysing delay.

Among the feature articles, this edition also includes an article from Sandra Somers highlighting the limited involvement of expert women in the construction industry.

The Country Updates offer an analysis of the application of the principle of good faith under English law, by Shy Jackson, and Egyptian law, by Waleed El Nemr. The different applications of the principle of good faith in common law and civil law jurisdictions is highlighted in these articles.

This edition also includes answers to *CLInt* FIDIC Questionnaire according to three jurisdictions: Hungary, Kazakhstan and Nigeria.

We hope that our readers will find this edition highly informative and we invite everyone interested in contributing to *CLInt* to submit a draft article to CLInt.submissions@int-bar.org.

We finally must inform our readers that the second part of Evelien Bruggeman's article titled 'Legal aspects of Building Information Modelling (BIM) in The Netherlands: the procurement of a work with a BIM component' will be published in the next edition of *CLInt* (Issue 4). The first part of her article was published in the July edition.

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FROM THE CO-CHAIRS

This issue of *Construction Law International* is very timely, as it arrives shortly after the 2018 IBA Annual Conference, which took place in Rome on 7–12 October.

As at prior IBA Annual Conferences, the International Construction Projects Committee (ICP) had five panels that were of great interest to all IBA members wishing to keep up with some of the most important issues encountered during the execution of construction projects all over the world. These issues were presented by distinguished speakers who offered their views from both common and civil law perspectives. The speakers were selected from those who volunteered following a general invitation made by the Co-Chairs via the ICP-net discussion forum. The response was overwhelming. The Co-Chairs were faced with the challenging task of selecting the speakers from a large number of applicants. They took into account not only the originality and relevance of the proposed topics for the presentations, but also considered their geographical origin, gender and legal background, while balancing the participation between newcomers and longstanding ICP members. As a result of our efforts, the ICP sessions were organised as described below.

On Tuesday 9 October at 09:30, Jane Davies Evans and our former Co-Chair, Bruce Reynolds, chaired the session 'Termination issues: actions for damages versus actions for wrongful termination'. Virginie Colaiuta, Edward Corbett, Shona Frame, Dimitris Kourkomelis, Thomas Stickler and Ian de Vaz discussed the consequences that derive from the termination of a construction contract, the legal grounds justifying termination of a contract and the claims for damages. The panellists analysed both strategic and practical issues and the papers prepared for this session have been reproduced in this edition of *CLInt*.

The second ICP session took place on Wednesday 10 October at 14:30 and focused on 'Project completion/handover issues: when final closeout is not final'. This session was chaired by Paul Cowan and Thomas Frad. Bill Barton, Christopher Beirise, Rony Vermeersch and Ana Candida de Mello Carvalho described the issues that owners and contractors usually face at the end of a project, and the completion and handover phase, such as the meaning of substantial completion, final completion and acceptance. They also covered the meaning of hot/cold/dry/wet commissioning.

Another session took place in the afternoon of Wednesday 10 October, relating to 'Consortium/joint venture issues: when friends are no longer friends', which was chaired by Sarah Sinclair and Jaime Gray. This session aimed to analyse how risks shape joint ventures and consortia, the need for joint and several liability to the owner, pre-bid agreements and what happens if one of the members refuses to enter into the final consortium/joint venture agreement. The speakers were Daniele Carminati, Ananya Kumar, Joseph Moore, David Ofosu-Dorte, George Rosenberg and Ioannis Vassardanis.

On Thursday 11 October at 11:15, Murray Armes and Andreas Roquette chaired the session 'Use and misuse of experts'. Kenneth Figueroa, Christian Johansen, Kim Rosenberg and Russel Thirgood discussed why the use and effectiveness of expert evidence is always in question. They also shared their positive and negative experiences when using experts, as well as their thoughts on what type of methodologies and techniques for assessing claims on extensions of time and additional compensation should be used and when. Their papers have been included in this edition of *CLInt*.

Finally, on Thursday 11 October at 16:15, Cheryl Feeley, Nicholas Gould, Tuomas Lehtinen and Sharon Vogel, under the leadership of Julio Bueno and Tony Dymond, acting as Co-Chairs, presented their experiences and proposals on the use of securities in construction contracts, including when to validly call a security, the enforceability of the same and what to do in case of improper calls.

Importantly, the IBA has defined a new format for the sessions of the Annual Conference. All the ICP sessions lasted 75 minutes, with the exception of the sessions 'Project completion/handover issues: when final closeout is not final' and 'Consortium/joint venture issues: when friends are no longer friends', which followed the old 180-minute format. If you have not already done so, please express your opinion on the new format by filling in the IBA questionnaire that was provided during the Annual Conference in Rome.

In addition to the above ICP sessions, the ICP organised a dinner for its members that took place on the Wednesday night in the wonderful restaurant Madre Roma, a lunch and an excursion to the historical harbour of Trajan on Friday.

We hope that both the sessions and the social functions were interesting and enjoyable. It was a pleasure to see you all in Rome!

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FIDIC around the world: Hungary

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In this questionnaire, references to FIDIC clauses are references to clauses in the 1999 FIDIC Red Book.

1. What is your jurisdiction?

Hungary.

2. Are the FIDIC forms of contract used for projects constructed in your jurisdiction? If yes, which of the FIDIC forms are used, and for what types of projects?

FIDIC forms of contracts are regularly used in domestic projects for construction of buildings, but also for civil engineering works, including large-scale infrastructure projects. The most common contract forms used in Hungary are the FIDIC Red Book (1999 version, as published in its Hungarian updated version in 2005) and the FIDIC Yellow Book (1999).

3. Do FIDIC produce their forms of contract in the language of your jurisdiction? If no, what language do you use?

The FIDIC forms of contract are translated into Hungarian (eg, in projects financed from State resources, only the Hungarian versions are used in practice).

4. Are any amendments required in order for the FIDIC Conditions of Contract to be operative in your jurisdiction? If yes, what amendments are required?

Certain supplemental provisions are necessary to be included in cases in which FIDIC contract forms are used for construction projects financed from State resources or if mandatory Hungarian construction law provisions so require. For example, in the case in which Contractor's fees will be paid from State resources under the construction contract, payment shall only be allowed if the Contractor provides a so-called negative tax certificate prior to the payment. Furthermore, mandatory construction law provisions oblige the Employer to assign a so-called construction trustee in cases in which the value of the project reaches the European Union threshold for public procurements.

5. Are any amendments common in your jurisdiction, albeit not required in order for the FIDIC Conditions of Contract to be operative in your jurisdiction? If yes, what (non-essential) amendments are common in your jurisdiction?

In the case of large-scale infrastructure projects, Employers prefer to exclude the applicability of Clause 10.2 of the FIDIC Red Book on deemed handover, which means that the use of the works by the Employer prior to the issuance of the Takeover-Handover Certificate shall not be regarded as a takeover of the works.

6. Does your jurisdiction treat Sub-Clause 2.5 of the 1999 suite of FIDIC contracts as a precondition to Employer claims (save for those expressly mentioned in the Sub-Clause)?

Yes, Hungarian State and arbitral courts generally consider Sub-Clause 2.5 as a precondition for the validation of Employer's claims. In the case in which an Employer attempts to validate claims or set-off against the Contractor without obtaining the Engineer's determination, the courts usually do not decide on such claims on their merits, but simply dismiss such claims on a formal basis. In the case of one arbitral award (see Oppenheim's note in *Construction Law International*, Vol 12 No 4, December 2017), the tribunal explicitly declared that such a dismissal (especially because the claim was brought forward as a set-off) shall not result in a *res iudicata*, which means that the Employer retained the right to validate its claim, provided it fulfilled all conditions contained in Sub-Clause 2.5 (ie, it obtained a proper determination from the Engineer).

7. Does your jurisdiction treat Sub-Clause 20.1 of the 1999 suite of FIDIC Contracts as a condition precedent to Contractor claims for additional time and/or money (not including Variations)?

Yes. Hungarian courts and tribunals are quite cautious about declaring claims time-barred because Hungarian law requires an explicit and clear agreement of the parties on exclusion deadlines. Because the time-bar provision in Clause 20.1 of FIDIC is sufficiently clear and explicitly formulated, Hungarian courts and arbitral tribunals generally acknowledge the validity of Sub-Clause 20.1 and reject Contractor's claims for additional time/money due to reasons other than Variations, where such claims were notified or elaborated later than the expiry of the deadlines set out in Sub-Clause 20.1.

8. Does your jurisdiction treat Sub-Clause 20.1 of the 1999 suite of FIDIC contracts as condition precedent to Contractor claims for additional time and/or money arising from Variations?

There is no unified practice regarding dealing with additional time/or money claims arising out of Variations. Some court decisions have declared that procedural provisions as set out in Sub-Clause 20.1 are also applicable to the validation of claims in connection with Variations, while others have stated that the Contractor shall be entitled to additional payment in the case in which the Engineer provided a clear instruction for the amendment of the scope, quantity or quality of the works (but the Contractor did not comply with Sub-Clause 20.1 when notifying its claim for additional payment).

9. Are dispute boards used as an interim dispute resolution mechanism in your jurisdiction? If yes, how are dispute board decisions enforced in your jurisdiction?

On Hungarian projects, in most cases, parties usually set aside (and thus do not apply) provisions on the referring of disputes to dispute boards.

10. Is arbitration used as the final stage for dispute resolution for construction projects in your jurisdictions? If yes, what types of arbitration (ICC, LCIA, AAA, UNCITRAL, bespoke, etc) are used for construction projects? And what seats?

It is quite common to use arbitration as the final (or sole) stage for dispute resolution on FIDIC projects in Hungary. If arbitration is agreed, the parties most commonly refer their disputes to the Court of Arbitration of the Hungarian Chamber of Commerce and Industry. In projects financed from State resources, the Hungarian State usually insists on referring disputes before ordinary Hungarian courts or the aforementioned arbitral tribunal.

11. Are there any notable local court decisions interpreting FIDIC contracts? If so, please provide a short summary.

In this respect, we refer to our answers to questions 6 and 7. As we mentioned, local court decisions have decided that complying with procedures set out in Sub-Clauses 2.5 and 20.1 of the FIDIC Red Book is a prerequisite for the validation of an Employer's or Contractor's claims.

Other notable court decisions shed further light on the role of the Engineer; namely, it is common practice in Hungary that Employers appoint related companies or even their own employees as Engineers. In many cases, Contractors have argued before courts that the Employers' exercising of rights to appoint Engineers represented a misuse of such a right. Hungarian courts, however, generally have taken the view that because Engineers do not have any right to decide disputes between the contractual parties, there is no requirement for the Engineer to be fully independent from the Employer.

12. Is there anything else specific to your jurisdiction and relevant to the use of FIDIC on projects being constructed in your jurisdiction that you would like to share?

As mentioned in the answer to question 6, Hungarian courts generally consider that complying with the procedure set out in Sub-Clause 2.5 is a pre-condition for the validation of Employer's claims. According to the first sentence of the second paragraph of Sub-Clause 2.5, the notice regarding the Employer's claim shall be given 'as soon as practicable' after the Employer became aware of the event or circumstance giving rise to the claim. Now, this term is interpreted quite flexibly by Hungarian courts, in some cases, simply entailing that the notice may be given during the entire term of the applicable civil law limitation period.

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FIDIC around the world: Nigeria

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1. What is your jurisdiction?

The Federal Republic of Nigeria.

2. Are the FIDIC forms of contract used for projects constructed in your jurisdiction?

Yes, the FIDIC forms are used for projects constructed in Nigeria.

The Conditions of Contract for EPC/Turnkey Projects (Silver Book) and the Conditions of Contract for Plant and Design-Build (Yellow Book) are typically used for the construction of gas processing plants, ports, refineries, power plants and solar plants across Nigeria.

The Conditions of Contract for Design, Build and Operate Projects (the Gold Book) are currently being considered by some project owners for the construction of gas plants that are to be operated by the Contractor for a period of time.

The Form of Contract for Dredging and Reclamation Works (the Blue Book) was recently used as the conditions of contract for reclamation works on an island proposed to be developed into modern districts along the Lagos Lagoon and the Lagos Coast.

3. Do FIDIC produce their forms of contract in the language of your jurisdiction?

Yes, the English language version of the FIDIC forms is used in Nigeria. English is the official language in Nigeria, although there are many languages spoken around the country.

4. Are there any amendments required in order for the FIDIC Conditions of Contract to be operative in your jurisdiction?

No amendment to the FIDIC forms is required for the forms to be operative in Nigeria. The provisions of the FIDIC forms are consistent with Nigerian law, which upholds the principle of sanctity of contract.

5. Are any amendments common in your jurisdiction, albeit not required in order for the FIDIC Conditions of Contract to be operative in your jurisdiction?

Although contracts based on the FIDIC forms are enforceable under Nigerian law, modifications are sometimes made to some provisions to meet the requirements of particular projects. For instance, provisions on access to and possession of site (Sub-Clause 2.1) are sometimes modified to achieve parties' preferences with regard to the right of possession of surface and sub-surface areas, and to make provisions for the right of access that other Contractors or employees of the Employer will have with regards to the site.

Owing to the sensitivity surrounding land in local areas, specific modifications are made to the FIDIC conditions to take care of interruptions that may be experienced as a result of protests and disruptions caused by local communities. In large infrastructure projects, a suite of clauses dealing with political force majeure are usually included to protect the Contractor.

Dispute adjudication board provisions are usually excluded in FIDIC forms used in Nigeria, except for contracts that are being financed by development finance institutions (DFIs). Instead, parties prefer mediation, and where mediation fails, they proceed directly to arbitration. This is because there is not yet much familiarity with the dispute adjudication board procedure among Nigerian project owners. When oil and gas industry operators use the FIDIC forms, they have to include clauses that incorporate specific local content requirements, which the operators are required by law to incorporate into procurement and services contracts.

6. Does your jurisdiction treat Sub-Clause 2.5 of the 1999 suite of FIDIC Contracts as a precondition to Employer claims (save for those expressly mentioned in the sub-clause)?

There is no reported case law dealing with Sub-Clause 2.5 as a precondition to Employer claims. However, it is reasonably certain that Nigerian courts will treat the sub-clause as a valid precondition to Employer claims. However, it is not clear how a Nigerian court will decide a question as to whether Sub-Clause 2.5 does not expressly take away the Employer's common law remedy of set-off, with the effect that an Employer may successfully set off its claim against sums payable to a Contractor without following the preconditions in Sub-Clause 2.5.

It has been observed that the word 'may' in Sub-Clause 15.4(a) may suggest that compliance with the precondition in Sub-Clause 2.5 is optional.[1] However, when interpreting Sub-Clause 15.4, it is very likely that Nigerian courts will adopt a pragmatic approach and read the contract as a whole.[2] This may lead to a determination that the intention of the 1999 suite of FIDIC contracts is to stipulate, irrespective of how they may arise, that any claim raised by an Employer should be notified to the Contractor as provided in Sub-Clause 2.5 and that such claim should, in addition, go through the process in Sub-Clause 3.5 and Sub-Clause 20.4.

7. Does your jurisdiction treat Sub-Clause 20.1 of the 1999 suite of FIDIC contracts as a condition precedent to Contractor claims for additional time and/or money (not including Variation)?

While there is no reported case law on Sub-Clause 20.1, Nigerian courts would treat the sub-clause as a valid precondition to Contractor claims. However, Nigerian courts are not likely to allow an Employer, who has breached its obligations and whose breach resulted in the claim that a Contractor did not give notice of within the allowable timeline (in Clause 20.1), to benefit from its own wrong.

8. Does your jurisdiction treat Sub-Clause 20.1 of the 1999 suite of FIDIC contracts as a condition precedent to Contractor claims for additional time and/or money arising from Variations?

As stated in the answer to question 7, there is no case law on Sub-Clause 20.1 as a precondition for Contractor claims for additional time and/or money. Nigerian courts will treat Sub-Clause 20.1 as a valid precondition to Contractor claims for additional time and money where no modification has been made to the time for completion and/or contract price following the Variation.

9. Are dispute boards used as an interim dispute resolution mechanism in your jurisdiction? If yes, how are dispute boards decisions enforced in your jurisdiction?

Under Nigerian law, the principle of sanctity of contract is upheld. Thus, Nigerian courts would require parties to give effect to the decisions of dispute boards until they are set aside through a final award in arbitration. However, if a party can demonstrate that a dispute board's decision was obtained by fraud or misrepresentation, such party may successfully apply to a Nigerian court to set aside the decision.

10. Is arbitration used as the final stage for dispute resolution for construction projects in your jurisdiction? If yes, what types of arbitration (ICC, AAA, UNCITRAL, bespoke, etc) are used in construction projects? And what seats?

It is common for parties to choose arbitration as the final stage for dispute resolution. For domestic projects, arbitration is usually conducted under the Arbitration and Conciliation Act 1988. Parties are free to choose the rules and the seat of the arbitration.

11. Are there any notable local court decisions interpreting FIDIC contracts? If so, please provide a short summary.

There is no reported court decision that has interpreted FIDIC contracts in Nigeria.

12. Is there anything else specific to your jurisdiction and relevant to the use of FIDIC on projects being constructed in your jurisdiction that you would like to share?

No.

Notes

1 Baker, Mellors, Chalmers and Lavers, *FIDIC Contracts: Law and Practice* (Informa Law from Routledge 2009), para 8.222.

2 As suggested by *ibid*, para 8.222.

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FIDIC Around the World: Kazakhstan

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For convenience, in this questionnaire, clause references are references to clauses in the 1999 Red Book.

1. What is your jurisdiction?

The Republic of Kazakhstan.

2. Are the FIDIC forms of contract used for projects constructed in your jurisdiction? If yes, which of the FIDIC forms are used, and for what types of projects?

Yes, FIDIC forms are used in Kazakhstan, including the Red Book, Pink Book, Yellow Book, Orange Book and Silver Book. Compared to the Russian Federation, FIDIC forms are used more often in the private sector in Kazakhstan in different projects.

In addition, FIDIC forms are used for infrastructure and road construction projects financed by international banks (the European Bank for Reconstruction and Development, China Development Bank, Asian Development Bank, and others).

In Kazakhstan, there is no bespoke standard construction contract form similar to FIDIC. Other construction contract forms such as ICE, JCT and NEC3, are not widely used in Kazakhstan.

As from 2006, the Ministry responsible for road development, recommended the use of FIDIC forms in almost all road construction projects. In 2011, specific rules were developed by

the Ministry for road construction projects. Under these rules, the Engineer's role is compatible with the general understanding of the Engineer's role in international construction projects. Previously, before 2011, the role of the Engineer was very formal and did not meet international standards in the construction sphere.

In 2015, the Engineer's role in the construction process in Kazakhstan increased further because of significant changes in local construction legislation. The Engineer has become more than just a part of the design development team. The Engineer's roles are: project management; quality and technical supervision; supervision of compliance with the project design documentation; cost control; and the Employer's representation on site.

3. Do FIDIC produce their forms of contract in the language of your jurisdiction? If no, what language do you use?

No, FIDIC does not produce its forms of contract in the Kazakh language. However, FIDIC does produce certain forms in Russian, which is also an official language in Kazakhstan.

In general, contracts are usually executed in two languages: English and Russian.

4. Are any amendments required in order for the FIDIC Conditions of Contract to be operative in your jurisdiction? If yes, what amendments are required?

Yes, substantial amendments are required in order to comply with mandatory legislation.

For example, the contract agreement form must be amended to add essential terms, including the total project cost with reference to a lump sum price or other price mechanism, the timeframe for completion, the detailed subject of the works, etc. In addition, Sub-Clause 8.7 must be amended, as liquidated damages are not applicable under Kazakh law. Amendments must also be made to Clauses 10 and 11 to reflect that, under Kazakh law, no claims may be brought after signature of the taking over certificate, except for hidden defects.

These examples are not exhaustive.

5. Are any amendments common in your jurisdiction, albeit not required in order for the FIDIC Conditions of Contract to be operative in your jurisdiction? If yes, what (non-essential) amendments are common in your jurisdiction?

Yes, several amendments are commonly made. For example, the provisions for a dispute adjudication board are unfortunately usually deleted from the contracts, and this option is rarely used in Kazakhstan. The arbitration clause is usually amended to provide for local litigation or local arbitration. In addition, the common law boilerplate clauses are usually amended to be more specific in order to avoid arguments on terminology in the future. Interim payment certificates are generally replaced by monthly acceptance acts (the form of which is established by local legislation). Indemnity terms under Sub-Clause 17.1 are very difficult to enforce in Kazakhstan, except for insurance agreements, and are generally not used. This list is not exhaustive.

More generally, the structure of the contract based on the FIDIC forms assumes the use of two main parts: the General Conditions and the Particular Conditions. In Kazakhstan this approach of amending the general conditions in a separate part of the contract is not usually followed. Instead, parties generally include all changes in the General Conditions and no Particular Conditions are included as part of the contract. Sometimes, our clients contact FIDIC directly to request their approval to amend the General Conditions. It takes one or two weeks to obtain permission from FIDIC.

6. Does your jurisdiction treat Sub-Clause 2.5 of the 1999 suite of FIDIC contracts as a precondition to Employer claims (save for those expressly mentioned in the sub-clause)?

In some specific situations, yes. There is an obligation to claim (notify) first and to allow time for voluntarily acceptance or denial of the claim.

7. Does your jurisdiction treat Sub-Clause 20.1 of the 1999 suite of FIDIC contracts as a condition precedent to Contractor claims for additional time and/or money (not including Variations)?

Yes, Sub-Clause 20.1 works as a condition precedent under Kazakh law.

8. Does your jurisdiction treat Sub-Clause 20.1 of the 1999 suite of FIDIC contracts as a condition precedent to Contractor claims for additional time and/or money arising from Variations?

Yes, Sub-Clause 20.1 works as a condition precedent under Kazakh law.

9. Are dispute boards used as an interim dispute resolution mechanism in your jurisdiction? If yes, how are dispute board decisions enforced in your jurisdiction?

In Kazakhstan, there are only ten to 20 projects where a dispute

adjudication board has been used under a FIDIC contract. Most of these projects are managed by foreign Contractors and international Engineers.

The local construction market does not recognise dispute boards as an effective institution, mainly because of the impossibility of enforcing dispute board decisions in Kazakhstan. In addition, the local mentality does not allow parties to trust the dispute board professionals.

Artyushenko & Partners is organising joint events with FIDIC and the Dispute Resolution Board Foundation (DRBF) in Almaty to promote the use of dispute adjudication boards, including training in Russian.

10. Is arbitration used as the final stage for dispute resolution for construction projects in your jurisdiction? If yes, what types of arbitration (ICC, LCIA, AAA, UNCITRAL, bespoke, etc) are used for construction projects? And what seats?

The most common practice is to use local courts, especially for State-owned/financed projects. Alternatively, if arbitration is used, parties generally choose LCIA, ICC and other foreign arbitration institutions with Paris, London or Washington, DC as the seat of arbitration. The third most common choice is local arbitration with the seat of arbitration in Almaty or Astana.

Approximately half of all construction contracts with foreign parties select English law as the applicable law for the contract, which is permissible under Kazakh law. Other contracts usually apply Kazakh law.

Even though Kazakhstan is party to the New York Convention, there are difficulties enforcing arbitration decisions in Kazakhstan.

11. Are there any notable local court decisions interpreting FIDIC contracts? If so, please provide a short summary.

There are not many local court cases involving FIDIC contracts. The problems generally encountered are poor translations of contracts into Russian or a lack of understanding by local judges as to the turnkey approach, the role of the Engineer and other issues arising under FIDIC forms.

12. Is there anything else specific to your jurisdiction and relevant to the use of FIDIC on projects being constructed in your jurisdiction that you would like to share?

A 2015 reform in Kazakhstan made it possible to carry out the final commissioning of projects without the involvement of any State bodies and has given the Engineer a role compatible with international practice (see our response to question 2 above).

The construction sphere in Kazakhstan is changing. The use of Eurocodes, instead of Soviet Union construction rules, is already legal. The BIM approach to design and development is expected to become mandatory in the coming years. These developments will have an effect on FIDIC construction projects in Kazakhstan in the future.

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ENGLAND

Good faith: what is it good for?

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To a lawyer with a civil law background, it must seem curious to observe the debate about good faith under English law. Even for some common law lawyers it may seem surprising that this topic is still raising such strong sentiments. What is clear, however, is that English law has done very well without having a good faith obligation. Indeed it is a popular choice of law for international contracts and the lack of good faith is not seen as a hindrance (possibly a benefit).

The question is therefore not whether English law must recognise good faith obligations. The more interesting question is whether there is a benefit in English law recognising good faith obligations and whether that would make a positive difference that would outweigh any perceived disadvantages.

This article is therefore not seeking to argue that good faith must be incorporated into English law but instead to consider whether there may be a benefit in recognising such obligations and whether that would reflect what parties expect of their contracts. This can be done by moving away from a general discussion of principles and looking at specific examples of typical situations that arise on projects. This, together with a review of cases where the English courts have recognised good faith, should provide a better understanding of its practical impact. This will also help to identify whether, especially in light of the growing use of collaborative contracts, there is any benefit in recognising good faith obligations.

Introduction to good faith

It is not necessary to set out in this article the full background to how good faith has been treated by the English courts, but it is worth noting that Bingham LJ, in *Interfoto Picture Library Ltd v Stiletto Visual Programs Ltd*,[1] made it clear that English law has not committed itself to an overriding principle of good faith but has developed piecemeal solutions in response to demonstrated problems of unfairness. A few years later, the traditional approach was confirmed in the House of Lords' decision in *Walford v Miles*,[2] which concerned the pre-contractual position and where Lord Ackner stated:

> '… the concept of a duty to carry on negotiations in good faith is inherently repugnant to the adversarial position of the parties when involved in negotiations. Each party to the negotiations is entitled to pursue his (or her) own interest, so long as he avoids making misrepresentations… A duty to negotiate in good faith is unworkable in practice as it is inherently inconsistent with the position of a negotiating party.'[3]

It is not easy to identify what is meant by good faith[4] and the courts have sought to identify the nature of the good faith obligation as an obligation to observe reasonable commercial standards of fair dealings in relation to contractual obligation[5] or an obligation to adhere to the spirit of the contract, to observe reasonable commercial standards of fair dealing, and to be faithful to the agreed common purpose and act consistently with the justified expectations of the parties.[6] In *Gold Group Properties Ltd v BDW Trading Ltd*,[7] the judge observed that good faith 'does not require either party to give up a freely negotiated financial advantage clearly embedded in the contract'.[8]

The question of whether a term requiring good faith can be implied into a contract raises very different questions from the interpretation of an express good faith provision. Shortly before the leading Court of Appeal decision on good faith in *Mid Essex Hospital Services NHS Trust v Compass Group UK*[9] (but after the first instance decision), the strongest case for recognising a general duty of good faith in English law was made in *Yam Seng Pte Ltd v International Trade Corp Ltd.*[10] The *Yam Seng* decision concerned an exclusive distribution agreement for toiletries under the Manchester United brand in the Far East. It was a brief agreement, drafted without the benefit of legal advice, and it did not contain any express good faith clauses. The relationship between the parties deteriorated and, ultimately, the agreement was terminated.

In his judgment, Leggatt J (as he then was) reviewed the cases relating to good faith to address Yam Seng's argument that there was an implied duty of good faith. He referred to the traditional English hostility towards a doctrine of good faith but observed that the refusal to recognise, if there was such refusal, a general obligation of good faith in England would appear to be swimming against the tide and that the concept of good faith has been gaining ground in other common law jurisdictions, including the American, Australian and Canadian courts.

Having demonstrated his willingness to consider a good faith obligation, he began by looking at the test for implying terms and the approach to contractual interpretation. He then applied these principles and began by observing that the relevant background contained not only matters of fact, but also shared values and norms of behaviour, for

example, an expectation of honesty that was seldom made the subject of an express contractual obligation. Having demonstrated that honesty can be implied as an obligation, he considered whether there were other standards, in addition to honesty, of commercial dealing that were so generally accepted that the contracting parties would reasonably be understood to take them as read, without explicitly stating them in the contractual document.

Leggatt J suggested that it was unlikely that a wider good faith duty would be implied where the contract involved a simple exchange but it could be relevant to contracts that involve longer-term relationships between the parties in which they make a substantial commitment. He described such contracts as 'relational contracts', requiring a high degree of communication, cooperation and predictable performance based on mutual trust and confidence, and involving expectations of loyalty that are not provided for in the express terms of the contract, but are implicit in the parties' understanding and necessary to give business efficacy to their arrangement. Applying those principles to the facts, he distilled the good faith principle into specific obligations that were a duty not to give false information and a duty not to undercut duty free prices.

Considering the traditional objections to good faith, Leggatt J's view was that the concept of good faith was not inconsistent with English law, there was no real risk of uncertainty and in fact such a clause could be established on the basis of accepted principles, such as the parties' intentions. This rationale, however, was not followed in later decisions and at present the courts appear to maintain the traditional reluctance to finding that good faith obligations exist and enforcing them, on the basis that English law has other principles that can be used.[11] That, however, does not mean a complete refusal to accept good faith and, as can be seen below, some judges have been more open to recognising good faith obligations.

The courts recognising good faith

The difficulty the courts face with good faith is the tension between the strict terms of the contract and allowing a party to enforce such negotiated terms, even where there is conduct that seems to go against what the parties, arguably, have intended. For that reason, it is worth considering some of the cases where the courts did feel comfortable expressing views as to what may be a breach of a good faith obligation. The *Yam Seng* decision discussed above is one such example, but there are others.

One of the earlier examples concerned a partnering contract and in *Birse Construction Limited v St David Limited*,[12] the judge stated that a partnering charter, while not legally binding, was intended to provide the standards by which the parties were to conduct themselves and against which the conduct and attitudes were to be measured. In that case, he considered the behaviour of other parties against the background of the duties described as 'mutual co-operation and trust' and a relationship that was intended to 'promote an environment of trust, integrity, honesty and openness' and 'to promote clear and effective communication'.

He observed that one would not expect, where the parties had made mutual commitments such as those in the charter, to be concerned about compliance with contractual procedures if otherwise there had been true compliance with the letter or the spirit of the charter. His view was that even though the terms of the partnership charter would not alter or affect the terms of the contract, an arbitrator would undoubtedly take such adherence to the charter into account in exercising the discretion to open up, review and revise.

A partnering contract was also the subject of the decision in *Willmott Dixon Housing Ltd v Newlon Housing Trust*,[13] where the contract was the ACA Standard Form of Contract for Project Partnering (PPC 2000). The issue was the enforcement of an adjudication decision and one party raised arguments as to whether the referral to adjudication had been served. In that case the judge pointed out that the parties had agreed to use the standard form of project partnering contract, including the agreement to work in mutual cooperation, and that this obligation also included performing the problem solving and dispute avoidance or resolution provisions, including the adjudication process. In that context, the party that failed to contact the other to confirm the position with regard to the referral document was in breach of its obligation to work in mutual cooperation and could not rely on a failure to receive the referral document.

Another case concerned the NEC3 Professional Services Contract, which contains in clause 10.1 an obligation to 'comply with the terms of the contract and act in a spirit of mutual trust and cooperation'.[14] In *Northern Ireland Housing Executive v Healthy Buildings (Ireland) Ltd*[15] the Northern Ireland Court of Appeal considered the interpretation of clause 61.1, which deals with compensation events, and suggested that interpreting that clause had to be done in the context of clause 10.1. In a subsequent decision in the same case,[16] the court looked at a party's refusal to provide relevant documents to support its claim for additional payment. The court

observed that 'it seems to me that a refusal by the consultant to hand over his actual time sheets and records for work he did during the contract is entirely antipathetic to a spirit of mutual trust and co-operation. Further clauses in the contract such as Clause 15 reinforce that spirit'.

The above cases demonstrate that there are circumstances where the courts will feel comfortable in finding that a party had not complied with a good faith obligation. This may well be as part of a wider issue and the decisions do not rely solely on a finding of breach of good faith but they do show that some judges feel comfortable making such findings when they feel the facts justify recognising a breach of good faith.

Specific circumstances where good faith may be relevant

A theoretical discussion of good faith is limited as it is a topic that is very fact sensitive. The scenarios described below, by definition, concern unusual, but not unlikely, circumstances and can be adjusted in different ways but they hopefully provide useful examples to test the wider principle of how and whether a good faith obligation may make a difference.

Disclosure of information

The first scenario considers the extent to which one party should provide relevant information to the other party. In a construction context, information on ground conditions (or other relevant information such as a government's willingness to issue a licence or permit) is highly relevant at the tender as well as construction stages and parties will agree a risk allocation, the price for works and the programme based on their assessment of that risk. In a situation where the contractor agrees to take on the risk of ground conditions because available information suggests that is a low risk, if the employer becomes aware after the works have started that in fact the risk is much higher, should the employer make that known to the contractor?

The employer will not usually have an obligation to disclose information (save where the contract may contain an early warning obligation) and may find it commercially advantageous to allow the contractor to carry on because it may reduce the employer's liability for employer risk events or provide a commercial negotiating position. The legal view would usually be that the contractor agreed to take that risk when signing the contract and that there is no general duty of disclosure.[17]

In reality, however, this may lead to delay that does not always serve the interests of the employer and delay damages do not always provide full compensation. A contractor may well feel that if the employer has relevant information, such information should be disclosed rather than be used to gain a commercial advantage. One can see that a contractor who comes across such behaviour by an employer is likely to take a similar approach when coming across an employer risk event. The interesting question is what the parties would have said at the time they signed the contract as to whether they would expect each other to communicate any relevant information they become aware of.

In a recent decision, Leggatt LJ found that certain furtive or opportunistic conduct was incompatible with a duty of good faith that he held was implied in a dispute concerning various business dealings leading to what he described as classic instance of a relational contract.[18] He held that a party could not enter into negotiations to sell its share to a third party covertly and without informing the other beneficial owner and that a party could not use its position as shareholder to obtain a financial benefit for itself at the expense of the other. In that case, it was held that the conduct amounted to a breach of good faith, as well as to duress.

In *ING Bank v Ros Roca SA*,[19] the Court of Appeal considered a situation where one party discovered after the contract was agreed that due to the passage of time and delay in the contract progressing, it would receive a much higher payment under the strict terms of the contract. In that case, Rix LJ rejected a good faith argument on the basis that there was no general notion of good faith in commercial affairs, but held that the party's awareness of this issue and its failure to disclose it gave rise to estoppel. That is an example of the English court using estoppel to achieve the right result, but estoppel only applies in certain limited circumstances.

Claim notification periods and time bars

Time bar clauses, which make timely notification a precondition to recovery, are a common feature of construction contracts. They serve a commercial purpose by creating certainty and ensuring that the party notified of an event that is its own risk has time to take steps to reduce the impact of such an event where possible. Such clauses, however, can also be regarded as onerous and can put a party at risk of losing its contractual entitlement, especially where the notification period is very short.

In this scenario, the risk of exceptionally adverse conditions is with the employer and a very severe storm hits the site. The contractor concentrates its efforts on managing the impact of the storm and notifies its claim two days after the expiry of the 28-day period for notification. The employer's project manager has been kept fully informed of events on site and is aware of the impact of the storm on the works but should the project manager rely

on the notice being late and take the position that as a result no additional money or time is due?

A lawyer may take the view that the contractor was fully aware of the contractual terms and has only itself to blame for not adhering to the notice period, regardless of whether the employer suffered any prejudice. The English courts tend to interpret such clauses narrowly and *contra proferentem*,[20] but accept that they are enforceable. The issue, however, is whether the employer would benefit from enforcing such a clause.

There is a commercial basis for such clauses[21] and a benefit to the employer in being able to deny entitlement (and the contractor may well learn not to repeat such a mistake). But in the long-term, not enforcing the time bar in such circumstances may result in the contractor taking a similar approach if it finds itself in a similar position where it could gain a commercial advantage owing to a similar employer oversight. A party can therefore decide whether to enforce its legal rights under the contract, to its benefit, or consider whether not taking such a step in certain circumstances will result in goodwill, which may be more of a benefit in the long-term. To an extent this is a commercial rather than a legal issue, but it does highlight the relevance of wider considerations beyond the agreed contractual terms.

It is worth noting that the topic of time barring provisions has been the subject of much discussion in Australia and in a recent report prepared for the Australian Government it was recommended that legislation should void a contractual term that makes a right to claim or receive payment (or an extension of time) conditional on giving notice where compliance with the notice requirements would not be reasonably possible, be unreasonably onerous or serve no commercial purpose.[22]

Ignoring the contract

In some cases, circumstances on a project mean that parties decide to operate a contract and manage it in a way that is more practical and suits both of them, but is not in accordance with the strict terms of the contract. If the parties engage in such conduct, should one party be entitled to enforce the contractual terms at a later stage on the basis that there has never been a valid variation of the contract?

Such a situation would give rise to unfairness, but one can see that in the absence of a formal variation the other party may find itself in difficulty under English law.[23] This is not, however, an unusual situation in a construction context and it would be difficult to justify the position of a party who seeks to resile from its own actions by relying on the terms of a contract that it also did not follow.

In *Mears Ltd v Shoreline Housing Partnership Ltd*,[24] having agreed that the basis for payment under the contract would be a target cost with a price list, both parties proceeded to operate the contract on the basis of an agreed schedule of rates because this was more practical in the circumstances.

The employer then sought to revert to the terms of the contract and make a deduction on the basis that the contractor had been overpaid. The contract was an NEC3 Term Services Contract and the contractor argued that there was a cause of action based on the trust and partnership language used in the NEC standard form of contract and clause 10.1. The contractor also argued that this resulted in an implied term that a party would not take advantage of the other party due to a departure from the strict terms of the contract, when that party was aware of the departure, and without warning the other party and giving it an opportunity to act differently. The judge found for the contractor, but on the basis of estoppel, and did not think there was an implied term as argued by the contractor.

This is another example of how English courts can use existing legal principles, estoppel in this case, which mean there is no need to make any findings about good faith. Relying on estoppel is not, however, a complete answer. Estoppel only arises in specific circumstances and could be used in this case only because the contactor was defending a claim for overpayment (using estoppel as a shield). The position would have been different if the contractor was seeking to claim payment based on the parties' conduct.

Deliberate breach of contract

A failure to make payment is not unusual, but what if a party decides deliberately to withhold payment when it knows it has no entitlement, knowing that the other party's financial position means it cannot afford the time or cost of enforcing full payment? The law provides a simple remedy by way of a claim for breach of the payment obligation (and in some circumstances may allow termination for repudiation), but it is arguable that this is the type of conduct that would constitute a breach of a good faith clause.

Similarly, what if a party decided to appoint one of its own employees to act as the engineer or project manager in the role of the independent certifier and then ensured that its employee favoured it when issuing certificates? Again, the contractor has a remedy by making a claim to determine the correct value of its entitlement, but this is the type of conduct that is likely to be seen as a breach of a good faith obligation. This may not result in additional recovery under English law, but could be taken into account as part of the overall claim and may provide a different basis for claiming general damages.

This type of situation was considered in *Imperial Chemicals Industries Ltd v Merit Merrell Technology Limited*,[25] where the

employer decided to stop payment and the evidence suggested that at least some people within the employer meant for this to result in the insolvency of the contractor, to avoid payment of the full amount due. In addition, the project manager resigned when the employer tried to interfere in its certifying role and the employer appointed an employee of its holding company as the new project manager.

The judge recognised that 'Modern business can be fairly ruthless commercially, and it may be that the founders of the modern industrialised world were the same',[26] but went on to find that this employee embarked upon his own course of conduct, which paid no attention to the contract and to the legal rights of the contractor. He then held that the appointment of that employee constituted a breach of contract.[27]

This decision is a good example of how English law already provides remedies in such circumstances and the contractor was successful without having to rely on good faith arguments. It is interesting that the judge felt it necessary to comment that the conduct of the employer's appointed project manager went beyond what would be an acceptable level of ruthlessness in business and while it is likely that the contractor felt there was little point in seeking to plead a breach of good faith, the ability to do so may be more useful in other circumstances where the positon is less clear. In another decision, however, a party's actions, based on a strategy of certifying the lowest values it believed would be defensible, were described as ruthless but lawful,[28] demonstrating that a party can act in its own interest and it will not be easy to identify when such conduct no longer becomes acceptable and is sufficiently serious to amount to a breach of a good faith obligation.

Collaborative and relational contracts

The reluctance to recognise good faith also needs to be considered in the context of an environment where the emphasis is on certainty and freedom of contract, so that parties can agree any terms they wish but must then be held strictly to the agreed terms. This, however, goes against the notion of relational contracts, referred to in *Yam Seng*, and the increasing emphasis in the United Kingdom on collaborative forms of contract.

The question is therefore whether there is a need for such collaborative contracts and whether there is any utility in seeking to identify a contract as relational. A different way to consider this question is to ask whether construction contracts have some different characteristics that mean they should be treated differently. In that regard, construction contracts will usually involve risks that neither party can fully eliminate or manage, such as weather conditions, ground conditions, the need for government permits or licences and a need for design to be developed, often leading to high levels of change. This will also often take place over several years, increasing the likelihood of events affecting the project. This is very different from a contract to purchase an item of machinery, especially when that is purchased off the shelf and where full payment is made immediately.

In a construction environment, there is a need for a high level of cooperation to limit the risk of time and cost overruns. The different types of risk and the lengthy time periods mean that, at different stages, both parties would benefit from the other party behaving collaboratively rather than enforcing contractual terms strictly for a short-term commercial advantage. That is not to say that the contract is to be ignored – the contract still very much determines the bargain and risk allocation – but collaborative behaviour means operating the contract so as to ensure the overall success of the project. What that means in practice is difficult to identify in advance but will depend on the circumstances in each case.

This may be regarded as an overly optimistic and commercially naive approach, but it represents the approach taken by the UK government and the use of alliancing contracts, which assumes that such an approach will help reduce costs and result in efficiencies. The UK government's Procurement/Lean Client Task Group has identified the NEC, PPC2000 and the JCT's Constructing Excellence forms of contract as the basis for trials seeking to achieve better delivery.[29] More recently, the Infrastructure Client Group published a Code for Alliancing[30] and new standard forms of alliancing contracts have been published by NEC and ACA.[31]

Including a good faith clause will not, on its own, create a collaborative environment and relationship.[32] That will require much more and there are many steps that the parties can take in order to ensure that they understand what collaboration means and implement it,[33] including ensuring a commercially balanced risk allocation and increased certainty of a profit margin as well as using procurement models such as early contractor involvement. Nonetheless, including such a clause will help to reinforce the message that collaboration is expected. Indeed, regardless of the reluctance of the courts to enforce good faith type obligations, there is a desire within the industry to use collaborative forms of contract that will often include good faith clauses. This is the case with the NEC standard form of contract, but the new FIDIC White Book 2017 edition form of contract also includes a good faith clause, as does the ICC Model Turnkey Contract for Major Projects.

While the approach in *Yam Seng* has not led to an overall change in

the English courts' approach, there have been a number of cases where it has been followed and judges have based their decisions on the contracts being relational.[34] This has been supported by Leggatt J in a talk given in 2016 to the commercial bar[35] and by Arden LJ in 2013,[36] who suggested that English law could accommodate the concept of good faith, which could result in economic advantages by providing a better structure for cooperative arrangements making English law more attractive internationally. It is also worth noting that in March 2017, the International Standards Organisation published ISO44001, Collaborative Business Relationship Management Systems – Requirements and Framework. A survey undertaken by NBS in 2018 included questions about the use of collaboration and identified that 65 per cent used a contract that had an ethos of mutual trust and cooperation, while 30 per cent adopted a more structured approached by using a formal partnering agreement. It was also noted that the industry saw the advantages of collaboration as enabling information sharing, reducing the number of disputes and improving the delivery of client objectives.[37]

Conclusion

There is no doubt that English law was and remains an effective, and internationally popular, legal system without the need to recognise good faith. To a very large extent, English law will provide an effective remedy when a party does not comply with its obligations and that is not affected by a failure to recognise good faith duties. That position under English law is based on the emphasis on certainty and enforcing the strict commercial bargain that the parties entered into.[38]

The issue is whether and how that approach operates in the context of an increasing tendency to use collaborative contracts. It is true that not all parties will want to use such contracts, especially in an international context, and that such contracts are only successful under certain conditions. Where, however, parties do choose to use such contracts, the courts and arbitrators will need to grapple with enforcing a wider obligation to collaborate. Whether or not a good faith is expressly incorporated, it is clear that, in such contracts, parties intend their relationship to be governed by more than may be encompassed on the strict words of the contracts. It will then be for the tribunal to decide whether to maintain the current approach and focus on a narrow interpretation of the express terms or to take a wider view and recognise obligations that are less certain and therefore less easy to enforce. As highlighted above, that will very much depend on the circumstances and in reality it appears that courts are able to recognise behaviour that would be regarded as commercially unacceptable and a breach of good faith. In other jurisdictions, the courts appear to have much less difficulty in enforcing such obligations.

In that respect, some lawyers may take the view that contracts operate well on the basis that if a party fails to perform, English law provides a cause of action that can be effectively pursued through court or arbitration and that nothing else is needed. For parties to a construction contract, however, lengthy and costly proceedings are rarely an attractive option, especially with the inherent uncertainty that construction disputes tend to involve. In most cases, it is therefore in the parties' interests to create an environment that is based on cooperation and encourages early settlement when disputes do arise. If contracts can be set up so that they promote such aims, that should be seen as a positive step and good faith clauses can be part of such contracts.

Notes

1 [1989] QB 433.
2 [1992] 2 AC 128. The same approach was followed in *Ultraframe (UK) Limited v Tailored Roofing Systems* [2004] EWCA Civ 585 at para 17, where Waller LJ agreed with Bingham MR's observation in *Philips Electronique Grand Public SA v British Sky Broadcasting Ltd* [1995] EMLR 472 at 484 that the implication of terms is so potentially intrusive that the law enforces strict constraints on the exercise of this extraordinary power, all the more so when parties enter into lengthy and carefully drafted contracts.
3 [1992] 2 AC 128 at para 138.
4 See in that regard Jackson, 'Good Faith in Construction – Will it Make a Difference and is it Worth the Trouble?' (2007) 23 Construction Law Journal 420.
5 *Berkeley Community Villages Ltd v Pullen* [2007] EWHC 1330 (Ch).
6 *CPC Group Ltd v Qatari Diar Real Estate Investment Co* [2010] EWHC 1535 (Ch).
7 [2010] EWHC 1632 (TCC).
8 [2010] EWHC 1632 (TCC) at para 91.
9 [2013] EWCA Civ 200.
10 [2013] EWHC 111 (QB).
11 See in that regard Jackson, 'Good Faith Revisited' (2014) 30 Construction Law Journal 379.
12 [1999] BLR 194 at 202.
13 [2013] EWHC 798 (TCC).
14 Now cls 10.1 and 10.2 of NEC4.
15 [2014] NICA 27 at para 29.
16 *Northern Ireland Housing Executive v Healthy Buildings (Ireland) Limited* [2017] NIQB 43 at para 43.
17 On the duty of disclosure more widely see Jackson, 'The Duty to Disclose: A Clash of Laws and Morality' (2008) 24 Construction Law Journal 675.
18 *Sheikh Tahnoon Bin Saeed Bin Shakhboot Al Nehayan v Kent* [2018] EWHC 614 (Comm).
19 [2011] EWCA Civ 353.
20 See, eg, *Northern Ireland Housing Executive v Healthy Buildings (Ireland) Ltd* at n 16 above at para 30 and *Obrascon Huarte Lain SA v A-G for Gibraltar* [2014] EWHC 1028 (TCC).
21 See in that regard *Multiplex Constructions (UK) Ltd v Honeywell Control Systems Ltd* (No 2) [2007] EWHC 447 (TCC) at para 103 for an explanation of the rationale for such clauses.
22 See Recommendation 84, John Murray AM, Review of Security of Payment Laws: Building Trust and Harmony, December 2017 and Chapter 16 for the wider considerations.
23 See in that regard the Supreme Court decision on the effect of non-oral modification clauses in *Rock Advertising v MWB Business Exchange* [2018] UKSC 24.
24 [2015] EWHC 1396 (TCC).
25 [2017] EWHC 1763 (TCC). See also the *Mid Essex* case at n 9 above where an express good faith clause was considered

in the light of excessive deductions used as part of a commercial strategy.
26 *Ibid* para 41.
27 *Ibid* para 140.
28 *Multiplex Constructions (UK) Ltd v Cleveland Bridge UK Ltd* [2006] EWHC 1341 (TCC) at para 628.
29 'Final Report to Government' by the Procurement/Lean Client Task Group, July 2012.
30 See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/487294/alliancing_code_of_practice_18122015.pdf accessed 22 October 2018.
31 Framework Alliancing Contract (FAC-1), which is endorsed by the Construction Industry Council and Constructing Excellence. See 'Improving Value Through the FAC-1 Framework Alliance Contract', SCL paper D209, November 2017.
32 See Koko Udom, 'Improving Collaborative Construction Contracts' (October 2013).
33 'Collaborative Construction 2: It's Now or Never' (Pinsent Masons, September 2017).
34 See, eg, *Bristol Groundschool Ltd v Intelligent Data Capture Ltd* [2014] EWHC 2145 (Ch) and *D&G Cars v Essex Police Authority* [2015] EWHC 226 (QB).
35 'Contractual duties of good faith', Lecture to the Commercial Bar Association, 18 October 2016.
36 'Coming to Terms with Good Faith', Singapore Academy of Law, 26 April 2013.
37 The National Construction Contracts and Law Report 2018, published by NBS.
38 In that regard, see the shift to a literal interpretation in *Arnold v Britton* [2015] UKSC 36 and the approach to implying terms set out in *Marks and Spencer v BNP Paribas Securities Service Trust Co* [2015] UKSC 72.

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EGYPT

The role of good faith as a challenge to the implementation of the claim procedures under the FIDIC Red Book 2017 edition in Egypt

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Introduction

The FIDIC forms of contract have been extensively used over the years in the Middle East North Africa (MENA) region. In 1994, it was reported that the FIDIC form of contract was the most used international standard form of civil engineering contract in the Arab Middle Eastern countries.[1] In a 2009 survey conducted by Norton Rose Middle East, which encompassed contractors, employers, developers and banks with a combined turnover of US$11.7bn, it was reported that 'FIDIC was by far the most used form of contract'.[2]

In Egypt, the FIDIC form of contract has been widely used in a considerable number of important projects, such as Terminal Two of the new Cairo airport, the Greater Cairo Wastewater Project and the Cairo Metro Project. Moreover, it has been suggested that the FIDIC form of contract has been widely used in all projects financed by the World Bank and United States Aid for International Development (USAID), both of which fund a large number of infrastructure projects in Egypt.[3] In January 2012, a construction contract was signed for the third and final phase of the Grand Egyptian Museum, which is a prestigious project funded in the most part (65 per cent) by the Japanese International Cooperation Agency (JICA),[4] which uses the FIDIC form of contract in its contracts worldwide. The importance of FIDIC in Egypt is further highlighted by the conferences FIDIC hosts in Egypt, which are attended by professionals from Egypt and the Middle East, such as the Conference hosted by FIDIC and the International Chamber of Commerce (ICC) on 9 and 20 April 2005, titled 'International Construction Contracts and Dispute Resolution', which attracted 130 participants from more than 26 countries.[5] In January 2011, FIDIC collaborated with the Cairo Regional Centre for International Commercial Arbitration (CRCICA) and the Egyptian Society for Consultative Engineers (ESCONE) to hold a Conference at the CRCICA to discuss the latest developments in FIDIC contracts. The Conference included 19 speakers, three of whom are key FIDIC representatives and the rest are prominent speakers in construction disputes in Egypt and the Middle East, including Jordan, Libya, Syria and Saudi Arabia. The Conference was attended by numerous representatives from Egypt and the Middle East. In April 2016, CRCICA and FIDIC collaborated again to present the Conference titled 'The Challenges of the Egyptian Construction Industry and the Role of FIDIC', which also included prominent speakers from FIDIC, as well as distinguished speakers and attendees from the MENA region and worldwide. In December 2017, FIDIC officially launched the 2017 FIDIC Suite of Contracts. This 2017 edition is an update to the 1999 Rainbow suite of contracts, which includes the FIDIC Red, Yellow and Silver Books.

Despite the prevalent use of the FIDIC form of contract in the MENA region, little research has been produced on the challenges of its

application in the region. However, one study, which was completed just a few months before the launch of the 2017 edition, addresses the challenge of the enforceability of time bar clauses in Egypt (in comparison with England and Wales) while using the FIDIC 1999 Red Book as the point of reference for the comparison.[6] Three comparison points were utilised, namely the statute of limitations, the principle of good faith and the prevention principle. This article builds on this research and addresses the concept of good faith as a challenge to the application of the FIDIC 2017 Red Book in Egypt.

Claim procedural requirements in the FIDIC 2017 Red Book

One of the most distinctive features of the FIDIC 2017 Red Book is its attention to detail in respect of procedures. FIDIC's rationale is the maintaining of the balanced risk sharing principles in the previous edition, while building on the substantial experience gained from the use of the FIDIC Rainbow suite of contracts for the 18 years spanning the first and second editions, which is achieved through 'greater detail and clarity on the requirements for notices and other communications'.[7] FIDIC has also attributed the increase in the time limits in the new edition to 'improved clarity and certainty'.[8] While this greater detail, certainty and clarity resulted in the new edition being nearly double its predecessor in size, it would be a substantial feat to outline the challenges for the implementation of the new FIDIC 2017 edition in a global sense. Therefore, the focus of this article is only on the claims procedures, which is one of the distinct features of the FIDIC 1999 suite of contracts, especially the so-called time bar clause in sub-clause 20.1 of the first edition.

While the 1999 edition combined the procedure for claims and dispute resolution into one clause, namely clause 20 titled 'Claims, Disputes and Arbitration', the new 2017 edition divides these procedures into two clauses, namely clause 20 titled 'Claims' and clause 21 titled 'Disputes and Arbitration'. The new clause 20, the focus of this article, is an expansion of what used to be sub-clause 20.1 in the 1999 edition, titled 'Contractor's Claims'. Table 1 provides a summary of the clause in accordance with its sub-headings. It is important to note the following definitions before analysing clause 20:

- Claim: according to sub-clause 1.1.6, means 'a request or assertion by one Party to the other for an entitlement or relief under any Clause of these Conditions or otherwise in connection with, or arising out of, the Contract or the execution of the Works'.
- Dispute: according to sub-clause 1.1.29, means any situation where any one party makes a claim against the other party, the other party (or the engineer) rejects the claim and the claiming party rejects the rejection of the other party (or the engineer). The non-response by the other party (or the engineer) to the claim may constitute a rejection.
- Notice: there is a sub-clause 1.3 titled 'Notices and Other Communications', which is dedicated to describing the constituents and requirements of a Notice, among which is that a Notice 'shall be identified as such and include reference to the provision(s) of the Contract under which it is issued where appropriate'.

Sub-clause	Brief description
20.1 'Claims'	Defines the three cases where a claim may arise, which include the situation where the employer considers itself to be entitled, where the contractor considers itself to be entitled and where a party or the engineer disagrees with the claiming party's entitlement or relief. The first two cases are the basis for the remainder of the claims procedures in this clause.
20.2 'Claims for payment and/or EOT'	This sub-clause is divided into seven sub-headings as follows:
20.2.1 'Notice of claim'	This sub-clause addresses the renowned notice requirement that was present in the FIDIC 1999 edition under sub-clause 20.1, but applies it equally to the employer and the contractor. The party presenting the claim is referred to as 'the claiming party', while the recipient of the claim is referred to as 'the other party'.
20.2.2 'Engineer's initial response'	This sub-clause addresses the situation where the claiming party is time-barred for not giving the required claim notice within the 28-day period. The engineer is required to give a notice within 14 days of the expiry of the 28-day period to record the claiming party's failure to provide the required notice. If the engineer fails the give the notice within 14 days, the claiming party's delayed notice is deemed to be valid. If the other party disagrees with the delayed notice being deemed valid for the delay of the engineer to give its notice, then the other party will give the engineer a notice with the details of the disagreement, which the engineer shall take into account in the determination. If the claiming party receives the engineer's notice within the 14-day period and disagrees that the claim is time-barred because there are circumstances that justify the late submission, the claiming party will include in the fully detailed claim submission the reasons justifying the late submission.
20.2.3 'Contemporary records'	This sub-clause places the obligation on the claiming party to keep contemporary records to substantiate the claim and gives the engineer permission to inspect these records without admitting any liability on the employer.
20.2.4 'Fully detailed claim'	A description of what comprises a 'fully detailed claim' is detailed in this sub-clause. There are four main criteria for a fully detailed claim submission, which are: (1) a detailed description of the event; (2) a statement of the contractual and/or legal basis; (3) all contemporary records; and (4) detailed supporting particulars of the amount or time claimed. A time limit of 84 days after the claiming party became aware, or should have become aware, of the events giving rise to the claim is set for providing this fully detailed claim. Special emphasis is placed on requirement (2) to the extent that failure to submit that requirement in specific within the 84 days shall invalidate the notice of claim given. This then triggers the procedures similar to those under sub-clause 20.2.2, where the engineer notifies within 14 days the claiming party and the consequences of the engineer failing to provide such notification within the 14 days.

20.2.5 'Agreement or determination of the claim'	This sub-clause sets out the engineer's obligation to provide a determination on the submitted claim. Importantly, it mentions that if the engineer notified the claiming party that the claim is time-barred under sub-clause 20.2.2 and/or 20.2.4, the engineer will nevertheless proceed with determining the claim. The determination should include whether the notice of claim is valid or not, taking into account the points raised by the claiming party when disagreeing with the engineer's notice that the claim is time-barred. The sub-clause lists three examples of circumstances that may be taken into account by the engineer to justify the lateness of the notice by the claiming party (although, the sub-clause mentioned that these circumstances shall not be binding on the engineer), which include: (1) whether and the extent to which the other party was prejudiced by acceptance of the late submission; (2) whether the other party had prior knowledge of the event; and (3) whether the other party had prior knowledge of the contractual/legal basis of the event.
20.2.6 'Claims of continuing effect'	This sub-clause addresses the situation where the event or circumstance giving raise to the claim has a continuing effect.
20.2.7 'General requirements'	This sub-clause includes general provisions such as: (1) the engineer will include in the interim payment certificates the amounts reasonably substantiated by the claiming party; (2) the employer will only be entitled to set off or make any deduction provided that the provisions of clause 20 are complied with (the concluding statement of sub-clause 2.5 of the 1999 edition); and (3) if the claiming party fails to comply with the provisions of this clause, the engineer will take into account the extent to which such failure prevented or prejudiced proper investigation of the claim (the concluding paragraph of sub-clause 20.1 of the 1999 edition).

Table 1: Summary of the claims procedures under clause 20 of the FIDIC 2017 Red Book

It is observed from the above that, while the 1999 edition contains a single time bar in sub-clause 20.1, the 2017 edition contains two time bars. The first is the time bar of the 28 days in sub-clause 20.2.1 for submitting the notice of claim and the second is the time bar of the 84 days in sub-clause 20.2.4 for submitting the contractual and legal basis for the claim as part of the fully detailed particulars submission. The 2017 edition contains provisions that may invalidate each of these time bars and may render the claim invalid despite the notice being submitted late. Obligations are placed on the engineer to notify the claiming party that its claim has been time-barred for late submission and leeway has been given to the claiming party to justify the circumstances for the late submission of the notice or of the contractual and/or legal basis of the claim. However, notwithstanding these provisions, which may be perceived to be a softening of the time bars in the new edition, there are challenges for the implementation of the new claim procedures in the context of the civil law jurisdiction of Egypt, among which is the principle of good faith. To understand these challenges, it is beneficial to consider some basic principles under the Egyptian Civil Code (ECC) with respect to the principle of good faith.

Good faith principle under the Egyptian Civil Code

Al Sanhoury on good faith

The provision of good faith is a mandatory requirement for the performance of any contract pursuant to Article 148 of the ECC, which states:

> 'A contract must be performed in accordance with its contents and in compliance with the requirements of good faith. A contract binds the contracting party not only as regards its expressed terms, but also as regards everything which, according to law, usage and equity, is deemed, in view of the nature of the obligation, to be a necessary sequel to the contract.'

To gain a clear understanding of this legal principle, we look to Professor Abdel Razzak Al Sanhoury, a renowned scholar in the Arab world and beyond, known for his 12-volume work titled *Al-Waseet fī sharḥ al-qānūn al-madanī al-jadīd* (Medium commentary on the new Civil Code), which was written in Cairo between 1952 and 1970. In the first volume of this work, paragraph 413, Al Sanhoury provides a commentary on Article 148 of the ECC. Before discussing good faith, Al Sanhoury elaborates in paragraphs 411 and 412 on the principle of the 'contract is the law of the parties' in Article 147/1 of the ECC and explains that the contract reflects the will of the contracting parties and, therefore, constitutes the law (although, he clarifies, it does not supersede the mandatory provisions of the law in absolute terms) that binds these parties in their contractual relationship. As such, the contract cannot be altered without the parties' mutual consent. He states that, even if a judge attempts to alter a contract for the purpose of achieving justice, the judge cannot implement this alteration by law. The significance of this observation is that Al Sanhoury titles paragraph 413, which comments on the principle of good faith in Article 148, as 'But the Contract Must be Implemented in a Manner that is in accordance with what Good Faith Entails'. The keyword here is 'But', as it indicates that the exception to the principle of 'the contract is the law of the parties' is the principle of good faith. Al Sanhoury clarifies that good faith under the 'new' Civil Code of 1948 is a mandatory requirement for the performance of all contracts and that there is no longer the concept that the Roman principle of *contracts de droit strict* (strict or literal application of contracts) can be applied in some contracts, while good faith (referred to as *contracts de bonne foi*) would be applied in others. Rather, good faith encompasses all contracts, whether at the formation stage or at the implementation stage.[9] It is

also worth noting that Article 148 is not limited only to the principle of good faith, which can be regarded as a nebulous term; 'law, usage and equity' can also complement the express contract terms.

Good faith and time bar clauses

Despite the significance of the principle of good faith in Egyptian law, the effect of the principle of good faith on the enforceability of time bar clauses is so scarcely addressed in Egyptian literature that reference has to be made to literature produced by law practitioners in the Middle East to draw parallels with Egyptian law. Although such reference may not fulfil the requirements of academic rigour, it is necessary as it provides insight from practitioners of a common law background, but who are practising under civil law in the Middle East. For example, Glover addresses the time bar clause under sub-clause 20.1 of the FIDIC 1999 Red Book with specific reference to the Egyptian and French Civil Codes and refers to the principle of good faith in civil code jurisdictions and describes it as being a mandatory provision of the law or public policy, which may defeat the time bar clause under sub-clause 20.1.[10] In 2015, Glover uses the United Arab Emirates (UAE) Civil Code as the basis for the civil law position and opines that the Civil Code application may adopt 'a more lenient approach' in comparison to common law.[11] On the principle of good faith,[12] he states that if an employer was made aware of the contractor's intention to claim in such manner, the employer could be seen as acting in bad faith if he later argues that the contractor did not meet the contractual timeframe. Alternatively, a time bar provision may not be relied upon by an employer in circumstances where the employer is in breach and was fully aware that this breach would cause delay to the project.

Similarly, Hall and Warren refer to Article 172 under the Qatari Civil Code[13] to argue that the principle of 'good faith' may be used to defeat the FIDIC 1999 time bar, although the circumstances in which it may apply vary and may be limited in scope.[14] They give an example of a situation where the employer denies the contractor an extension of time claim on the grounds of non-compliance with the notice requirement, when the employer or engineer knew, or ought to have known, that the contractor had been delayed for reasons that are contractually attributed to the employer. King echoes the statements made by Glover seven years earlier, as she compares the concepts of good faith in English law and the UAE Civil Code.[15] She concludes that the time bar under sub-clause 20.1 of the FIDIC Red Book may be restricted where the party relying on it knew about the breach, whether informally or through a meeting for which minutes were taken, because denial of a claim due to the time bar when it had already been communicated, even if informally, would constitute an act of bad faith.

Challenges to the implementation of the FIDIC 2017 edition

It can be stated that one of the challenges for the implementation of the claims procedures in the FIDIC 2017 edition with respect to Egyptian law is that a second time bar was introduced in the procedure. Thus, not only is the 'claiming party' (the term used in the new 2017 edition) barred from an entitlement to a claim if a notice is not given within 28 days pursuant to sub-clause 20.2.1, but also, pursuant to sub-clause 20.2.4, the claiming party is barred from entitlement through the invalidation of the claim notice given if the contractual and legal basis of the claim is not submitted within 84 days from the event giving rise to the claim. In light of the above highlighted points raised by legal practitioners in the Middle East, the new arrangement triggers a few questions:

- If the 'other party' (ie, the term used in the new 2017 edition) knew, or ought to have known, of the claim for which a notice is given, wouldn't such knowledge render unenforceable the other party's rejection of a late notice by the claiming party?
- If the other party is in breach of its contractual obligations, can these time bars be relied upon by the other party to reject a valid claim submitted by the claiming party?
- If a valid notice is submitted by a claiming party within 28 days, but the contractual and legal basis of the claim is not submitted within 84 days, is it 'equitable' (the term used in Article 148 of the ECC) to render the notice invalid and consequently reject the claim?
- If a claiming party abides by the timelines in the claim procedures, but does not abide by the requirements of a notice under sub-clause 1.3 (eg, the letter is not identified as a notice or the sub-clause in question is not made reference to in the subject of the letter), would such non-compliance with notice requirements invalidate the claim under Egyptian law? This question applies not only to the claim procedures, but also to all provisions in the FIDIC 2017 edition that require a 'Notice' to be given.

The answers to these questions may be debatable, as there could be a tension between the principle of the 'contract is the law of the parties' set forth in Article 147/1 of the ECC and the principle of good faith, equity and custom being sequels to any contract in Article 148. This is especially the case in the third and fourth questions, as they relate to compliance with procedural requirements that have been agreed to by the contacting parties. The first two questions seem to be more

straightforward, as the situations posed therein may interfere with the mandatory requirement of good faith in Article 148 and would most likely not invalidate a claiming party's claim.

It is acknowledged that the new edition provides leeway so that the two time bar clauses may be subject to re-assessment by the engineer (referred to in the next section as a possible 'civil law influence'), but it is worth distinguishing between a matter that is left for the engineer to determine and a matter that is mandated by law. It is suggested that the route taken by the FIDIC 2017 edition is the former, which can subject the engineer determination to controversy and debate that may be finally decided upon by a dispute adjudication and avoidance board (DAAB) or an arbitration tribunal. This is especially the case considering that the engineer may not be familiar with the intricacies of the Egyptian law and may most likely determine a dispute on factual and contractual grounds only, irrespective of any applicable Egyptian law principles.

A civil law influence?

One distinctive observation in the claim procedures of the 2017 edition, which distinguishes it from the 1999 edition, is the leeway given to reconsider claims that have been time-barred under the contract. This is reflected in sub-clauses 20.2.2, 20.2.4 and 20.2.5. In sub-clause 20.2.2, the claiming party is entitled to submit reasons that justify the lateness of a submitted notice to claim, while in sub-clause 20.2.4 the claiming party is entitled to submit reasons that justify the lateness of submitting the contractual and legal grounds for a claim. Sub-clause 20.2.5 obligates the engineer to determine the claim, notwithstanding whether the claim was time-barred under sub-clause 20.2.2 or sub-clause 20.2.5. Importantly, as mentioned in Table 1, sub-clause 20.2.5 lists three examples of circumstances that may be taken into account by the engineer to justify the lateness of the notice by the claiming party. An examination of the three circumstances, while taking into account the discussion above regarding the literature produced by legal practitioners in the Middle East, demonstrates that all factors have bases under the ECC, where at least two are directly associated with the principle of good faith. The first factor is 'whether or to what extent the other Party would be prejudiced by acceptance of the late submission'. It is suggested that this factor is related to the principle set forth in Article 224 of the ECC that 'damages fixed by agreement are not due if the debtor establishes that the creditor has not suffered any loss'. Although the ECC provision more appropriately addresses liquidated damages, the applicable principle here is that the breach of contract must have caused loss to the other party. Thus, if the other party did not suffer any loss or harm as a result of the late notice, the time bar would not be applicable. An analogous principle is reflected in Article 5 of the ECC, which outlines factors that constitute an unlawful exercise of a right (often referred to as the doctrine of 'abuse of right'), among which is 'if the benefit it is desired to realise is out of proportion to the harm caused thereby to another person'. Again, the emphasis here is on 'harm' and if it is out of proportion to the benefit realised from applying the contractual principle. Accordingly, if the claiming party is seven days late for submitting a notice of claim worth US$1m, it can be considered that the benefit realised (claim rejection due to seven-day notice delay) is out of proportion to the loss caused to the claiming party (US$1m) thereby rendering the other party's reliance on the time bar abusive. In both scenarios, the common denominator is the harm/loss factor or, in FIDIC's words in sub-clause 20.2.5, the 'extent of prejudice' suffered by the other party as a result of the late notice submission.

The second and third factors are associated with 'any evidence of the other party's knowledge of the event or circumstance giving rise to the Claim' (second factor) and 'the contractual and/or other legal basis of the Claim' (third factor). It is suggested that both of these points are directly associated with the principle of good faith, equity and usage under Article 148 of the ECC. It is submitted that the above highlighted factors that the engineer may consider (although not bound to) when determining a dispute, coupled with the 'advance warning' provision in sub-clause 8.4 with respect to each of employer and the contractor, are signs of influence from civil law jurisdictions in the drafting of the 2017 FIDIC edition.

Conclusion

Although the principle of good faith was one of the challenges for the enforcement of the time bar in sub-clause 20.1 of the FIDIC 1999 Red Book, the challenge in the claim procedures within the 2017 edition has become twofold in light of the two time bars included in sub-clauses 20.2.2 and 20.2.4. The challenge, however, is somewhat diluted with the leeway given regarding the claiming party's justification for a late notice and the engineer's consideration of these justifications. It is suggested in this article that the civil law influence, through the principle of good faith, has seeped into the claims procedures in the new FIDIC edition through the circumstances the engineer may consider when determining if a claim is time-barred by a late notice submission. Although sub-clause 20.2.5 states that the engineer is not bound to consider these circumstances, contracting parties are advised that such circumstances may be considered binding under the civil law jurisdictions of Egypt as well

as several Middle Eastern countries.

Notes

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Where are the expert women?

Sandra Somers
Driver Trett, Singapore

Being a provider of expert witness services for the construction industry means consistently delivering great quality service and real value. To succeed, consultancies providing these services must use only the most able professionals in the business and therefore they need to strive to be the employer of choice. To achieve that, we need diversity. As far as diversity goes, The *Wall Street Journal* states appropriately:

> 'Research shows that gender equality is as good for business as it is for individuals. Diverse teams and companies produce better results and higher revenue and profits, which lead to more opportunity for everyone, not just women.'[1]

We all know how women in construction are under-represented, so much so that the subject is often reported in the global media. For instance, in the United Kingdom, the *Guardian* newspaper reported that women made up just 11 per cent of the UK construction workforce in 2015 and that one per cent of this figure accounted for female site operatives. This is a slight improvement from 2002/3 where women accounted for nine per cent of the UK construction workforce.[2] In 2018, this figure increased marginally to 12.4 per cent.

Below, figure 1 summarises the information published from a number of sources on women in the construction industry globally and is inclusive of site trades. Specific countries where a comparison over time can be made are Germany, which reached a plateau of 14 per cent in 2013/14; and Australia, which shows a very slow and practically incremental increase of 0.3 per cent over a period of six years.

	Year								
Country	2008	2010	2012	2013	2014	2015	2016	2018	Notes
UK						11		12.4	9% reported in 2003
Greece					2				
Germany			13	14	14				
Scandinavia					35				'Women with golden skirts'
USA							9.1		
Peru								30	Female participation in rural road maintenance only
India	50								Of that 50%, 1.4% are engineers or construction professionals, the remainder are female labourers
China		33							Majority of females are labourers
Cambodia							20-40		Females are labourers only
Japan								3	
Australia				11.7	11.9			12	

Figure 1: Percentage of women in construction inclusive of site operatives[3]

Looking at Europe, it is apparent that there is a disparity ranging from the lowest (Greece at two per cent in 2014) to the highest (Scandinavia at 35 per cent in 2014) of the data presented. Of this 35 per cent, four per cent are chief executive officers (CEOs) and 15 per cent are board members. It should be noted that Norway introduced a 40 per cent female representation quota in 2003, due to a general lack of females in senior positions. However, this created a phenomenon known as 'women in golden skirts', meaning that one woman would hold multiple senior positions in a variety of companies in order to fulfil this quota. This phenomenon distorts the true picture in this context.

In Cambodia and Peru, more or less one-third of the construction workforce are women. However, this is purely as site labourers working in the lowest paid positions 'without equal pay for equal work'. For Peru, participation is only for road maintenance in rural areas. In China and India, very few women in construction are not working as labourers. In India, despite half the workforce being female, this has resulted in a significant decrease in females studying engineering.

Discounting Scandinavia, it seems that in the more developed countries the percentage of females in construction is between 3 and 14 per cent.

Discounting Scandinavia, it seems that in the more developed countries[4] the percentage of females in construction is between three and 14 per cent, with Japan having the lowest participation and Germany the highest.

Interestingly, these statistics are comparable to the figures relating to the appointment of female arbitrators. The London Court of International Arbitration (LCIA) annual report for 2013 shows 9.8 per cent of the 162 appointees selected by the LCIA and 6.9 per cent of the 160 appointees selected by the parties were female.

At the International Chamber of Commerce (ICC), the number of female arbitrators nominated by parties or co-arbitrators, or appointed by the court, was at 10.4 per cent in 2015.[5] This is still less than the 11 per cent of women in construction in the same year in the UK.

Where are the women in construction?

Focusing on the role of construction professionals, it is apparent that this is a global issue compounded by the fact that a majority of construction markets are suffering from a skills crisis. A recent international survey performed by Turner and Townsend showed that 56 per cent of the construction markets analysed are currently suffering from a skills shortage, up from 46.5 per cent in the previous year.[6]

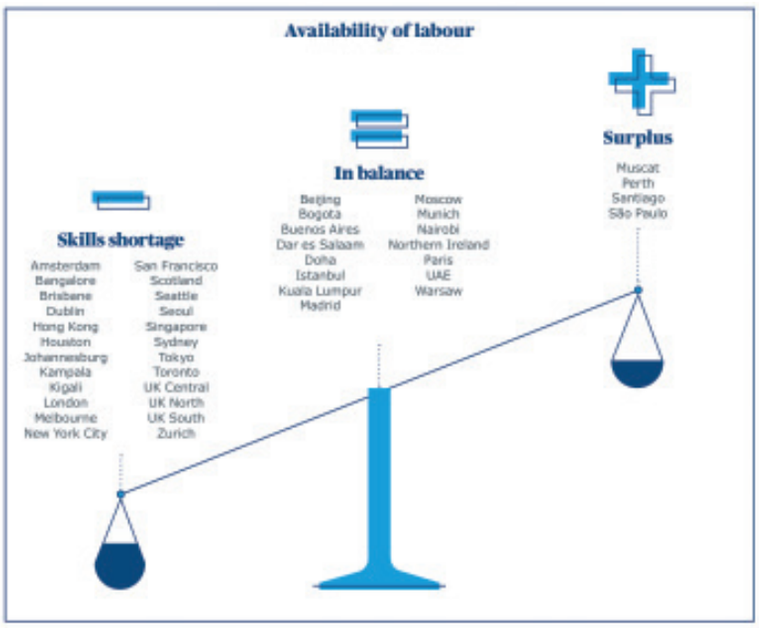

Figure 2: Availability of labour, reproduced from Turner and Townsend International Construction Market Survey 2017

Taking the UK as a working example, the failure to attract females into construction may have something to do with the lack of knowledge of construction as a career option in the first place. A recent report from early 2017[7] found that construction was not promoted to the girls surveyed across several secondary schools. The report explained that 'the industry is offered as a career choice to boys but thought as traditionally not for girls. People think the industry has a macho culture and they think women can't progress within it'.

The stigma associated with working on-site was found to be the cause of the lack of interest in taking this career option in most, if not all, other countries where reports were available. Other issues included: lack of female facilities and poor maternity entitlements, to a (sometimes significant) wage gap between male and female workers. Despite these issues being identified by various main contractors and government bodies, there has been little improvement.

This is also reflected in the very low number of women studying construction at university (a very humble eight per cent)[8] although this figure is almost doubled for female engineering students.[9]

In terms of women filling the more senior managerial roles in the sector, this was also around eight per cent in 2008.[10] More recent figures indicate that this number doubled in 2016.[11]

This is in direct contrast to the legal profession where '[i]n most countries of the world, women make up the majority of law students',[12] at approximately 60 per cent.[13] However, when it comes to the more senior positions in law, for instance managing partner level, only four per cent are women.[14] This is notwithstanding that women may take a career break or leave the legal profession, which is likely to slow progression. As a very broad statisitic, Harvard Business Review reports that around 43 per cent of highly qualified women (inclusive of other professions) leave to have children and of that 43 per cent, it was found that 93 per cent want to return to their careers and 74 per cent actually do return.[15]

... when it comes to the more senior positions in law [...] only four per cent are women.

For construction and engineering, it follows that if there are fewer females entering the sector, logically there can only be fewer females holding senior positions or going on to become experts. This logic seems to dissipate in the legal sector.

The low number of female construction professionals and operatives is fairly surprising given that the industry, especially in the UK, has worked hard over the past couple of decades to try not only to improve, but also to change peoples' perceptions. This change came about as a result of the Latham Report entitled *Constructing the Team*, published in 1994. Fundamentally,

the report was commissioned by the government to review the procurement and contractual arrangements in the industry, which were so badly in need of reform.

Sir Michael Latham's report is regarded as highly influential, having had a significant impact on the industry at the time. A number of the recommendations made in the report were implemented into UK legislation via the Housing Grants, Construction and Regeneration Act 1996 (more commonly known as 'the Construction Act'), as well as through other bodies formed specifically to deal with issues that were raised.

Although the Latham Report is more famously known to have identified poor payment practices and helped to reform the adversarial nature of the industry by advocating practices such as partnering and collaboration, it is less known for its attempts to address gender equality. Under paragraph 7.24 the report states:

> 'Women are seriously under represented in the industry. There is no obvious reason why this should be so at a professional consultant level, while the traditional excuses offered in respect of site operatives are becoming less relevant as the building process becomes more mechanised, there is more off-site prefabrication and plant replaces labour.'[16]

Recommendation Number 20 out of a total of 75 recommendations (including sub-recommendations) of the report then states: 'Equal opportunities in the industry also require urgent attention.'

Notwithstanding this, four years following the Latham report, the Eagan report was published in 1998. The report, entitled *Rethinking Construction*, states it was built upon the 'firm foundations' that Latham laid. The scope was intended for improving quality and efficiency in UK construction. Despite this, there is not a single mention of equal opportunities or diversity.

Girls on site

Historically, in 18th century Britain, women could be found as apprentices in a host of construction occupations including bricklayers, carpenters, joiners and shipwrights.[17] This was made possible through the Statute of Artificers of 1562–63, which set the framework for the parish apprenticeship system and was not gender-specific, referring to apprentices as 'persons' or 'boys and girls'.

However, this statute was repealed in the early 19th century[18] and women could no longer work in the building trades until World War I and II. This re-entry was agreed upon between the government and trade unions as long as wages were kept lower (around a third of that of the men) and women were obliged to be released from their positions after the war.

Returning to more recent times, I asked a number of female construction professionals what challenges they faced when working on site.

One female, from a European country where there are extremely few females in construction, had originally graduated as a civil engineer. She worked her way up to site agent and eventually went on to become an expert witness. She stated that there were many challenges along the way that she attributed to being a woman, including:

- being refused a job with a contractor;
- having her own foreman refuse to talk to her; and
- not being viewed as competent despite being a chartered engineer.

She found that directing men was particularly challenging, as they appeared to doubt her and more effort was required to justify her decisions.

Having been based in London for some time now, she still finds that even though she is an established and respected expert in her field, she sometimes gets the feeling that male clients would prefer to talk to her male colleagues.

This statement is very much in line with studies performed by Cettner (2008),[19] who found examples of harassment, such as client representatives not wanting to shake hands with female representatives of the contractor. Cettner also found examples of open resistance from male colleagues towards female colleagues.

Gender issues can also be identified within the legal profession, as the IBA Legal Policy and Research Unit's (LPRU) international survey[20] found discrimination due to gender had been experienced by two-thirds of women compared with ten per cent of men. The report, *Women in Commercial Legal Practice*, states: 'Women more commonly report having experienced discrimination than men,

[Despite being a] respected expert in her field, she sometimes gets the feeling that male clients would prefer to talk to her male colleagues.

particularly in relation to gender, age and career responsibilities.'[21]

For construction, it is difficult to determine the full extent of discrimination against females. Comprehensive and conclusive data does not seem to be available. Recent reports range from a female in Japan being stopped by a client from inspecting a concrete bridge, despite the fact that she was the only engineer on site qualified for the job;[22] to construction being described as 'the last frontier for women at work' by Australia's *Sydney Morning Herald*.[23]

Alternatively, there are plenty of positive reports. Working on site there can be a great feeling of comradery and protectiveness; the willingness to pass on knowledge from the senior, more experienced staff to juniors is endearing; it's a fast-paced, decisive and stimulating industry. You deal with people from all walks of life; it is both challenging and rewarding.

In terms of expert witness services within construction, consultancies generally consist of project planners, engineers and quantity surveyors. Many of us also have advanced qualifications in law and alternative dispute resolution (ADR); we may even be non-practising barristers. In terms of the work that we do, this places us somewhere between the two arenas of construction and law. It is evident that because of the statistics from both these separate industries, insofar as the numbers of women are concerned, the implication is severe.

The female expert witness

Focusing just on the role of expert, I asked a number of experienced senior legal and construction professionals their views.

Generally, female experts are seen as a rare breed. As a rough estimate, one in every ten experts is a woman. Other senior legal professionals recall working with one or two female experts within construction in the whole of their already long and successful careers to date. This is something to be expected, simply because the role grows through the construction sector where female under-representation already exists.

Nicola Cohen, Chief Executive from the Academy of Experts, reports that in very broad terms, the ratio of men to women that go through the academy is probably eight to one across the board. However, Cohen states that, from experience, this ratio is definitely less in accountancy and other areas, such as the medical disciplines. This is interesting because although it indicates that the disparity between the male to female ratio in construction is one of the highest, the same issue permeates other industries, even if to a lesser extent.

Given there is only a slim chance that a female will become a student of construction, not to mention in getting through life on site, how do you actually go on to become an expert witness?

I asked Wendy MacLaughlin of HKA this question. MacLaughlin is one of two female experts listed in the 2017 Who's Who Legal, in fact she is the only female expert listed for delay matters and she is cited as 'the highest-rated Expert at the firm'. She states: 'It was not by design that I became an Expert, and I don't refer to myself as that, I'm a delay analyst. What I didn't know was that… delay analysts would be appointed as Experts.'

This is also the case for myself and other female experts with whom I spoke. They found themselves in the position as a natural progression from their current role. Whether this differs from male counterparts cannot be determined without further study.

What about performance?

The feedback on how well these women perform is positive. Leading international arbitrators, senior barristers and counsellors to whom I spoke all agreed that the female experts they have worked with were excellent and generally better prepared. One senior barrister went so far as to say women are 'clearer in their reports and in the witness box and tend to have done more work themselves'.

This feedback is very encouraging. So aside from the sheer lack of numbers, what else is holding us back?

Cohen from the Academy of Experts explains: 'Firstly, being an Expert is certainly not for everyone irrespective of gender. In addition to knowledge and experience, one has to be prepared to be "shot at in public", work totally anti-social long hours frequently at very short notice.'

Further, the Society of Women Engineers states that there isn't a strong network of females in engineering. The American Society

[All legal professionals] agreed that the female experts they have worked with were excellent and generally better prepared.

of Mechanical Engineers (ASME) and UK organisation *#ChicksWithBricks* also include the lack of female role models as a factor. Further, the Institution of Engineering Designers[24] state the number of females choosing to study science-related subjects in the UK is the lowest in Europe and that diversity is required to overcome this problem. Overall, confidence came up as a key factor.

The feedback from senior legal professionals is: the tendency is to appoint the same experts in the same way that people appoint the same arbitrators, and those experts tend to end up being men. A further observation from an acclaimed female QC in construction is: 'Just as most people think of men when you say "Arbitrator" or even "Counsel", they think of men when you say "Expert Witness".'

This is certainly supported by the available statistics for the appointment of arbitrators and females at partner level. With regard to statistics for the appointment of experts, this information is not available. However, it has to follow that if the majority of experts are men, then the tendency would be to expect the same.

The head of dispute resolution at a leading law firm in Singapore stated that he had seen good and bad experts of both sexes (this is inclusive of other industry sectors such as medical) notwithstanding the general rarity. He stated that he would not consciously insert the gender debate into any expert selection process, but considered it was all about competence and steadiness, which overshadow sensitivities over gender.

This statement is interesting because it infers the 'best person for the job' argument, which relies upon the person(s) making the decision to not be affected by their own unconscious bias, should it exist. The problem is, most people do not always know that it exists within them, hence the term unconscious bias.

Regardless of this, how do you become the best person for the job if you are persistently encountering unconscious bias? Owing to its competitive nature, this argument (if taken to extremities) encourages women to see each other as the enemy. This can result in women taking on more masculine traits or adopting a masculine value system[25] to become 'one of the boys' and hoping to be included, instead of utilising more natural feminine traits, such as communication and team work – essential attributes for any workplace.

Good advice would be to overcome these obstacles by showing colleagues your brilliance, which means working extra hard and being extra good at whatever it is you do. This will mean being persistent and mustering your courage. More significantly, it will also remove any shred of doubt that you are not the best person for the job.

Are things changing?

It is evident that times are changing, albeit slowly and more in some areas than others. Certainly, the LCIA has reported a significant improvement for the year 2016. In terms of diversity, 20.6 per cent of arbitrators appointed that year were female. However, this was largely attributable to LCIA nominations (as opposed to party nominations), who made 78.4 per cent of the selections. This tells us that the change is being implemented by the institution rather than by the parties and in reality represents very small numbers.

The ICC also reports that the most noticeable growth occurred between 2015 and 2016, where the proportion of female arbitrators jumped from 10.4 per cent to 14.6 per cent. In March 2017, the ICC also launched a section on its website dealing specifically with diversity. Abhinav Bhushan, ICC Director for South Asia, states: 'In so far as appointments are concerned, be it Arbitral, Mediation or Experts, we make no distinction and our stress on gender diversity is equally applicable to all these areas.'

Further, there is the work of Arbitral Women,[26] an international non-governmental organisation with the primary objective of advancing the interests of women and promoting female practitioners in international dispute resolution; and the Equal Representation in Arbitration (ERA) Pledge, which is a call to the international dispute resolution community to commit to increase the number of female arbitrators on an equal opportunity basis.[27] This pledge recently extended to include experts of all sectors.

Notwithstanding this, the number of women appointed to construction arbitration tribunals is still fewer than in other sectors. This includes the appointment of females to dispute boards, where, as an example, the FIDIC Presidents list has three female panellists out of a total of 69. Percentage wise, the number of female panellists is 4.3 per cent. When comparing this figure against a sample ratio of male to female barristers practising construction, this

percentage ranges between 24 and 33 per cent worldwide.[28] For legal professionals in band 1 law firms practising construction worldwide, this ratio is around one-third female[29] and includes all levels from associate to legal director. Note, however, that the number of females at partner level and above ranged between 3.6 and 15 per cent. The sample percentage of female practitioners of construction law does not appear representative against the FIDIC presidents list.

Further, the IBA LPRU report states: 'women's progression to senior positions and positions of authority within commercial law firms appears to have stalled'. Further, despite the introduction of diversity policies, law firms, '… after 30 years, have been found to be wanting'.

Interestingly, MacLaughlin states: 'I've worked on matters where from Partner to consultant everyone in the law firm and Expert team has been female, apart from the client. Brisbane is a 50:50 mix, as are most of our offices in Australia. London on the delay side is also 50:50.'

With my present employer in Asia, we have an unusually high proportion of female consultants in Hong Kong and Singapore. In view of this, it was felt that a mentoring scheme would be of great benefit, something not often formalised in the construction sector. To date, the scheme is proving very successful, such that a similar initiative for the male consultants is currently being discussed. It is hoped that this initiative will start the ball rolling and extend further into other offices across the globe.

Further, Cohen from the Academy of Experts notes: 'recently I have noticed an increase in female applicants especially in construction. We are also seeing an increase in those applying who are at the early stages of their "Expert" work.'

As for women in construction, the Randstad Report for 2016 forecasts that women are expected to make up a quarter of the UK workforce by 2020[30] and is likely to be instrumental in plugging the skills gap. However, the Randstad Report does not state how this will happen.

Generally, this progress is reassuring for women in arbitration and construction, including any potential future experts; however, this does not appear to be the case for women in commercial legal practice, particularly female construction lawyers.

What else can be done?

For female experts and women in the legal profession, the guidance on what we can do in terms of progression converges. However, as well as networking, profile building, finding support for yourself and helping others, what else can be done?

Credit: GBALLGIGGSPHOTO/Shutterstock

Women need to start promoting themselves much earlier, says a leading female international arbitrator. Apparently, this does not happen until later when compared to male counterparts. If you are interested in becoming an expert, as well as training at the Academy, MacLaughlin suggests finding a barrister who can give you a mock cross-examination on something you have written and see how you fare.

The IBA LPRU report also showed that as well as mentorship being important, sponsorship came up as 'critical', but only as a formal and transparent programme.

What is encouraging to see of late is a leading Australian law firm[31] taking the initiative and providing a series of seminars tailored specifically for female experts. This was set up to address not only female under-representation, but also the fact that new experts often struggle to be appointed.

For construction, there are many initiatives and attempts being made to attract more women; however, they are fragmented or distorted and ultimately failing to have any significant impact. Across the continents, it is apparent that strategic leadership is required. Currently there is no strategic body that regulates the industry as there is in the finance and health sectors.

One long-term solution would be to have single-sex schools or single-sex classes for science, technology, engineering and mathematics (STEM) subjects. The results show that single-sex schools have approximately equal numbers of girls taking arts and humanities subjects as there are taking maths and science subjects at Advanced Level.[32] It was also found that girls perform better academically than those at mixed schools.[33] Promotion of single-sex schools may seem extreme, but so are the low numbers of females in construction and engineering.

Looking at diversity in general, there is the recently launched Alliance,[34] which seeks to facilitate equality of opportunity for all in dispute resolution, regardless of background, location, sex, ethnicity or age, and works with others to achieve these aims. One of the founders, Lucy Greenwood, was recently awarded the 2018 Diversity Award.[35]

The WomenLEAP organisation (which is not specific to any sector) has an 'Allies in Action' programme, which is a calling to all people in society to take responsibility for changing patterns of injustice where they are in a strong position to do so themselves. For instance, 'Allies include men who work to end sexism, white people who work to end racism, heterosexual people who work to end heterosexism, able-bodied people who work to end ableism, and so on'.[36]

This is interesting because it tells us that those who find themselves in a strong position or status in life have the capacity to effect change. This means that these people are by default leaders and therefore role models. The lack of female role models came up as an issue as one of the barriers to entry and also why women are harder to retain. It follows, then, that any woman in construction (whether as a construction or legal professional) holds the position of role model whether they are aware of it or not.

Conclusion: changing mindset

Most countries will have mandatory health and safety training before and during working on a construction site. Fundamentally, this training is about changing mindset and raising awareness of the dangers that can and do exist, but which are not always obvious to the untrained eye. For instance, something that might not immediately appear to be a risk or a hazard could at some point later cause an incident. An example of this would be leaving materials and tools scattered where someone walking by could slip, trip or fall resulting in an injury. Another example would be walking past a group of labourers operating a mobile elevated working platform (MEWP) and noticing that not all of the feet are on the ground. This would make the platform unstable and could result in the MEWP overturning.

Health and safety training teaches us that the responsibility to call out risks and hazards lies with every single person on the site team. This includes not only the main contractor, but all sub-contractors and the client. The underlying message being, it is far better to say something than to walk on by and assume this is someone else's problem or even not a problem at all. It's about showing a duty of care to your colleagues regardless of whether you know them personally or not. This changing of mindset has been and continues to be an upward struggle; however, with persistence and tenacity, it has broken through not only ignorance but also apathy

and acceptance with regards to creating a safer work environment.

Similarly, the issues of ignorance, apathy and acceptance also apply to gender equality in terms of changing the current mindset. Certainly, apathy and acceptance must be broken and ignorance transformed by continuing to raise awareness of these issues. Ignorance exists because we do not always see what is going on around us and, more to the point, we do not know how to see it. The reasons apathy and acceptance exist may be because of not wanting to upset the status quo, and also not wanting to be tarnished as a supporter of 'feminism' – something that has had a negative connotation thanks to propaganda since the days of the suffragettes in the late 19th and early 20th centuries. The desire of not wanting to be tarnished includes both males and females alike. However, one must ask, now we have reached the 21st century, have we not gone beyond this?

Bearing all this in mind, and just as vehemently as health and safety, any passer-by is responsible in calling out against apathy, acceptance and ignorance in order to effect change.

A consequence of not doing this has resulted (in the UK at least) in opportunities to effect change then being lost. This is with direct reference to the Latham and Eagan reports, and the failure to secure the continuation of female employment in the trades following the First and Second World Wars with the trade unions.

In summary, a comparison can be drawn from the information available regarding women in construction and women in the legal profession. Similarities exist in that there are very few women taking senior positions in both sectors; this includes the number of female experts. For construction, a key factor is the sheer lack of numbers in the first instance. In view of this, becoming an expert will be a ratio to the number of construction workers in total; therefore, until the base level number of women in construction increases in proportion to their male counterparts, it is unlikely that the expert level ratios will improve.

The lack of women in construction starts young, in what can only be described as gender bias where it is not a profession that is encouraged 'for girls'. However, this is clearly not the case for the legal profession where the number of female graduates outnumbers that of males and yet progression to the more senior levels is not necessarily proportional. It could be argued that the male to female ratio will never be equal, if we consider other factors, such as the number of women leaving to raise families. However, a significantly high proportion of highly qualified women will return to work after a career break.

Both sectors report discrimination, however. For law institutions such as LCIA and ICC are confronting these issues with slow but obvious success. Diversity policies in commercial legal practice and recent attempts to attract women into construction do not appear to have been all that effective. However, according to certain predictions, the future is bright (at least for construction) and there does appear to be an increase in the number of women emerging as expert witnesses.

Notes

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Forensic schedule analysis methods: reconciliation of methodologies' different results

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Perceived wisdom within the construction industry is that different Forensic Schedule Analysis (FSA) methods produce different results on the same set of facts. Although there are many potential variables that could cause this, such as bias of the analyst or the quality of the implementation of a method, some experts have expressed concern that because the methods themselves generate different results, some may be potentially defective. This paper will explore that question by examining a specific set of facts and applying each of the four major FSA methods – as-planned versus as-built (APAB), Windows, time impact analysis (TIA) and Collapsed As-Built (CAB) – to those facts. Further, the paper will explain how and why that occurs, how to quantify and reconcile the differences and what conclusions a FSA expert should draw from those differences.[1]

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Forensic schedule analysis methods

Forensic schedule analysis (FSA) is the applied use of scientific and mathematical principles, within a context of practical knowledge about engineering, contracting and construction means and methods, in the study and investigation of events that occurred during the design and construction of various structures, using the critical path method (CPM).[2] An analyst begins an FSA with: (1) a review and analysis of the planned construction sequencing in the baseline schedule model; (2) calculation and analysis of activity duration (with respect to planned quantities, estimated resources and productivity levels), activity sequencing and resource scheduling; and (3) the evaluation of the trade-offs between cost and time. The analyst then, either by using the existing schedule model or by creating mathematical or statistical model, analyses in a verifiable and repeatable manner how actual events interacted with the baseline model and its updates if appropriate. The form that the mathematical or statistical model takes defines the analysis 'method.'

This paper references methodologies recognised by both AACE International's Recommended Practice on Schedule Delay RP29R-03 (2011) ('RP29R-03') and the Society of Construction Law's Delay and Disruption Protocol 2nd Edition (2017) ('DDP2'). While there are significant areas of overlap, the two expert guides have different purposes: DDP2 is intended to 'provide useful guidance on some of the common delay and disruption issues that arise on construction projects, where one party wishes to recover from the other an extension of time (EOT) and/or compensation for additional time spent and the resources used to complete the project.'[3] It is intended for use both during the project as part of the management system, as well as after-the-fact dispute resolution.

AACE's Recommended Practice on Forensic Delay Analysis (RP29R-03) states it is intended 'to provide a unifying reference of basic technical principles and guidelines for the application of critical path method (CPM) scheduling in forensic schedule analysis.'[4] Its focus on the methodologies and associated issues is purely forensic.

While using slightly different names, DDP2 and RP29R-03 essentially describe identical methodologies when viewed as a group of four 'families' of interrelated methods. The table below provides a correspondence map between the methodologies used to compare how they consider the same set of facts.

The differences in results

A common criticism of the major methods of examining schedule delay is that different methods applied to the same set of facts yield different results. Several practitioners have previously examined these criticisms.[5] Although there have been varied results from the studies, it is generally accepted wisdom in the industry that the major methods return different results when applied to the same set of facts. This has created a perception in some that some or all the methods are inherently unreliable and therefore invalid. This inability to explain why there are different results, and the tautological conclusion that therefore some (or all) of the methodologies are flawed has exacerbated the 'battle of the scheduling experts' in various dispute resolution forums. These battles have sometimes created the impression that FSA experts are frauds simply offering their biased opinions to their client.[6] Such views do little to efficiently resolve disputes.

Many of the problems with reconciling the results of competing forensic schedule analyses stem from issues unrelated to the accuracy of the methodology itself. These problems include, but are not limited to:

Figure 1: family names of delay methodologies

DDP2	Common Name	RP29R-03
Name		Name
As-planned v as-built	APAB	Observational / static / gross
Time slice analysis	Windows	Observational / dynamic / periodic
Time impact analysis	TIA	Modeled / additive / multiple base
Collapsed as-built	CAB	Modeled / subtractive / single base

- the incorrect selection of a method, which results in attempting to use an FSA methodology poorly equipped to achieve the goal of the analysis;
- the poor implementation of a method, which both negatively effects the perception of the methodology, and raises the issue of competency of the analyst; and
- the use of a schedule series that is unreliable, unverifiable or otherwise not capable of supporting a forensic analysis. Since many projects do not have properly maintained schedule updates, it is inherently incorrect to try to use an FSA method that relies on such updates.

While these factors are often the most common causes of problems with dispute resolution where competing forensic schedule delay analyses are involved, the methods discussed in this paper are not expressly designed to correct for these factors. Instead, the authors anticipate the four major method groups being chiefly used when analyses are competently prepared by competing yet experienced analysts, as to the existence, quantum and responsibility of delays.

Different methods tend to analyse schedule models in different ways. The APAB, for instance, measures 'what actually happened' by using hindsight to calculate the as-built critical path (ABCP) and measuring delays along this path. In contrast to this, the Windows methodology measures what the project team believed to be critical as of a given schedule's data date, and the impact that events had on the contemporaneous critical path. To overcome the problems caused by the differences in the methods, the authors recommend a common communication format: the cumulative delay graph. 'Cumulative delay' is the number of days of delay that have accrued through a given point in time. To generate a cumulative delay graph, one must plot the number of days of delay that an analysis shows the project to have suffered as a function of each date during the project. The source and the frequency of the data points for the cumulative delay graphs will vary slightly between methods. Most notably, the cumulative delay graph for the APAB should be plotted as the daily delay measure (DDM) graph.[7] This method enhancement provides for identifying the quantum of delay at any given point in time by measuring the degree of lateness of individual activities predicated on a comparison of their actual performance

Different methods tend to analyse schedule models in different ways.

dates with their late-planned dates. For the Windows, TIA and CAB, the days of predicted delay should be plotted as of the data date of the schedule at which the delay days are shown to have accrued. As will be discussed further, the resulting graph can assist in identifying reasons for differences in specific windows of the project, thereby facilitating resolution.

FSA comparison procedure

The cumulative delay graph is part of a larger reconciliation process between methodologies because it allows a direct comparison of the quantum and timing of delay, albeit not the responsibility for delay. For our comparison of the number and timing of delay days generated for each methodology, we have undertaken the following seven steps:

1. The source data is validated as a prerequisite to method selection.
2. As part of the method selection process,[8] the project records are examined to determine whether the contemporaneous view of criticality should be a primary determining factor in deciding which method to use.
3. The causal activity for a window must be identified. The causal activity should be determined on as frequent a periodicity as the analysis method will allow.
4. The DDM line should be plotted. This line will serve as a baseline for comparison of all the other analyses. The DDM will serve as the cumulative delay graph for the APAB analysis.
5. Each of the analyses is then plotted on a cumulative delay graphs. Each data point should be the predicted completion date of the schedule as a function of that schedule's data date. We overlaid all the lines onto a single graph for easy comparison.
6. Each time-window of the project duration is reviewed, and the causal activities identified by each analysis, and the amount of delay determined to have accumulated because of that causal activity are noted.
7. Differences in either the causal identification or in quantum of delay were identified and explained. The differences

should be able to be explained as resulting from the differences in the analysis methods themselves.

The purpose of this procedure is to first and foremost underline the fact that there are documentable and quantifiable reasons why two competent analysts of the same project could return different results. This will not, of course, resolve differences in opinion about the underlying reason or responsibility as to why a causal activity was delayed. If both parties identify the same activity and similar quanta of delay, but have different opinions about why that specific activity was delayed and therefore apportion responsibility differently, this reconciliation process will not help resolve that issue. However, if that is the case, then the dispute is no longer about the schedule analyses and is instead properly concerned with the facts of the case.

Creation of the test schedule series

The ability to reconcile the results of different methods hinges in part on an understanding of the normal differences that will be exhibited by the cumulative delay graphs of each method. To establish and analyse these differences, the authors created a test schedule series consisting of a baseline schedule, 37 updates, an as-built schedule, and a 'collapsible as-built'[9] schedule. While the test schedule is neither simple or simplistic, it does provide known limits of variables present in most real-world schedules.

The model baseline schedule was based on a hypothetical bridge construction project, wherein an existing bridge with two separate spans was being replaced, one span at a time, with active traffic shifted to the other span. The proposed maintenance-of-traffic plan mandated that a single span be open to two-way traffic during the construction; therefore, the general process for construction involved switching all traffic to the existing span, demolishing the abandoned span, construction of the new span and switching all traffic to the new span. The second existing span would then be demolished and the second new span constructed in its place.

The collapsible as-built schedule was used to calculate the as built critical path of the project, and was also used in the performance of the Collapsed As-Built analysis.

The model baseline schedule contained over 432 activities, had a Notice to Proceed date of 1 March 2010, and a predicted completion date of 7 June 2012 for an overall planned duration of 829 days.

The authors included a total of 17 activities that represented delays that occurred during this project. Five of these activities represented contractor-caused delays (such as start delays or rework issues), while the remaining 12 activities represented owner delays. These 17 activities were tied into the network of this schedule, with appropriate predecessors and successors for the issue described by the delay activity. The schedule was recalculated, again as of the original data date of 1 March 2010. The new predicted completion date of the schedule was 19 April 2013, or 316 calendar days after the baseline predicted completion date. This schedule served two functions. First, it was a detailed as-built schedule complete with actual start and completion dates. Second, it could function as a collapsible as-built with no dates assigned to the actual start or finish columns, thus allowing the network logic calculations to drive all the dates and float calculations.[10]

The collapsible as-built schedule was used to calculate the ABCP of the project, and was also used in the performance of the CAB analysis. To create the test series of 37 update schedules necessary for portions of this analysis, the authors extracted the actual start and finish dates, and the actual durations, from the as-built schedule, and input them into a de-progression spreadsheet. Through this means, a complete set of updates, reflecting both progress and logic changes (reflected in the delay activities) was created, mimicking a real project.

The schedule series was also created with a 'weather exclusion period' that was simply a non-work period in the calendar assigned to asphalt work. According to the calendar, no asphalt work could occur between the start of the third week in December and the end of the second week in March. Any asphalt activities that were pushed into this non-work period would immediately jump forward three months, when the weather would presumably be warm enough to place asphalt. This is a common technique in construction schedules to represent periods during which no work can be performed on a type of work for a specified period, and it has a magnifying effect on delays.

The 39 test series schedules that were originally created represented the contemporaneous updates that the analyst would receive as the project record schedules. These schedules were then copied (as necessary) and used to implement the four methodological analyses. Clearly, the four methods require different schedules for performance: the APAB requires only the baseline schedule and the as-built; the CAB requires the collapsible as-built schedule; the windows requires all the schedules as they existed during the project; and the TIA requires all the schedules as well as the fragnets for insertion into the schedules. Fragnets are small sub-networks that generally contain activities with logic and duration.

Creation of the cumulative delay graph

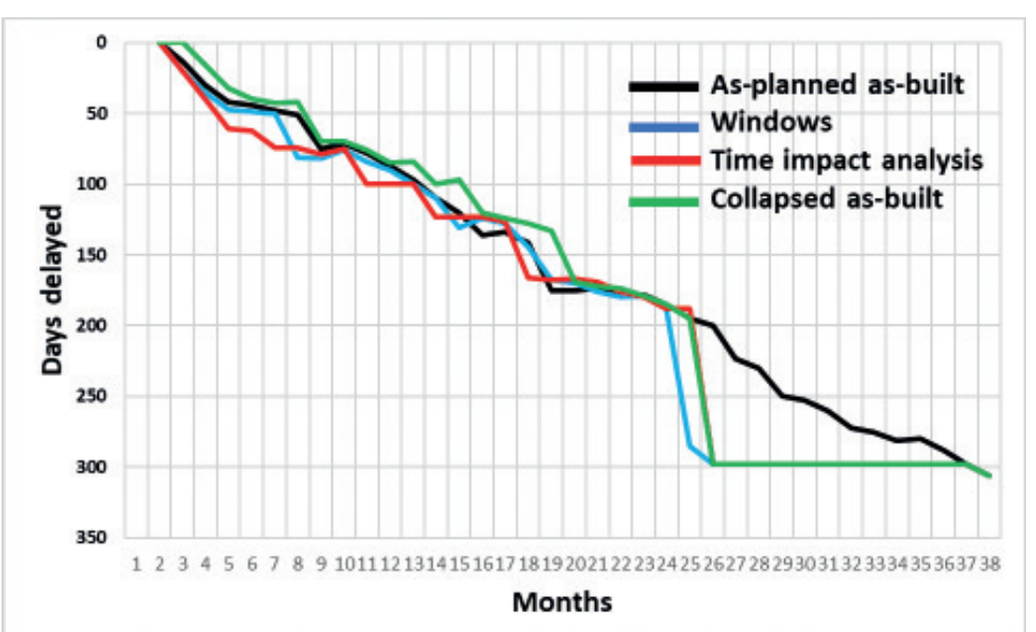
The combined cumulative delay graph is shown in Figure 2. The black line represents the APAB-DDM line, generated from the comparison of the as-planned dates in the baseline to the actual dates in the as-built. The cumulative delay graph for each method was developed by calculating the predicted completion date for each schedule in the analysis method's series of schedules, and plotting the delay predicted completion date as of the data date of the schedule within which it was calculated.

Generally, the cumulative delay graph for the CAB, when only one party's delays are removed from the CAB diverges the most from the other three analyses. However, when both parties' delays are removed from the CAB (green line) the CAB returns results like the other methods. The APAB-DDM line (in black), the windows line (blue), and the TIA line (red) run along a largely similar path between March 2010 and December 2011; after this point, the windows line and the TIA line both drop precipitously, whereas the APAB-DDM line continues along roughly the same slope as before this point. Analysts seeking to reconcile the differences between methods must understand the causes and implications of these differences, and how it relates to the specific way the method analyses the CPM schedule and measures delay.

As-planned versus as-built and the daily delay measure

APAB[11] analyses compare a baseline schedule plan, consisting of one set of network logic, to the as-built state of the same network. The schedules can be compared globally, or can be broken into smaller time-windows that can increase the granularity and precision of delay determination. Additional mathematical analyses (such as productivity analysis, earned value analysis and measured mile analysis) help establish the ABCP and apportion responsibility for specific periods of delay to specific parties – so that the analysis does not descend into a 'total time' analysis, which has been widely rejected by courts.[12]

Figure 2: combined cumulative delay chart



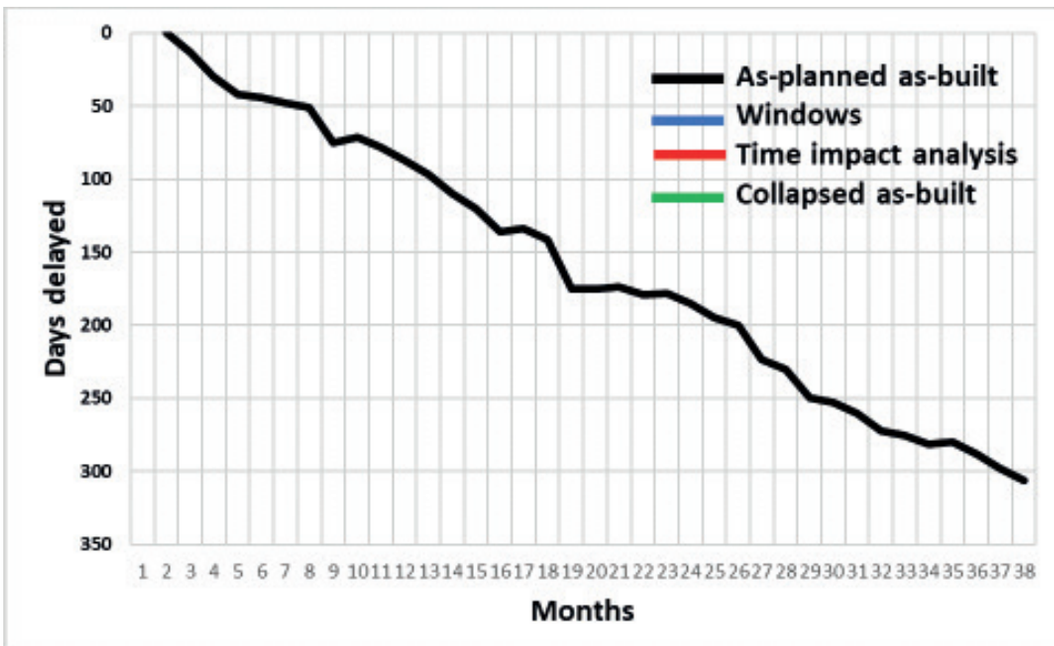


Figure 3: daily delay measure graph of the as-planned versus as-built

In its simplest implementation, the APAB borders on a 'total time' methodology. In such cases, the analysis does not consider the day-by-day events that caused delays. However, more sophisticated implementations of the methodology attempt to identify the ABCP through a careful examination of the record. It is not a projection of how many days ahead or behind schedule the project management team believed itself to be at a given point in time – it is a mathematical calculation of the actual number of days of delay at the point of measurement.

The calculations for the APAB-DDM values were performed on a weekly basis for the duration of the project, and plotted in Figure 3. The slope of the APAB-DDM line cannot exceed one day lost in a single day. Given that the APAB-DDM does not recognise delays until they actually occur (no project forward delay), this is expected. As measured by the APAB-DDM, the delay accumulated during a window will not exceed the duration of that window.

The DDM line in Figure 3 serves as the basis of comparison for the cumulative delay lines of the other methods. Since it measures the actual delay as it occurred, it provides a useful reference point from an observational perspective against which analysts can compare the modelled methods.

The windows methodology uses the update schedules created during construction to reconstruct the events of the project.

Windows

The windows methodology uses the update schedules created during construction to reconstruct the events of the project, and thereby demonstrating the changing nature of the critical path through each of the successive updates.[13] As project events such as progress and unforeseen conditions unfold, and are reflected in the contemporaneous schedules, the effects of progress and subsequent network will cause gains and losses to each schedule's predicted completion date. Additionally, subsequent schedules in the contemporaneous series will show when the critical path of the project shifts from one area to another. The size of the window to be analysed is variable: month-to-month is common, but it is possible to make the windows narrower (such as week-to-week) or define windows by alleged delay events.

The update schedules created for the test series were used to develop the cumulative delay graph. When owner delay activities start during the update period, they were shown with their actual start date and a remaining duration proportional to the original duration, assuming straight-line progress across the activity. They were not used to

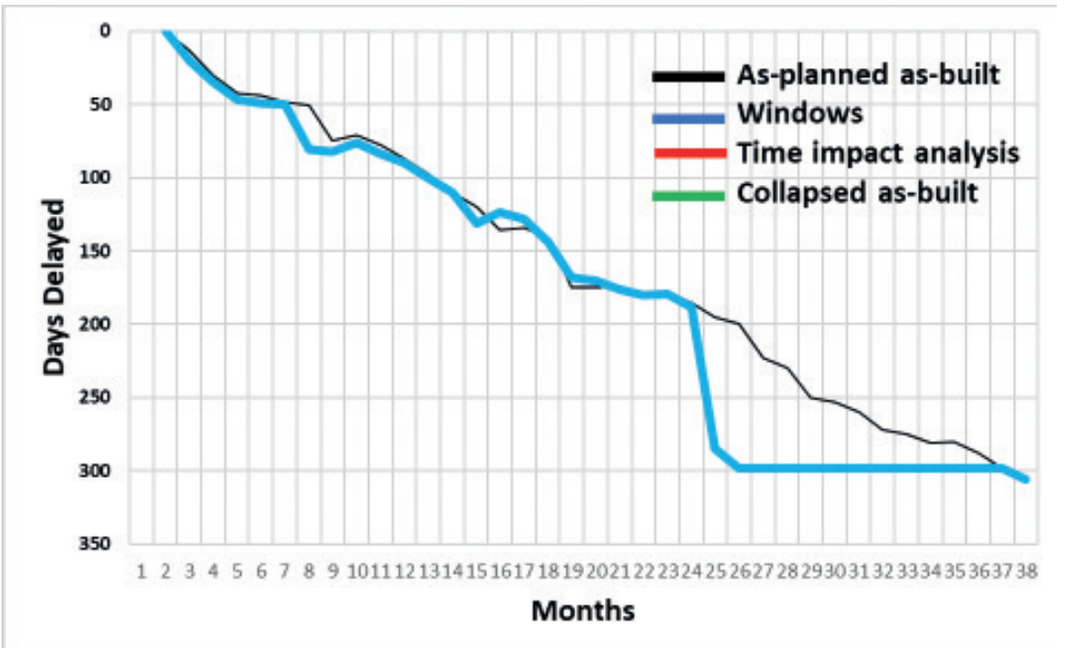
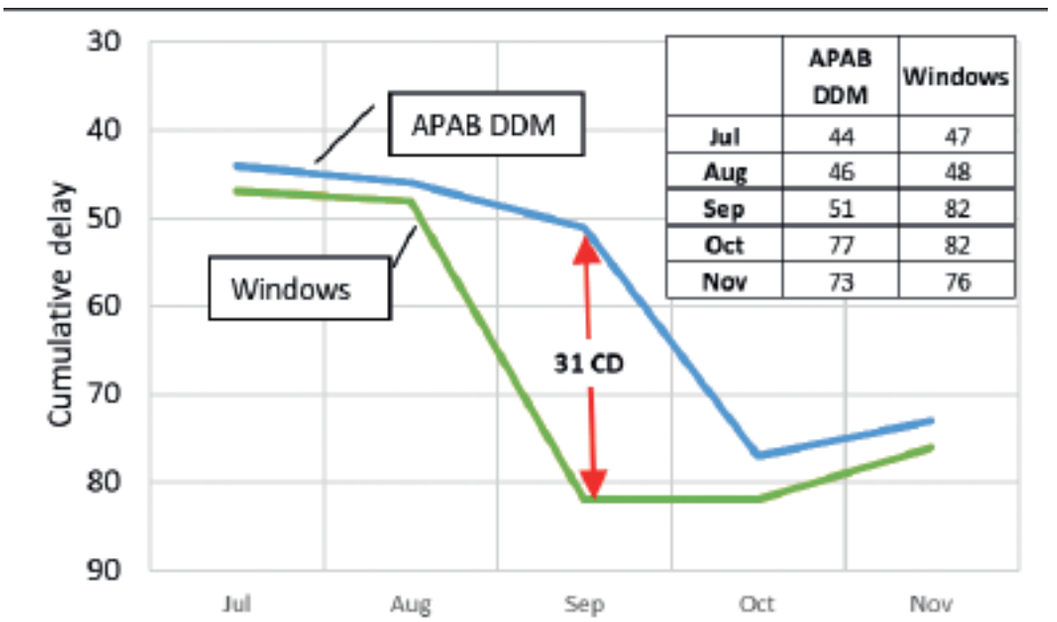


Figure 4: windows compared to APAB-DDM

forward-project the entirety of the delay, as is the case with TIA. Figure 4 shows this.

The most notable feature of the windows line is that between Notice to Proceed 1 January 2012, it generally follows a similar path to the APAB-DDM line; however, it is also clear that the windows line tends to show delays earlier than the DDM line. Specifically, the windows line accrues delay between one and 30 days earlier than the APAB-DDM line. On average, the windows line leads the DDM by approximately five days. The early lead time is a function of the two methodological differences, but the amount of the lead is dependent on the timing of the actual delays.

This is consistent with expectations: windows predicts the upcoming window's delay as of that schedule update's data date, whereas the APAB-DDM line tracks actual delay as it occurs. Refer to Figure 5, below, which isolates the cumulative delay graph for the period between July 2010 and November 2010.



	APAB DDM	Windows
Jul	44	47
Aug	46	48
Sep	51	82
Oct	77	82
Nov	73	76

Figure 5: windows compared to APAB-DDM, (July to November)

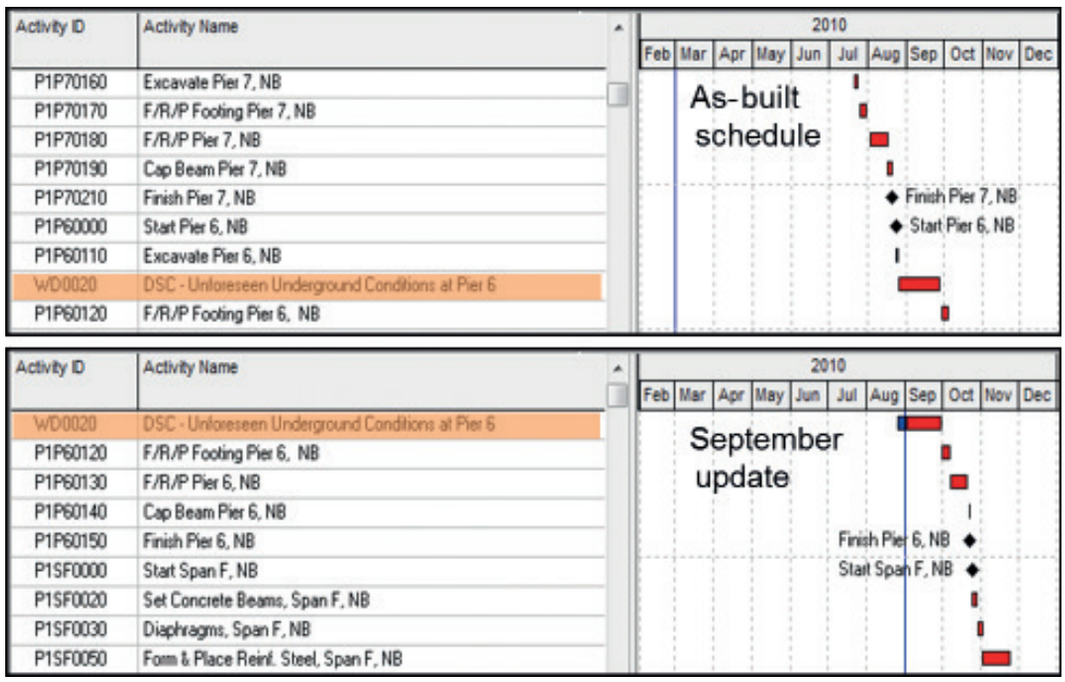


Figure 6: as-built schedule critical path versus windows critical path (DD: 1 September 2010)

Note that at the beginning of this elongated window, on 1 July 2010, the windows shows that the update schedule shows a predicted delay of 47 days, whereas the DDM shows that the project actually experience 44 days of delay.

Reviewing the as-built schedule in Figure 6, one can see that the project was progressing through excavation and construction of Pier 7 of the northbound bridge lanes, and upon completion of that work, the excavation of Pier 6 began. In late August 2010, a differing site condition was discovered and in the September update, the impacted activity was shown with a predicted start delay due to the contemporaneously inserted fragnet. This fragnet insertion caused the jump in the windows cumulative delay graph from -48 days to -82 days (see Figure 5) as of 1 September 2010.

The as-built schedule in Figure 6 reflects the same activities on the as-built critical path during the same time frame; however, an APAB is not tracking a predicted delay – it tracks when the delay actually happened. In this case, the impacted activity does not start until late September. As such, the delay is not recorded as of 1 September 2010 data date of the contemporaneous update – it is recorded as of 29 September 2010, when Activity #P1P60120 actually started. The salient point is that the DDM does not look forward, and therefore the delay accrued over the window until the point where the two analyses are largely in agreement.

In January 2012, the windows line drops from a predicted delay of 185 days to almost 300 days of delay. This is because of the previously discussed weather exclusion period. This sudden drop of 115 days is, again, a predicted delay resulting from the effects of the weather period. Note, however, that the APAB-DDM continues to trend steadily downward at an average slope of approximately eight days/month.

For the purposes of establishing that the windows graph is the appropriate measurement tool and that it should supersede the other method's graph for a given period, the analyst performing the windows should establish the following:[14]

1. the analyst must confirm that the means and methods were accurately represented in the contemporaneous update; and
2. the analyst must confirm that the schedule was used to plan and execute the project.

The analyst would conceivably accomplish this through review of project documentation such as meeting minutes, daily reports and correspondence. This backup information would be essential, however, to justifying the use of a specific method's cumulative delay graph and associated causal activities.

Time impact analysis

TIA is one of the most common and widely accepted methods to analyse project

delays. TIA compares two schedules with the same data date – one schedule (the unimpacted schedule) that represents the status of construction and the critical path just before the discovery of an event, and a second schedule (the impacted schedule) that represents what happens to the critical path and the predicted completion date once the delay event occurs. The event, administrative resolution time and added work necessary to return to original contract work are represented in the impacted schedule through the addition of a fragnet consisting of representative activities and logic. The comparison of the predicted completion dates of these two schedules (before and after the fragnet insertion) determines whether there is entitlement to a time extension.

added work has been completed, and is therefore *retrospective* TIA.

When plotted on a cumulative delay graph, the TIA line tends to identify delay earlier than the windows line in a manner similar, yet more pronounced, than did the windows line when compared to the APAB-DDM. The TIA line is an average of approximately 13 days earlier in this test model. Again, this lead is related to the fact that TIA is predicting delay rather than measuring actual delay; however, in contrast to windows, TIA is predicting delay in inserted fragnets as well as in the original CPM network. To better understand the differences between the two, refer to Figure 7.

If the fragnets inserted into TIA are always representative of the other party's alleged

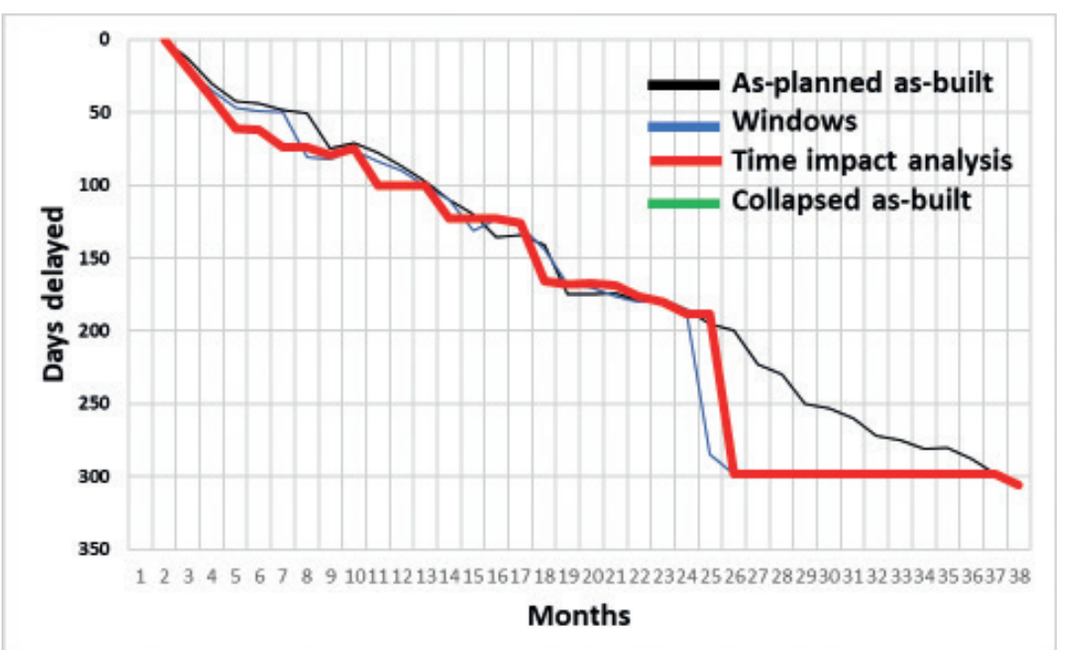


Figure 7: TIA compared to APAB-DDM

Though widely popular and commonly used, one important aspect of TIA is also widely overlooked: the timing of the analysis. If TIA is conducted before the added work is performed, it is *prospective* TIA.[15] A Prospective TIA is an essential tool for the project scheduler to determine the likely impacts of changed conditions on a project and is often included as a requirement in the contract as a prerequisite for granting a time extension.

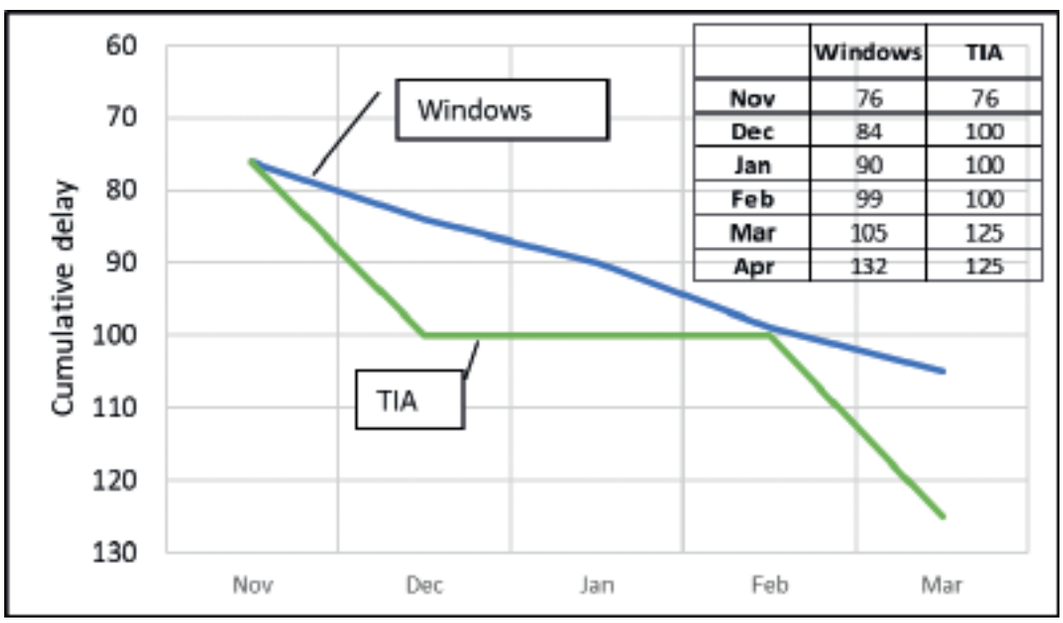
However, as discussed, the forensic analyst is constrained by the fact that they join the project after project completion. Therefore, any TIA that is performed is done after the

delays, then the analysis will tend to show that the other party is responsible for most of the delays. For this reason, it is not good practice to only model one party's delays. Delays caused by the contractor are often not known until they occur, while delays caused by the owner, which are often changes in scope, are usually known at least a month prior to their actual occurrence. However, there are conceivably occasions when such an analysis could be appropriate, and when that happens, the inserted fragnets should be representative of the contractor's contemporaneous planning.

The impact is seen in the cumulative delay graphs in the way that more delay

accrues earlier in the TIA graph. Figure 8 shows the windows and the TIA graph for the period between November 2010 to April 2011.

Both cumulative graphs begin at the same point of delay, each calculating that the project was 76 days behind schedule as of 1 November 2010. However, at the start of December 2010, TIA calculates that the project is 100 days behind schedule, compared to only 84 days for windows. The TIA cumulative delay graph stays flat from 1 December 2010 to 1 February 2011, at which point it begins to accumulate delay again. The authors reviewed the test schedules to determine what the driving activities were during this window, and determined that in the 1 November 2010 update schedule, TIA included a fragnet representing a differing site condition. Like the fragnet insertion described in the windows section, above, the insertion of the fragnet caused the sudden loss of 24 days during as of 1 November 2011. In comparison, the windows line identifies only an eight-day delay during the same month, related to poor contractor production. If the effects of the differing site condition fragnet are to appear in the windows, they will do so when the delayed start of the impacted as-planned activity (the same activity that is the successor to the fragnet in TIA) consumes that activity's float and alters the contemporaneous update's predicted completion date.



	Windows	TIA
Nov	76	76
Dec	84	100
Jan	90	100
Feb	99	100
Mar	105	125
Apr	132	125

Figure 8: TIA compared to windows (November to April)

This dichotomy reveals the heart of many disputes. One party uses a modelled technique that 'proves' that the critical path ran through an owner-caused differing site condition, while the other party's modelled technique 'proves' that the problem was actually sustained poor production. Particularly if the contractor is using TIA and the owner is using the windows, this argument can go on without resolution. TIA effectively alleges that, as of 1 November 2010 (or reasonably close to that date), the contractor had identified the differing site condition, had estimated the duration of time necessary to overcome the change in order to return to contract work and had perceived that the predicted completion date was delayed by 24 days as a result.

These are the facts that must be proven to establish the propriety of the TIA's conclusions; without this, it is very easy to foresee scenarios when one party's analyst simply forward-impacts a CPM model with fragnets of the other party's delays until the analyst's client apparently bears no responsibility for any delay. The TIA line will simply stair-step down through the project duration, claiming that delay accrued earlier than it actually did and was always the responsibility of the other party. Identification of owner delays earlier than they actually effect the ongoing work using either TIA or windows can result is seriously over estimation of owner delays. Therefore, for the purposes of establishing that the TIA graph is the

appropriate measurement tool and that it should supersede the other method's graph for a given period, the analyst performing the TIA should establish the following:[16]

1. The analyst must confirm that the means and methods were accurately represented in the contemporaneous update.
2. The analyst must confirm that the schedule was used to plan and execute the project, and that the results of the CPM calculation influenced the contemporaneous understanding of criticality.
3. The analyst must also confirm that as of the data date of the schedule (or reasonably soon thereafter) the project management team became aware of the issue modelled in the fragnet, that they impacted the schedule with the fragnet, and that the resulting shift in the critical path and later predicted completion date influenced the project management team's contemporaneous understanding of criticality.
4. The analyst should also be prepared to discuss whether there was contemporaneous pacing.

Collapsed as-built

The CAB method develops a CPM model of the as-built schedule by creating logic and durations that reflect the apparent logic that drove the work and the actual dates on which the work was performed. The analyst then dissolves selected delay activities recalculates the schedule in order to show what would have happened had a certain event not taken place. The CAB method can either be performed in a single step (deleting all alleged delay activities at once) or in multiple steps (removing one activity at a time and recalculating after each deletion). The authors have performed the CAB analysis subtracting the delays that are the responsibility of the owners, as well as those belonging to the contractor.

…the Collapsed As-Built [method] measures delay in a significantly different manner than the other three methods.

As discussed above, the CAB measures delay in a significantly different manner than the other three methods. First, it does not attempt to start at the notice-to-proceed (NTP) date, where there were zero days of delay accrued, and work forward through each window. Instead, it analyses the project in reverse, starting with the actual number of delay days accrued. Second, the method is designed in its normal application to specifically identify only one party's delays. For the purposes of this analysis, the authors therefore performed the CAB analysis removing both parties' delays. The delays of both parties (including progress-related delays) were dissolved in turn at each data date. The results of this implementation are shown in Figure 10.

The implementation shows project delays progressing backward towards (and ultimately reaching) zero. This line appears like the

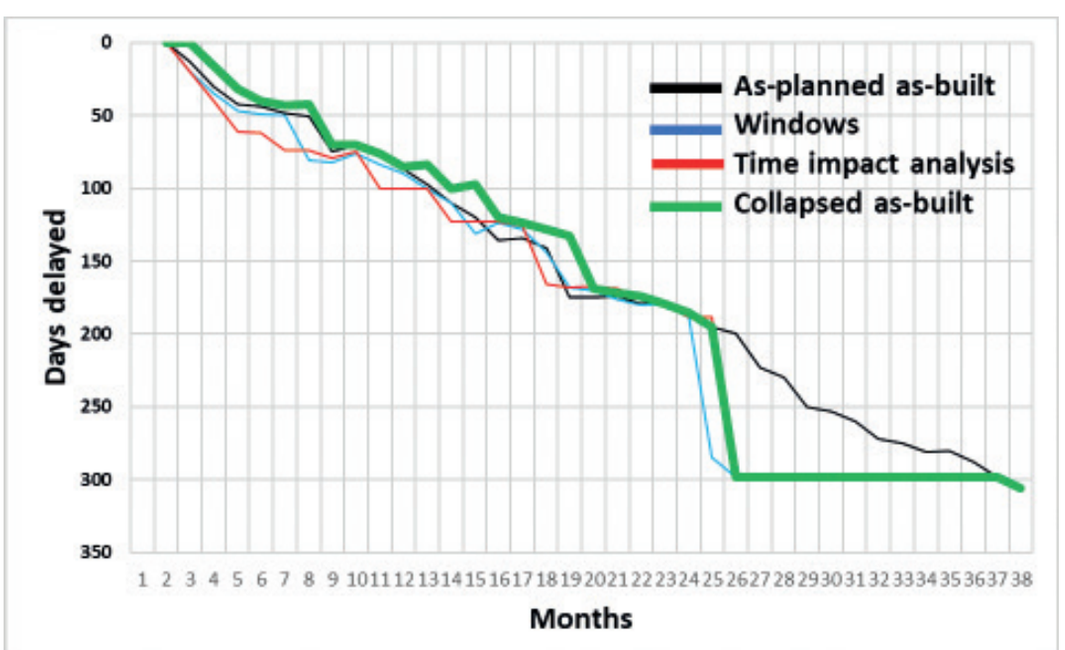


Figure 9: collapsed as-built (both parties)

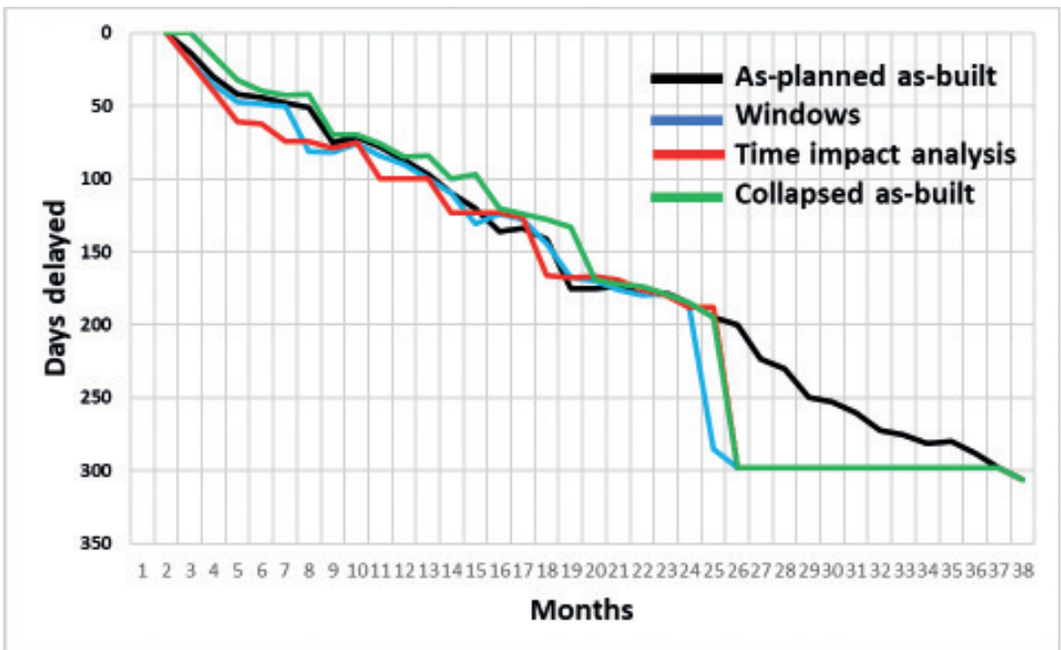


Figure 10: summary four methodologies trend lines

other cumulative delay lines produced by the other methods (see Figure 9).

One noticeable feature of this implementation of the CAB is the fact that the jump in accrued delay occurs later in time in the CAB than it does in the windows or TIA. In fact, the CAB cumulative delay graph tends to identify delay later than the other lines, including the APAB-DDM lines. This seems intuitively correct, given the fact that a collapsed as-built analysis is performed backwards from the end of the project and is identifying their impact at the end of the impact.

Removing both parties' delays and recalculating as of a given data date shows what would have been driving the critical path had neither party deviated from the accepted plan. One possible use of deleting both parties' delays, however, could relate to checking the status of possible concurrent delays (which is sometimes a use of collapsed as-builts in their standard implementations).

It is also a possible benefit of deleting both parties' delays to generate the cumulative delay graph shown in Figure 10 is to check the adequacy of the collapsible as-built model. As previously stated, the authors acknowledge that the creation of a collapsible model is one of the more difficult and sometimes controversial aspect of performing CAB. Plotting the cumulative delay graph as described in Figure 10 may provide a useful back-check to the as-built logic applied by the analyst creating the collapsible model.

The shift of perceived contractor-caused delay […] is a major difference in the two analyses, and would likely be the cause of argument between two competing analysts.

Method reconciliation

Again, it is commonly asserted that different methods applied to the same set of facts can result in ostensibly different results. This is particularly true when examining apportionment of delay resulting from two methods. For instance, in TIA, inserted fragnets are only representative of owner delays. As such, the fragnet insertion can radically shift apportionment of delays when compared to the windows Figure 11 shows a comparison of the results of the windows and the TIA, where the period delay is assigned to the party who owned responsibility for the causal activity in that update schedule.

It is clear that the fragnet insertion in the TIA significantly shifts the apportionment of delay in the schedules. The shift of perceived contractor-caused delay from 39 per cent in the windows, as compared to just 13 per cent in the TIA, is a major difference in the two analyses, and would likely be the cause of argument between two competing analysts. Analysts performing a windows on behalf of an owner would likely state

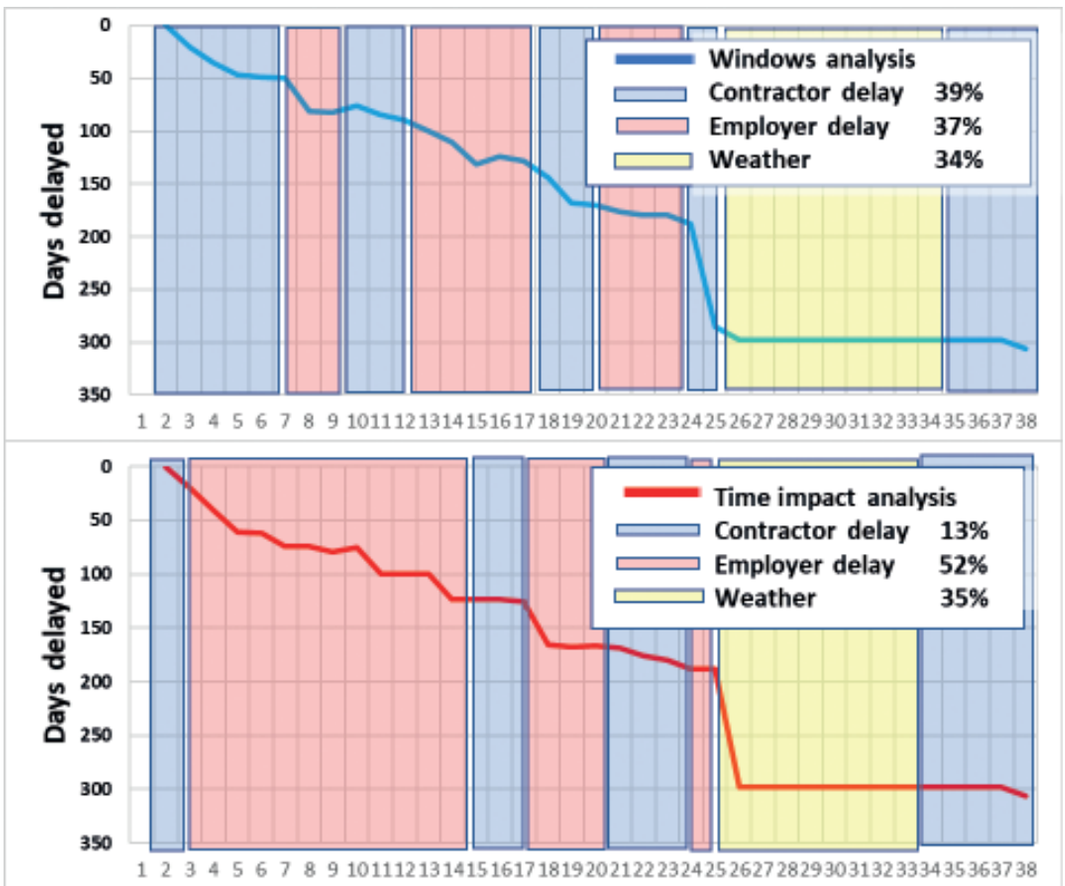


Figure 11: comparison of delay responsibility between windows and TIA

that the TIA is taking advantage of the 'stair-step' nature of that analysis to continually push the critical path just beyond the influence of contractor-owned activities by constant insertion of owner-caused fragnets. The TIA is more likely to be a legitimate view of the project's delays, if the fragnets were understood at the time the delay is shown to have accrued and the knowledge of the critical path influenced the project management team's actions.

Conclusions

The use of the cumulative delay graph can be a useful tool in reconciling the apparently different results of methods. It is particularly useful when used as part of a larger process of putting the results of the methods into a common format and a collaborative effort between the parties to establish periods of similarity and differences. The cumulative delay graph will aid in establishing when delays accrued; it will not, however, resolve disputes where causation of the delay is at issue.

The APAB-DDM line establishes when the delay actually occurred. The windows line tends to show that delay accrues slightly earlier than the APAB-DDM line, because the windows is calculating the delay to the predicted completion date based on the unedited CPM network alone. TIA tends to show that delay accrues earlier than the windows, because TIA is calculating delay to the predicted completion date based on the CPM network as impacted by fragnets. A longer fragnet will tend to claim more delay earlier. The CAB that deletes both the owner and contractor delays in turn results in an analysis graph that is generally similar to the path of the windows and TIA, though it tends to follow both lines by a few days.

The cumulative delay graph highlights that, when a delay either actually occurred (as in the APAB-DDM line) or when it was perceived to have occurred by the parties (as with the windows, TIA and CAB), a clear understanding of the evolution and timing of each delay is essential. Finally, analyses developed outside of standards of good practice will likely show radically different results on this chart. Therefore, the use of this technique can help refute the

technical implementation of the opposing expert's analysis.

Notes

1 This paper was originally prepared, presented and published in 2014. This 2018 version has been edited to use more commonly used delay terminology as identified in both the Society of Construction Law's Delay and Disruption Protocol (2017) and AACE's Recommended Practice on Schedule Delay RP29R-03. Several detailed pages of CPM explanation following Figure 11 have been deleted.
2 AACE International, 'Forensic Schedule Analysis' Recommended Practice 29R-03, AACE International, Morgantown, WV, (2011), p 1 [AACE RP29R-03].
3 Society of Construction Law, SCL Delay and Disruption Protocol, 2nd ed (2017), p1 [DDP2].
4 AACE RP29R-03, s1.1.
5 Robert D'Onofrio and Anthony Meager, 'What is a Schedule Good For? A Study of Issues Posed by Schedules on Complex Projects,' *The Construction Lawyer*, Winter 2013, p 6; Mark Sanders, 'Forensic Schedule Analysis: Example Implementation,' *AACE International Transactions*, (Morgantown, WV: *AACE International*, 2008); Mark Sanders, 'Forensic Schedule Analysis: Example Implementation Part 2,' *AACE International Transactions*, (Morgantown, WV: AACE International, 2011'; Mark Sanders, 'Forensic Schedule Analysis: Example Implementation Part 3,' *AACE International Transactions*, (Morgantown, WV: AACE International, 2012).
6 Andy Ness, 'Experts and Expertise in Construction: Black Letter Law and the Debate of Whether Scheduling /Programming Experts are Imposters - Its All Smoke and Mirrors.' Conference of the International Bar Association, Dublin, 1 October 2012.
7 John Livengood, Daily Delay Measure: A New Technique to Precisely Identify Delay, 2003 AACE International Annual Meeting Proceedings, AACE International, Morgantown, WV, 2003.
8 AACE RP29R-03, p 1.
9 The creation of a collapsible as-built CPM schedule is one of the steps in performing a CAB analysis.
10 AACE RP29R-03, p. 1
11 AACE RP29R-03, p. 1
12 AACE RP29R-03, p. 1
13 AACE RP29R-03, p. 38–50. See also; Lee Schumacher, *Seattle Daily Journal of Commerce*, 25/26 December 1991. These two articles are the basis for the contemporaneous period analysis method.
14 These recommendations are made to be performed in concert with the recommendations of RP 29R-03's s 2 on source validation.
15 Tim Calvey and Ron Winter, RP 52R-06 (2006), Time Impact Analysis – As Applied in Construction, *AACE International*, Morgantown, WV.
16 These recommendations are made to be performed in concert with the recommendations of RP 29R-03's s 2 on source validation.

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FEATURE ARTICLE

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Construction scheduling: issues for lawyers

Douglas Stuart Oles
Oles Morrison Rinker & Baker, Seattle

This article was presented at the ICP Working Weekend held in May 2018 in the Netherlands.

The use of computer-based scheduling tools in project planning, management and claim documentation has become increasingly complex over the last several decades. Contractors and employers vary widely in their sophistication in using such schedule tools, and courts and arbitrators have approved various approaches in trying to ascertain the causes and extent of project delays.

Many articles have offered advice as to proper technical use of scheduling software, and this is not one of them. The intention of this article is to share practical experience that may assist lawyers when trying to promote the proper use of construction schedules.

Team selection

Employers, engineers and contractors all tend to get involved in project scheduling on complex construction projects. Employers need to forecast the time period required for design and construction to estimate how

Contractors and employers vary widely in their sophistication in using… schedule tools, and courts and arbitrators have approved various approaches in trying to ascertain the causes and extent of project delays.

long they must wait for the completed works and to plan appropriate financing. Engineers are typically asked to provide the employer with at least a preliminary schedule for the design phase of the project, and they are often also asked to identify long-lead items of material and equipment that will be needed. Construction contractors are often asked to submit detailed schedules for the planned works and to update those schedules on a regular basis. Subcontractors will often be expected to provide detailed schedule updates for their own particular parts of the required works.

To perform these various functions, it is important for each project participant to engage persons with specialised scheduling expertise. If they lack such expertise in-house, they should select one of the many well qualified independent scheduling consultants.

Since engineers and contractors are regularly engaged in construction projects, they normally have someone in mind to perform the required scheduling services as a project gets started. Many employers are not, however, regularly engaged in complex construction, and they are likely to rely on their engineers or lawyers for referrals of scheduling experts. From a lawyer's standpoint, it can be helpful to engage the services of a consultant who also has good skills in communicating complex ideas to a neutral third person.

In addition to selecting an experienced schedule team, employers should give some thought to the types and levels of scheduling that will be required from the engineer and contractors. More detailed schedules are not always better. Needlessly complex schedule submittals drive up the costs of project administration and schedule submittals need to be in a form that is readily comprehensible to the employer's team members who will be reviewing them.

Preliminary schedules

It is typical to perform some level of schedule planning even before the exact period of construction has been ascertained. As indicated above, most employers will want an early indication as to the duration of the project, in part to assist in financing. They will also need this information to plan the duration of their own contract administration activities. The first step is typically a conceptual schedule outlining the major components of the design, permitting, construction and commissioning processes. On a design-bid-build project, such schedules are often prepared for the employer by its engineer. On design-build projects, an employer may ask design-builders to propose schedules as part of their competitive submissions.

These preliminary schedules can serve various purposes. In addition to outlining the estimated length of the process, preliminary schedules can help to identify required permits, access issues and long-lead items of material or equipment that may be needed for the work. In the power industry, for example, many employers believe they can save overall cost by purchasing key equipment components directly (rather than paying a contractor mark-up). When employers do this, however, they must also bear in mind their concomitant duty to coordinate their equipment purchases with the rest of the project schedule.

Preliminary schedules must necessarily make assumptions regarding events that are not yet known. For example, they must make assumptions as to how long it may take to obtain required easements and permits and prepare and review key submittals and how long it may take for manufacturers to supply key materials or pieces of equipment. There may also be uncertainty as to how much time will be needed for an employer agency (or its affiliates) to conduct required punch list inspections. The durations of such activities may be substantially affected by fluctuating market conditions.

Baseline schedule

After a construction contract is signed, and a notice to proceed has been issued, the contractor is typically required to submit a 'baseline schedule' for review by the employer's management team. Unfortunately, such schedules can become a source of dispute between the parties, and it is not uncommon for parties to disagree on whether a baseline schedule is sufficient for approval. This is partly due to the lack of an industry standard definition as to criteria for approving a baseline schedule. There are also some employers and engineers who seem to believe that they gain an advantage by declining to 'approve' any contractor's baseline schedule, fearing that their approval might be misconstrued as endorsing the contractor's subjective means and methods.

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There are, however, good practical reasons why parties on a construction project should work promptly and in good faith to establish a mutually agreed baseline schedule. To begin with, it allows each participant to plan its own activities on a common timeline consistent with the overall project. Second, it provides a practical starting point from which to measure delays that may need to be either recognised or mitigated. Third, the employer can always qualify its approval by noting that it does not endorse the workability of the contractor's means and methods.

To facilitate an agreed baseline schedule, it is helpful if the parties can reach a consensus as to certain key assumptions that underlie the planned performance of the works. For example, some contracts will specify time periods in which the contractor can expect to receive substantive responses to requests for information (RFIs), submittals and change order proposals. If contractors are held to strict time limits on submission of claims, it may be reasonable that employers should similarly agree to reasonable time limits for their responses to contractor submissions. If the employer insists upon long review periods (or refuses to agree on any time limit), it will be very difficult for a contractor to prepare a workable baseline schedule. Similar issues apply to employer responses to submissions from an engineer during the design phase of a project.

If an employer has requested a fixed price to perform work that is not yet fully designed, the schedule should make some allowance for potential impacts that may arise when the balance of design is known (regardless of whether the remaining design will be provided by employer or contractor). On projects where an employer-furnished design is not yet complete when a contract is signed, the schedule should address that uncertainty in a manner consistent with the risk allocation provisions of the applicable contract.

One reason why parties have difficulty agreeing on durations for use in a baseline schedule is their mutual tendency to disclaim responsibility for the delays that can be expected to occur if the contemplated time periods are not achieved. The proper balance in allocating schedule risk is beyond the scope of this article, but it is an issue that will not go away merely because it is not addressed in an initial construction contract.

Ultimately, one of the challenges to baseline schedules is trying to predict and anticipate certain circumstances that are not reasonably foreseeable when a contract is signed. Many later events (eg, labour strikes, unusually adverse weather, differing site conditions, natural disasters and changes in law) can all impact the job without any active fault on the part of any party.

Few sophisticated contractors will accept responsibility for the costs or time impacts of problems that cannot reasonably be predicted and quantified….

One method of addressing these uncertainties is to include cost allowances and schedule contingencies, for example, a provision for potential time extension when a design is finalised or a permit has been issued. Another possible approach is to use liquidated delay damages and/or bonuses for early completion that create incentives for both parties to minimise later delays. Few sophisticated contractors will accept responsibility for the costs or time impacts of problems that cannot reasonably be predicted and quantified at the time when a fixed price contract is signed.

Resource loading

An increasing number of construction contracts require contractors to submit schedules in an electronic format that is loaded to reflect the planned use of labour, materials and subcontractors on the project. Resource-loaded schedules can help a contractor to plan its flow of work in a manner that minimises inefficient spikes in crew size or overtime labour. Such schedules may also enable an employer to check whether a contractor is devoting sufficient crew size and overtime hours to complete the works within the required time. They may also be a check on what some employers regard as excessive front-loading in a contractor's schedule of values to be used in progress billings.

On some projects, however, resource loading can become a bone of contention between the parties, especially if it is used unduly to restrain a contractor's flexibility in modifying its sequences and flow of work. As a job gets started, crews acquire greater skill through a 'learning curve' and become accustomed to prevailing weather and other local site conditions. After gaining this experience, a contractor may reasonably

expect to modify the sequences or durations of its various activities. If one activity is unexpectedly delayed, it serves everyone's interest that the contractor has reasonable flexibility to mitigate the delay through resequencing. Therefore, an employer should not treat a resource-loaded schedule submission as a rigid commitment that can only be modified by the employer's consent. With regard to project scheduling, too much detail can be just as counterproductive as too little.

Schedule float

Most sophisticated construction scheduling is based on the critical path method (CPM), an approach that concentrates on activities that will affect the overall completion date if they are delayed or accelerated. Activities that can be delayed without postponing the overall project completion date are said to have 'float time'. A lawyer may help to promote helpful dialogue by asking a client how it uses float in planning (or reviewing) a project under construction.

Over the years, a legal debate has arisen as to 'who owns float'. The general unwritten 'rule' is that float time is available to all parties as they have need of it, at least up to the point when it materially and adversely affects the cost or efficiency of construction. Some employers have gone as far, however, as to specify in their contracts that float time belongs exclusively to the employer. This kind of clause really makes no practical sense because it would be utterly impractical to administer a construction project if one party had a right to delay all non-critical activities without consequence. Activities with float time are needed so that a contractor has reasonable ability to resequence work and thereby mitigate many of the small delays that commonly occur on a construction job. A job where every activity is critical would truly be a nightmare for project administration.

Where there is uncertainty over a contractor's right to use float time, some contractors will create schedules that effectively hide float time by indicating activities to be more critical than they really are. When this happens, the scheduling process effectively becomes a game, and its essential purpose of providing a realistic and updated planning tool is sacrificed.

Activities with float time are needed so that a contractor has reasonable ability to resequence work...

Logic constraints

In a CPM schedule, each activity should normally be tied to at least one predecessor and at least one successor activity. Once built-in float is used, the result should be that delays will have corresponding impacts on downstream successor activities.

Many schedulers modify their schedules, however, to include logic constraints that artificially constrain the sequence of related activities. They may, for example, fix a date by which a certain activity must be complete. Such constraints can serve useful purposes, for example, in avoiding periods of time when work cannot proceed due to an adverse weather season, but they can also interfere with the normal function of the scheduling software that is designed to reflect schedule impacts through the entire period of a job.

Logic constraints in CPM schedules are most common when a project is getting started and relationships between some of the detailed activities have not yet been defined. As a job moves forward and the schedule becomes more refined, however, the use of logic constraints should typically decrease.

Lawyers seeking to assist clients in understanding schedule issues on a project should be aware of logic constraints and, in appropriate cases, may wish to inquire about them.

Schedule updates

Contractors are typically required to submit a monthly update that serves multiple purposes. Such updates generally record:

1. progress to date;
2. the plan for going forward; and
3. the need (if any) to adjust the mandatory schedule milestones based on excusable delays that may have occurred.

Special updates or time impact analyses may also be required more frequently if a substantial delay has occurred.

Effective updating generally requires updated input from key subcontractors and suppliers, but employers should also provide updates as to any employer-furnished material deliveries, and engineers should provide updates on their issuance of any

further design that they may have committed to provide.

When delays indicate a need to adjust the mechanical or substantial completion date, the employer generally needs to make a decision. If a time extension is properly requested and denied, the contractor is likely to assert a claim for constructive acceleration, based on experience indicating that acceleration tends to result in cost inefficiency. An employer should therefore take care in evaluating a request for time extension because, in some cases, the most cost-effective way of completing a job may be to allow more time.

Of course, it is not always practical for an employer to grant additional time. Schools must be open when they are required to offer classes and sport stadiums must be available when the team season begins. Therefore, an employer may decide to direct acceleration of work even when a contractor has incurred an excusable delay. If an employer refuses to grant time extensions when they are owed under contract, the contractor's resulting constructive acceleration may lead to claims of resulting labour inefficiency. The employer is therefore ill-advised simply to deny all time extensions reflexively, or to delay taking action on requests for time in the hope that the problem will go away.

What then does an employer reasonably require in order to evaluate a time extension request? The facts will vary from one job to another, and they may depend on the sophistication and experience of the employer's schedule reviewing team. In some cases, a dispute review board can assist the parties in determining whether and to what extent a time extension has been justified.

Employers should also bear in mind that they have another option aside from granting or refusing a time extension that is indicated on a schedule update. That option is a short or long-term suspension of work. If a job is being impacted by a type of delay for which the employer is contractually responsible (eg, a major differing site condition or delays in finalising an employer-furnished design), the option of a temporary suspension of work should at least be considered.

Employer variations

One common cause for contractor claims of delay is variations issued by an employer. When variations are issued, it is not unusual for the parties to differ as to whether they have an impact on the overall completion of the project.

In some cases, variations are so substantial that they fundamentally alter the sequences and/or durations of original scope work. And in those circumstances, courts and arbitrators tend to sympathise with contractors who claim resulting delays, even if they are unable to demonstrate with scientific accuracy how each of their originally planned activities was changed by the employer's variation.

In advising employers, it is often prudent to consider whether it makes more sense to award a separate contract (for variations) rather than interrupting an ongoing contract by injecting changes that will significantly impact progress.

Treating delays in schedule updates

Many construction contracts contain detailed requirements for contractors to give notice of delays when they are encountered. Much less seldom do employers agree to place similar requirements on their own notices of counterclaims or back charges, although such notice can be very helpful in mitigating overall resulting impacts.

When a delay begins, its overall duration is often not yet clear. This creates multiple difficulties for construction parties and their schedulers. They are often required to reflect the delays in a schedule update, but there may be no effective way to predict their duration or ultimate impacts. Some contracts allow contractors to reserve their submission of proposed schedule impacts until after the end of the delay becomes known, but many contracts require the contractor to offer at least a forecast of delay as soon as possible.

One initial problem is to distinguish the cause of a delay from its effects. For example, a one-week delay in submitting information to an equipment manufacturer may cause weeks of delay to the ultimate supply of equipment if manufacturing time slots must be reserved well in advance. A short delay to a concrete pour just before the start of winter may cause months of delay if the pour must be deferred until the following spring. On the other hand, many delays to non-critical activities may have no impact on the overall completion of a job. Therefore, the scheduler begins with identifying a specific delay but then must engage in a separate process of determining how it is likely to affect the job as a whole.

Another complication arises if a delay is of uncertain duration. For example, a collapsed bridge on an access road may stop key construction from moving forward, and no one can immediately predict how long it will take to repair the bridge or provide alternative access. In such cases, lawyers should assist their clients in making sure that schedule updates are prepared and reviewed in a manner that takes into account the inherent uncertainties regarding the delays at issue.

It is also important that delays should be segregated into categories corresponding with events that are compensable under the contract, as compared with those that are: (1) excusable but not compensable; or (2) neither excusable nor compensable. This kind of reporting is particularly difficult if a project is suffering from multiple overlapping or concurrent delays.

Concurrent delays

When a contractor gives notice that its work is being delayed by a compensable cause (eg, an employer variation, a differing site condition or some other employer delay), employers will often scrutinise the project schedule to see if the job would be delayed in any case by a non-compensable cause (eg, a force majeure or under-manning by a contractor). Many reported decisions in the United States and other countries have tried to sort out such competing lists of alleged delays, and the applicable law on concurrent delays is generally beyond the scope of this article.

In trying to advise a client on concurrent delay, a lawyer should begin by examining the burdens of proof that may be established either by contract or under the law governing the contract.

In addition, there is a general divergence of opinion between courts that simply deny relief to either party in cases of concurrent delay, as compared with those that attempt to allocate delay-related costs between them.[1]

In evaluating concurrency, it is also important to distinguish between two truly independent delays and a situation in which one delay effectively results from another. For example, a framer may delay shipping steel studs to a job site when it knows that there are already delays to pouring the slabs on which the framing will be built. This does not mean that the supplier's 'late' shipment should be treated as a concurrent delay when analysing the late slab pour. Delays should only be treated as 'concurrent' if they would have occurred independently of the other delay being analysed.

Methods of schedule analysis

Many books and articles have been written regarding the use of time impact analysis and other technical approaches to assessing the relative impacts of specific delays. Some methods begin with a planned schedule and add adjustments for known delays. Other methods begin with an as-built schedule and remove identified delays to ascertain how the job might have progressed without them. Other methods divide a job into a series of shorter time periods ('windows') and attempt to assess what acts and omissions caused the delays or accelerations occurring in each period.

This article will not comment on the relative merits of those various technical approaches, but two general comments are offered:

- CPM scheduling is not an exact science, so that efforts to infer delays from periodic schedule updates are only as accurate as the updates themselves; and
- one should be sceptical of analyses prepared after a project that attribute delays to causes that were apparently not observed or recorded while the work was actually in progress.

Conclusion

Schedules can be a useful tool for project planning and evaluating delays. They can help to identify the impacts of delays and suggest paths towards mitigating their effects. On the other hand, a lack of careful scheduling may cause parties to lose valuable contract rights, both in prosecuting and defending delay-related claims. Lawyers should know enough about CPM scheduling to check that their clients are implementing a reasonable scheduling scheme, and trial lawyers should understand the degree to which the CPM schedule is and is not an exact science.

Notes

1 See W Stephen Dale and Robert M D'Onofrio, *Construction Schedule Delays* (2016 edn), 179 et seq.

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FEATURE ARTICLE

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Delay analysis: a comparison of the UK and US approaches

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The United Kingdom Society of Construction Law (SCL) first published its Delay and Disruption Protocol (the 'Protocol') in 2002 to provide guidance on some of the common issues that arise on a project in assessing extensions of time or compensation for delay. The Protocol is not legally binding unless incorporated into the contract (which is rare), but has been used in the UK and internationally as instructive in approaching common delay and disruption issues.

In 2017, the SCL published a revised second edition (the 'SCL Protocol') following industry feedback, updates in case law and changes in technology since it was first published. The SCL Protocol sets out 22 Core Principles followed by more detailed guidance on the principles, common terms, financial heads of claim and record-keeping. It states that it is intended to be a balanced document reflecting the interests of all parties in the construction process and aims to be consistent with good practice, as opposed to setting a benchmark of best practice.[1] The SCL Protocol no longer recommends specific model contract clauses, which is consistent with its status as 'guidance' rather than a legally binding document.[2] It also includes as a Core Principle that extension of time claims should be submitted and assessed contemporaneously rather than adopting a 'wait and see' approach.[3]

The SCL Protocol continues to focus upon the UK construction market and, in particular, the English law position although it has received less uptake by the courts in the UK than it has in other jurisdictions. The Australian courts have shown a particular willingness to seek guidance from the SCL

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Protocol,[4] as have the courts in Hong Kong.[5] In January 2017, the Malaysian Society of Construction Law published its own supplement to the first edition of the SCL Protocol to take account of the needs and expectations of the local industry. It remains to be seen whether other branches will adopt a similar approach.

In 2017, the American Society of Civil Engineers (ASCE) Construction Institute Schedule Delay Analysis Standards Committee published consensus industry standard guidelines for schedule delay analysis in the United States in accordance with the American National Standards Institute (ANSI) under the designation ANSI/ASCE/CI 67-17 Schedule Delay Analysis (the 'ASCE Standard').[6] The ASCE Standard was created because there was no true industry standard addressing schedule delay analysis, rather several competing lower 'manual of practice' level documents that did not provide adequate guidance. The ASCE Standard is targeted at the industry at large and aims to address delay analysis methods used only to support the party's position as opposed to being based on contemporaneous CPM Schedules. As such, the committee focused on evaluation of delays after the delaying event concludes and set out 35 guidelines that any CPM schedule delay analysis should follow in an effort to help standardise principles used in the analysis.[7] The ASCE Standard states that its guidelines 'generally reflect best engineering principles associated with schedule delay analysis and reflect standards of practice in the United States construction industry'.[8]

Both the SCL Protocol and the ASCE Standard were published in the same year with a focus on their own domestic markets, albeit the SCL has acquired an international following in recent years. Both are intended to provide guidance of general application subject to the specific contract and legal jurisdiction of the matter. Both documents are also intended to be balanced and represent the interests of all parties in construction disputes. However, they have slightly different recommendations. This article compares some key aspects of the two and considers whether the more established SCL Protocol could learn anything from its cross-Atlantic cousin.

Both [the SCP Protocol and the ASCE Standard] are […] intended to be balanced and represent the interests of all parties in construction disputes.

Ownership of float (similar)

Ownership of float can be a contentious issue:

- Should the employer get the benefit of any float that the contractor has built into its programme if it instructs a variation/ additional work or any other employer-related delay occurs?
- Should the contractor get an extension of time, even if a delaying event does not push out the completion date, in order to preserve its float?

From a contractor's point of view, any float has been built into the programme for its own benefit, as a protection against liquidated damages. As a result, the contractor should be free to dictate how it is used.

The employer will argue that it has paid for the contractor to be on site for the whole contract period (including the float) and should be entitled to the benefit of it.

The two documents take a similar approach to ownership of float. The ASCE Standard (guideline 5.2) advises that the default industry standard is that float is owned by the project and can be used by either party, subject to the contract terms and conditions. Similarly, the SCL Protocol (Core Principle 8) advises that time extensions are only granted when float is exhausted so float is also used on a first-come-first-served basis. The SCL Protocol does recognise that this should not preclude the contractor from recovering costs for employer delays that cause it to miss its planned completion date (but not necessarily its contractual completion date) where that planned date is reasonable and the employer is aware of it (Core Principle 13).

This is in line with the approach of the Joint Contracts Tribunal (JCT) standard form of contract in the UK.[9] In it, the entitlement to extension of time only arises where the delaying event (known as a relevant event) causes a delay to the contractual completion date. However, some of the other forms adopt a different approach. In both the New Engineering Contract (NEC) and Fédération Internationale des Ingénieurs-Conseils (FIDIC) standard forms, float is owned by the contractor.[10] The NEC distinguishes between planned completion and completion date the former being the date in the

contractor's programme. It provides that a delay to the completion date is assessed as the length of time that, due to the compensation event, planned completion is later than planned completion as shown on the accepted programme.[11] This preserves the 'terminal float' in the project for the benefit of the contractor and also shows the importance of ensuring that the accepted programme is up-to-date.[12] The Chartered Institute of Building (CIOB) Time and Cost Management Contract takes a different approach again, with each party setting aside 'time contingencies' at the start of the project for their exclusive use for events identified within their respective risk registers although total float can be used by either party.[13]

Federal contract forms in the US include a statement that float is not owned by either party. US standard forms of contract generally allow for an equitable adjustment to contract time in the event of a delay but do not always specifically address float.[14] The Engineers Joint Contract Documents Committee (EJCDC) identifies that to obtain a time extension the delay has to be 'adversely affecting an activity on the critical path' at the time of the impact, which means exceeding the float in the schedule.[15] ConsensusDocs requires identification of float in the schedule with monthly updates.[16]

Concurrent delay (slightly different)

Regarding concurrent delay, the two documents are slightly different. Both the SCL Protocol (Core Principle 10) and ASCE Standard (Chapter 8) provide that concurrent delay is excusable, meaning that an extension of time can be granted, but non-compensable, meaning no loss and expense flows from it.

There is currently a divergence in approach between the English and Scottish courts in how concurrent delay should be treated. In England, the courts have followed the approach set out in the SCL Protocol and ASCE Standard and allowed a full extension of time but no compensation for the period of concurrency.[17] The rationale behind that has been explained as being that if parties have expressly provided in their contract for an extension of time caused by certain events, the parties are taken to have contemplated that there could be more than one effective cause of delay (including a cause that would not qualify for an extension of time) and this express contract term amounts to an

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agreement that there should be an extension of time.[18]

However, in *City Inn v Shepherd Construction*, the Inner House of the Court of Session in Scotland (the Scottish Appeal Court) found that where there are two competing causes of delay (one of which is excusable and the other that is not) and where neither is a dominant cause of delay, the extension of time and any compensation attaching to it should be apportioned fairly and reasonably between the competing causes.[19] It is worth noting that this case was based on a JCT form of contract that includes a reference to the extension of time being 'fair and reasonable', which may have influenced the approach. This approach has been criticised by some commentators who suggest allowing only a partial extension of time when there has been employer delay is contrary to the prevention principle.[20]

More recently, there was the case of *North Midland Building Ltd v Cyden Homes Ltd* [2018] EWCA Civ 1744. In it, the contract contained a clause providing that 'any delay caused by a Relevant Event which is concurrent with another delay for which the Contractor is responsible shall not be taken into account'. These clauses have been increasingly used in the UK and mean that the contractor bears the risk of not being entitled to an extension of time and of bearing the resulting liquidated damages if there are concurrent contractor and employer delaying events. In this case, the court upheld the validity of such clauses on the basis they represent a clear allocation of the risk to the contractor.

The standard form contracts used in the UK do not take a standard approach to concurrent delay. JCT and NEC do not deal with the issue at all,[21] whereas FIDIC allows parties specifically to set out in the Special Conditions how concurrent delay should be assessed, failing which it is to be assessed 'as appropriate taking due regard of all relevant circumstances'.[22] Given the vagueness of the default, parties may prefer to use the Special Conditions to agree a specific method of analysing this. The CIOB contracts are even more specific and are the only UK standard form contracts to provide a definition of concurrent delay.[23]

The standard form contracts used in the UK do not take a standard approach to concurrent delay. JCT and NEC do not deal with the issue at all…

The standard form contracts in the US, and federal contracts, all generally provide for a time extension for an excusable delay, without any language precluding the amount of time extension for concurrent delay. American Institute of Architects (AIA) and ConsensusDocs do not specifically address concurrent delay. The EJCDC contract specifically says that any 'concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled'.[24]

Review of schedule delays during the project (different)

During the project, the two documents take a different position on evaluation of schedule delays. The SCL Protocol (guidance with Core Principle 4) advises use of prospective time impact analysis (TIA) at the start of the delay whether before or after the delay has finished during the project. It is not until time-distant from the delay event that the SCL Protocol (Core Principle 11) recommends switching to a retrospective delay analysis method.

By contrast, the ASCE Standard does not specifically address using a prospective TIA, but does recommend generally following the contractually mandated procedure. This frequently involves use of a prospective TIA once changed work is identified. However, after conclusion of the delay, the ASCE Standard (Chapter 4) suggests using actual impact to the scheduled completion date whether during the project or long after completion.

Both the SCL Protocol (Core Principle 4) and ASCE Standard (Chapter 1) encourage resolution of issues during the project rather than waiting until the end of the project. However, the SCL Protocol's recommendation of allowing a different method time distant from the delay or after project conclusion may be an impediment to expeditious resolution. For instance, if one of the parties does not like the result of the prospective TIA method, that party would have an incentive to wait until it becomes time-distant from the event, then choose a different delay analysis method that produces a better result while still following the SCL Protocol recommendations.

This can, likewise, be the position within the JCT form of contract. It provides for applications for extension of time to be made 'as soon as reasonably possible'[25] after a delay

event becomes apparent and for decisions on whether or not to award extension of time to be made within 12 weeks.[26] That would require a prospective analysis. However, it also provides for a post-completion review and for an additional (but not reduced) extension to be granted if 'fair and reasonable' and based on a retrospective analysis.[27] The NEC calls for more 'on the spot' prospective analysis as the contractor is required to apply for compensation events within a strict eight-week time period.[28] The project manager then has a fixed period of time to respond.

The US standard forms all require initial notice of time extension requests, but do not specify a period for submitting the claim particulars. The US federal contract forms typically specify a 'prospective' TIA when the delay is first identified, but do not address how to treat delay if no agreement is reached while the delay is ongoing. As a result, some courts have opined that a retrospective TIA comparing the delay between schedule updates is acceptable after the fact on federal projects and is not inconsistent with the prospective requirement in the contract.[29]

Unlike the SCL Protocol, the ASCE Standard's position of recommending one consistent set of guidelines whether immediately after the delay or long after completion of the project means that there would be no incentive for the parties to wait to resolve time-related disputes in terms of following the guidance.

However, employers tend to be of the view that a retrospective analysis, which allows any subsequent contractor delays to be factored into the analysis, is favourable to them and would be inclined to wait before making its analysis, regardless of the contract terms.

Entitlement to extension of time versus compensation for the same period (different)

The SCL Protocol and ASCE Standard differ with respect to the relationship between extension of time requests and the method of calculating compensation. The SCL Protocol (Core Principle 12) advises that extension of time entitlement does not automatically lead to entitlement to compensation. It further provides (Core Principle 22) that once it is established that compensation for prolongation is due, the evaluation of the sum due is made by reference to the period when the effect of the employer risk event was felt and not to the extended period at the end of the contract.

By contrast, ASCE Standard (guideline 4.4) advises that the actual impact to the schedule is evaluated by comparing the schedule before and after the delay. ASCE Standard guidelines 4.5 and 4.6 affect excusable delays, while guideline 4.7 addresses compensable delay, identifying that compensable delay has to extend the longest path. Where there is excusable delay, a time extension to offset liquidated damages is granted. Where there is compensable delay, the contractor receives compensation as well. Taken together, excusable and compensable delays are both evaluated within the framework outlined in guideline 4.4, meaning that generally the same method of assessment that is used to identify compensable delay would automatically match an excusable time period.[30]

This will be heavily influenced by the contract terms. In JCT, there is a different list of events giving rise to extension of time (relevant events) and loss and expense (relevant matters). This reflects the risk allocation. Relevant events include both employer fault events (eg, variations and access delays) and neutral events (force majeure and weather), whereas relevant matters are only employer fault events. Further, there can be entitlement to loss and expense for disrupted activities, even where there is no delay to completion. This arises from the wording of the loss and expense provision which allows for recovery where 'the regular progress of the Works or any part of them has been or is likely to be materially affected'. In NEC, all compensation events bring an entitlement to time and money. The money element is assessed at the date of notice.[31] Likewise, US standard forms of contract and federal contracts generally outline which events are both excusable and compensable (measured the same way), versus which events are solely excusable (but not compensable). The US standard forms typically follow the guidance from the Federal Acquisition Regulation (FAR) applicable to federal contracts where extreme low-probability events outside the control of either party are excusable, but not compensable.[32]

Schedule delay analysis method selection (slightly different)

For selection of delay analysis method after the fact, the documents are similar, but

Neither the SCL Protocol nor the ASCE Standard explicitly recommend a schedule delay analysis method.

slightly different. Neither the SCL Protocol nor the ASCE Standard explicitly recommend a schedule delay analysis method. The SCL Protocol (guidance 11) mentions six common methods and several other less common methods, but does not identify any preference among these. The SCL Protocol lists a variety of factors to be deployed in deciding which method to use.[33] While most of the factors would affect the risk of using a less accurate or less preferred method, many have no bearing on validity or acceptability of method, such as value of dispute, time available, nature of the events, nature of the project and forum of dispute resolution. The only factors likely to have a substantive effect on selection of method by potentially limiting options available are quality of records, quality of programmes and contract conditions. SCL Protocol guidance 11.8 recommends the parties get together and agree a method to save time and cost. While good in theory, in practice there would be pressure on both sides to pre-investigate methods that would give each side a better position ahead of the meeting to agree a method, because knowing results ahead of time might influence the method discussion. The court in *Walter Lilly v Mackay* had controversially seemed to suggest that the same answer should result whether a prospective or retrospective analysis was undertaken but that has recently been doubted in *Fluor v Shanghai Zhenhua Heavy Industry Ltd*, where the facts known at the time of the delay to those on the ground were recognised as limited and may lead to a different result when looking back with the benefit of hindsight.[34]

The ASCE Standard also does not recommend any particular method, nor does it mention any specific methods by name. The ASCE Standard only references methodology in Chapter 1, recommending that whichever method is used should comply with the underlying 35 guidelines and principles outlined in the Standard, such as incorporating the delays into the analysis in chronological order, using the CPM schedules to evaluate delay by measuring the change to the projected completion date of the schedule, and apportioning concurrent delay. The ASCE Standard approaches the issue from a different direction but attempts to achieve the same goal as the SCL Protocol – to minimise dispute over method. It remains to be seen whether it will have the desired effect in practice although parties may well simply continue to select the method most advantageous to their own position.

Changing schedules after the fact (slightly different)

With regard to changing schedules after the fact, the SCL Protocol and ASCE Standard have slightly different positions. The ASCE Standard (Chapter 10) includes several guidelines addressing when and to what extent changes should or may be made to the contemporaneous schedules during a delay analysis performed after the fact. The SCL Protocol does not address the topic directly, but guidance 11.2 advises that the selection of a delay method must be 'sound from a common sense perspective' where there is a risk that use of the contemporaneous schedules 'might produce anomalous results'.[35] This could be likely to be interpreted to apply a reasonableness standard for making those determinations, as opposed to the ASCE Standard's more prescriptive guidelines on that point. It is notable that the JCT contract has an overriding requirement for a 'fair and reasonable' extension of time. The AIA similarly provides a time extension 'for such reasonable time as the Architect shall determine'.[36] The ConsensusDocs also allows for an 'equitable adjustment to the Contract Time'.[37] EJCDC contains 'Contractor shall be entitled to an equitable adjustment'.[38]

In terms of case law, there are numerous examples of the courts preferring a common-sense and fact-based analysis as opposed to a complex computer-generated analysis where the output can only be as good as the underlying data inputted into the analysis.

For example in *City Inn v Shepherd Construction*, the first-instance judge commented in relation to the employer's programme analysis:

> 'It accordingly appears that a number of errors exist in [the] programme… In my opinion that inevitably makes [the] as-built critical path analysis of very doubtful value. It is in my opinion clear that such a programme is critically dependent upon the logic links between different activities; that was accepted by both experts. If that is so, I am of opinion that [it] must be correct… 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.'

By contrast, the judge preferred the fact-based approach of the contractor's expert approach, commenting that it:

> 'appeared to me to be based on the factual evidence. Moreover, his method of proceeding appeared to be based on sound practical experience and on common sense; I also found the logical connections that he drew in discussing programming to be entirely intelligible'.[39]

In the US, courts and boards tend to apply significantly more preference to not changing the contemporaneous schedules used during the project, providing that those schedules have a 'rebuttable presumption of correctness' and 'in the absence of compelling evidence of actual errors in the CPMs, we will let the parties "live or die" by the CPM applicable to the relevant time frames'.[40] In the same vein, US courts and boards strongly frown on after-the-fact schedule delay analysis methods that contradict the schedule updates. In *Sterling Millwrights*, 'the court gave no weight to [the expert's] after-the-fact [method] with its made-for-litigation critical path'.[41] In *Jiminez*, the board added:

> 'Appellant seeks to have us rely on its CPM expert, and his newly created CPM analysis, which was prepared during litigation. Not surprisingly, this CPM showed VA-caused delays to the AHU accounting for the entire delay through 1999. Such self-serving analyses, created after project completion and which make adjustments to attain new and revised projected schedules, depending on theoretical contingencies, are of limited value.'[42]

The court in *Titan Pacific* commented generally that: 'Analyses made after project completion, however, that make adjustments to attain new and revised projected scheduling depend on theoretical contingencies. They are of limited value'.[43]

Early completion (similar)

The SCL Protocol and ASCE Standard take similar stances on delay to early completion schedules where the contractor plans to complete earlier than the contractual completion date either to save on preliminary or overhead type costs or to earn an early completion bonus. Both SCL Protocol (Core Principle 13) and ASCE Standard (guideline 6.2) acknowledge the right of the contractor to recover losses for delays to an early completion schedule, but only under certain conditions. The SCL Protocol (Core Principle 13) adds the condition that an early completion schedule has to be 'realistic and achievable', and disclosed to the owner at the time of contracting. The ASCE Standard (guideline 6.1) recommends that an early completion schedule be 'reasonable and achievable', and advises that while it is good practice to disclose, disclosure may not be needed in order for recovery. Here, the NEC contract is useful in that it includes the concept of time risk allowances being included in the accepted programme, as well as the scheduled and contractual completion dates.[44] If properly prepared, the programme will therefore be sufficiently transparent to allow this. Other standard forms are less prescriptive as to content. US standard forms similarly do not address early completion specifically, but their endorsement of 'reasonable' or 'equitable' adjustments may apply to delay to an early completion schedule.

Acceleration/mitigation (similar)

For acceleration and mitigation, the SCL Protocol (Core Principle 16) and the ASCE Standard (Chapter 11) are very similar in terms of directed acceleration and voluntary acceleration. The SCL Protocol covers mitigation requirements in more detail, but both documents identify that mitigation effort requiring additional costs is acceleration as opposed to mitigation.[45] That is not necessarily the case in the standard forms, however. JCT requires the contractor to use best endeavours to prevent delay in the progress of the works.[46] While there is no definition of what would constitute best endeavours, this can involve expenditure. FIDIC places a more specific obligation on the contractor to submit a revised programme showing 'revised methods' to the employer where progress has fallen or will fall behind the programme or actual progress is too slow to complete within the time for completion.[47] ConsensusDocs takes the position that: 'Parties each agree to take reasonable steps to mitigate the effect of such delays'.[48]

The ASCE Standard (guideline 11.3) identifies a five-part test for proving constructive acceleration after it has occurred:

1. an excusable delay was encountered;
2. a time extension request was made;
3. the owner denied or did not act on it;
4. the owner insisted completion must be met and the contractor notified the owner

it construed that insistence as a directive to accelerate; and

5. the contractor expended extra resources to accelerate.

The SCL Protocol (Core Principle 16) states that where the contractor and employer agree that accelerative measures should be undertaken, the basis for payment and records to be kept should also be agreed. Where there is no agreement, but the contractor is considering accelerating to avoid liquidated damages in circumstances where it considers it is entitled to an extension of time, the Protocol advises the contractor should attempt to have its extension of time dispute resolved in accordance with the contractual procedures prior to accelerating. The rationale for this is most likely because of the difficulty in making a constructive acceleration claim in the absence of agreement. Going to a dispute is only of assistance if it is fast. In that case, either time will be awarded (negating the need to accelerate or incentivising the employer to agree to pay costs if the project is time-critical) or it will not meaning the contractor will be incentivised to accelerate at its own cost in order to avoid liquidated damages. A longer dispute resolution process would not allow this certainty. In many cases, there would be many other factors at play and, in practice, constructive acceleration claims are very difficult to establish. In reality, a contractor may need to make its own commercial decision based on an assessment of the relative risks.

Summary

Overall, the SCL Protocol and the ASCE Standard are not substantially different. The differences between jurisdictions using these are likely to be as a result of the underlying legal and contractual position and then, in practice, the approach of parties in operating the contract, and the reality of availability of good quality programmes and records to analyse. Both documents support the effort to narrow disputes and resolve conflicts as efficiently as possible, in order to keep parties focused on constructing the project. That is a worthy aim, although the contentious nature of some construction projects means that they are not a panacea.

Notes

1 SCL Protocol 2nd Edition, Introduction Parts E and F.
2 SCL Protocol 2nd Edition, Introduction Part K(g).
3 SCL Protocol 2nd Edition, Introduction Part K(b) and Core Principle 4.
4 *Alstom v Yokogawa Australia PTY Ltd (No 7)* [2012] SASC 49; *Santos Ltd v Fluor Australia PTY Ltd* [2017] QSC 153.
5 *Leighton Contractors (Asia) Ltd v Stelux Holdings Ltd* [2004] HKCFI 804.
6 ASCE Standards, p iii, ASCE Standard ANSI/ASCE/CI 67-17 Schedule Delay Analysis.
7 C 1 Introduction, p 1, ASCE Standard ANSI/ASCE/CI 67-17 Schedule Delay Analysis.
8 C 1 Introduction, p 1, ASCE Standard ANSI/ASCE/CI 67-17 Schedule Delay Analysis.
9 See, eg, cls 2.28.1.2 and 4.20.1 of the JCT Standard Building Contract with quantities 2016.
10 Cl 63.5 of NEC4 and cl 63.3 of NEC3 and cl 8.5 of FIDIC (2017 editions).
11 Cl 63.5 of NEC4.
12 The importance of the accepted programme is also recognised by the SCL Protocol, Core Principle 9.
13 Cl 45 of the CIOB Time and Cost Management Contract (2015).
14 Ar 8.3.1 of American Institute of Architects (AIA) A201 General Conditions of the Contract for Construction 2017; Art 6.3.1 of ConsensusDocs 200 Standard Agreement and General Conditions between Owner and Constructor 2017; Art 4.05, C of EJCDC C-700 Standard General Conditions of the Construction Contract 2018.
15 Art 4.05, D, 1 of EJCDC C-700 2018.
16 Art 6.2.1 of ConsensusDocs 200 2017.
17 *Henry Boot Construction (UK) Limited v Malmaison Hotel (Manchester) Limited* (1999) 70 ConLR 32 QBD (TCC), where this was the position as agreed by the parties; approved in a number of cases since including *Walter Lilly & Co v Mackay* [2012] EWHC 1773 (TCC).
18 *Keating on Construction Contracts*, para 8-026.
19 *City Inn v Shepherd Construction* [2007] CSOH 190.
20 John Marrin QC, *Concurrent Delay Revisited*, SCL (2012).
21 Except for the JCT Major Project Construction Contract (2016), which provides that the employer must make a 'fair and reasonable adjustment to the Completion Date notwithstanding any period of concurrent delay', cl 18.7.3.
22 Cl 8.5 of the FIDIC Red Book.
23 Cl 52.1 of the CIOB Time and Cost Management Contract and cl 41.1 of the Contract for Complex Projects.
24 Art 4.05, D, 2 of EJCDC C-700 2018.
25 Cl 2.24 of the JCT Design and Build Contract (2016).
26 Cl 2.25.2 of the JCT Design and Build Contract (2016).
27 Cl 2.25.5 of JCT Design and Build Contract (2016).
28 Cl 61.3 of NEC 4.
29 See, eg, *George Sollitt Const Co v US*, 64 Fed Cl 229, 268 (2005); In re Fru-Con Const Corp, ASBCA No 53544, ASBCA No 53794, 05-1 BCA (CCH) s 32936, 163162, 2005 WL 874471; Appeals of Harrison Western Corp, ENGBCA No 5556, ENGBCA No 5576, 93-1 BCA (CCH) s 25382, 1992 WL 221976 (Corps Eng'rs BCA 1992).
30 The only exception to that general rule might be the special case of early completion, which is also treated the same by both the SCL Protocol and the ASCE Standard (see 'Early completion (similar)' below).
31 But *cf Northern Ireland Housing Executive v Healthy Buildings* [2017] NIQB 43, which suggested it could be actual cost incurred (rather than anticipated cost at the date of the notice) if known at the time the assessment was made. Deeny J remarked at [54] 'why should I shut my eyes and grope in the dark when the material is available to show what work they actually did and how much it cost them?'

32 FAR 52.249-10(b)(1); ConsensusDocs, Arts 6.3.1 and 6.3.2; EJCDC C-700 Art 4.05, C; AIA A201 Art 8.3.1.
33 SCL Protocol, guidance 11.3.
34 *Fluor v Shanghai Zhenhua Heavy Industry Ltd* [2018] EWHC 1 (TCC) 654.
35 SCL Protocol, guidance 11.2.
36 Art 8.3.1 of AIA A201 2017.
37 Art 6.3.1 of ConsensusDocs 200 2017.
38 Art 4.05, A in EJCDC C-700 2018.
39 *City Inn v Shepherd Construction* [2007] CSOH 190 at paras [38] and [40].
40 *Appeal of Santa Fe, Inc*, VABCA No 2168, 87-3 BCA (CCH) s 20104, 1987 WL 47788 (Veterans Admin BCA 1987).
41 *Sterling Millwrights, Inc v United States*, 26 Cl Ct 49 (1992).
42 *In re Appeal of Jimenez, Inc*, VABCA No 6351, VABCA No 6352, VABCA No 6353, VABCA No 6354, VABCA No 6421, VABCA No 6422, VABCA No 6423, VABCA No 6591, VABCA No 6611, 02-2. BCA (CCH) s 32019, 2002 WL 31185730 (Veterans Admin BCA 2002).
43 *Titan Pacific Const Corp v US*, 17 Cl Ct 630, 35 Cont Cas Fed (CCH) s 75693, 1989 WL 78828 (1989), aff'd, 899 F 2d 1227 (Fed Cir 1990).
44 Cl 31.2 of NEC 4.
45 SCL Protocol, Core Principle 15, at 7; ASCE Standard ANSI/ASCE/CI 67-17 Schedule Delay Analysis, guideline 4.4.
46 Cl 2.25.6.1 of the JCT Standard Form Building Contract with Quantities.
47 Cl 8.7 of the FIDIC Red Book.
48 Art 6.3.3, ConsensusDocs 200 2017.

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Assessing disruption on construction projects 'measured mile' versus 'system dynamics': a comparison

The second edition of the Society of Construction Law 'Delay and Disruption Protocol' (2017) (the 'SCL Protocol'), which is already receiving some judicial approval,[1] continues to hold the 'measured mile' as the most accepted method for calculating disruption[2] – but, for the first time, the SCL Protocol now also refers to the newer method of 'system dynamics'. This article reviews the major challenges confronting claimants seeking to recover disruption damages on construction projects, including establishing causation, correctly quantifying damages, ensuring applicability to claim and acceptance in courts or arbitrations, as a context for comparing and contrasting two of the most reliable lost productivity quantifying methods[3] – 'measured mile' and 'system dynamics'.
Based on this comparison, it is evident that 'system dynamics' addresses fundamental issues of causation and quantification established in legal precedents and authoritative texts on construction law.

Claiming for disruption: a long and winding road

Disruption is defined by the SCL Protocol as:

> '[…] disturbance, hindrance or interruption to a Contractor's normal working methods, resulting in lower productivity or efficiency in the execution of particular work activities. […] Work that is carried out with a lower than reasonably anticipated productivity rate (i.e. which is disrupted) will lead to: (a) activity delay; or (b) the need for acceleration, such as increasing resources, work faces or working hours, to avoid activity delay; or (c) a combination of both – and therefore, in each case, loss and expense. Hence, 'disruption' is concerned with an analysis of the productivity of work activities, irrespective of whether those activities are on the critical path to completion of the works.'[4]

Disruption is caused by changes to the project, that is, by unplanned events and conditions that could not reasonably have been anticipated at the time of entering into the contract and directly or indirectly affect productivity and quality. The SCL Protocol description also captures, succinctly, difficulties associated with disruption and its analysis: loss of productivity; overlapping events and conditions; the impact of managerial measures; out-of-sequence work; ripple effects; quality issues; rework and so on. To be entitled to resultant damages, a contractor must address the complex nature of disruption along with the requirements stipulated in the contract, authorities on construction law[5,6] and ratified in legal precedents[7,8] namely:

- Liability: which party bears the contractual/legal responsibility for the disruptive events and conditions?
- Causation: what was the causal link connecting the change to the damages being claimed?

- Quantify damages: what additional costs were incurred because of the change?

By their nature, disruption claims do not allow precise, contemporaneous productivity measurement. As Shea[9] put it: 'One of the ironic things about loss of productivity claims is that often the very factors that produce the loss of productivity can also serve to preclude the accurate and precise record-keeping.'

Moreover, there is no rigorous methodology for quantifying such damages. Different methods (outlined in the SCL Protocol[10] and AACEI RP25R-03[11]) have been used to assess disruption on construction projects; the very existence of such a broad variety of estimating methods points to the challenges faced in claiming for disruption costs:

- disruption is not immediately apparent and not contemporaneously documented; and
- its indirect effects ripple through the project, and are often felt well after the event that caused it ended.

The literature on the practical shortcomings of these methodologies is extensive. Gemmell's recent survey[12] targeted at professional groups (experts, judges/arbitrators, lawyers and contractors) found that 74 per cent of respondents believed that 'measured mile' had been used 'successfully' less than 50 per cent of the time – and only 26 per cent of respondents reported a success rate higher than 50 per cent. Given the shortcomings of disruption analysis methodologies, the recent inclusion of 'system dynamics' in the SCL Protocol is timely. It would be instructive, therefore, to compare and contrast 'measured mile' and 'system dynamics' on the basis of criteria derived from such requirements and the complex realities encountered in disrupted projects and in the course of drafting claims.

The 'measured mile' method

'Measured mile' analysis is a method of estimating loss of productivity by comparing the productivity during an 'unimpacted' period with that achieved when the project was 'impacted'. The method is applied on an event-by-event basis, and relies on:

- the work activities performed and periods being identical (or significantly similar); and
- the 'unimpacted' period being sufficient as a baseline.

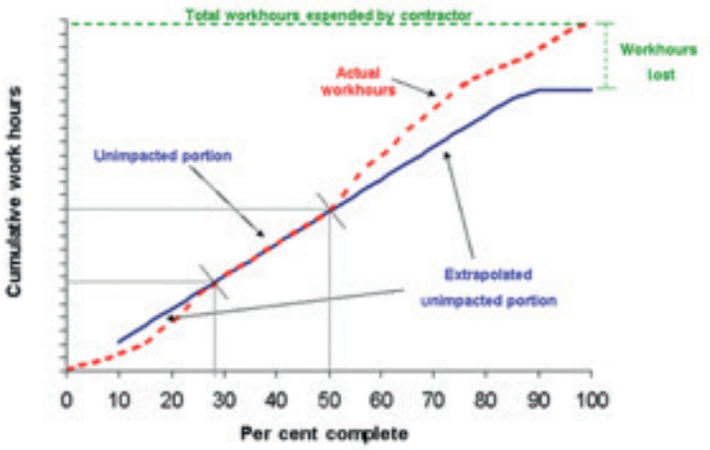

Figure 1: a graphical (original) illustration of the measured mile[13]

If these conditions are met, the productivity from the 'unimpacted' period is compared to the 'impacted' period, with the variance in productivity (delta) considered as due the impacting event.

Systems dynamics

The SCL protocol describes 'system dynamics' as:

> '[…] a computer simulation approach using specialist software to produce a model of the disrupted project. That model replicates the complex network of relationships and interactions that influence labour productivity and rework including the various stages of the project (design, approvals, procurement or manufacturing, installation, construction, commissioning and taking over), the different parts of the works, workflows and project participants, and the direct effects of the claim events.'[14]

As succinctly described above, 'system dynamics' uses simulation models that capture the complex network of causal interactions that connect project activities, decisions and performance. When 'system dynamics' is used in disruption analysis, a simulation model will first be calibrated to produce an 'as-built' simulation that faithfully matches the recorded historical performance of the project, inclusive of unplanned events and conditions (see Figure 2).

Once an 'as-built' model has been developed, a second ('but-for') simulation is run, removing the direct impacts of the unplanned events and conditions are removed. The difference

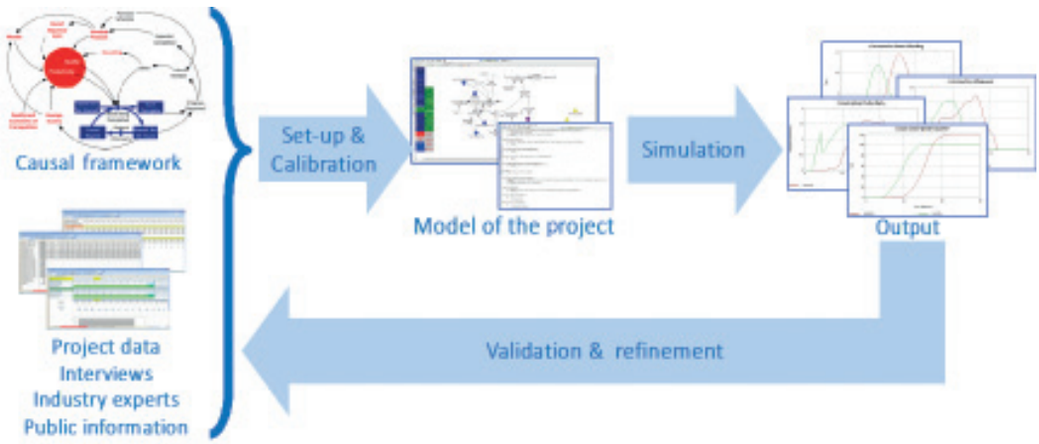

Figure 2: basic steps in the system dynamics modelling process

between simulations provides the disruption 'quantum' caused by the unplanned events and conditions being considered.

Comparison between 'measured mile' and 'systems dynamics'

This section compares how 'measured mile' and 'system dynamics' perform against criteria essential for meeting the legal tests for quantifying damages and establishing causation in a disruption claim, and thus essential for establishing entitlement and achieving recovery of disruption costs.

For clarity, the comparison will be structured around issues relating to:

1. quantifying disruption;
2. establishing causation; and
3. overall applicability and acceptance of the methodologies.

Challenge 1: quantifying disruption

Quantifying disruption properly and holistically relies on the use of productivity data, accounting for rework, and making sure that the entire project is considered.

Use of productivity data

Quantifying damages is difficult when supporting documentation and records are inadequate, which is invariably the case in disruption.

Quantifying damages in disruption is difficult when supporting documentation and records are inadequate...

'Measured mile' compares the progress per hour spent that has been achieved during the period impacted by a change to that achieved during an unimpacted period. It then uses the resulting implied loss in productivity to quantify claimable disruption costs. It is based on an event-by-event comparison of 'the productivity on an unimpacted part of the contract with that achieved on the impacted part. Such a comparison factors out issues concerning unrealistic schedules and inefficient working.'[15]

'System dynamics' is substantively different: it derives unimpacted productivity rates from actual 'as-built' efficiency, and from the number, timing and nature of the disruptive events suffered by the project.

Accounting for rework

Disruption does not just stem from losses in productivity, it is also caused by increases in rework.[16] Rework can amount to a significant proportion of construction costs and this fraction can grow exponentially in massively disrupted projects. The complicating factor when dealing with rework is that it is often incurred long after the causal event. Without a way of estimating how rework propagates through time, the full disruptive effect of a change cannot be assessed.

'Measured mile' does not explicitly address rework, and thus cannot determine which disruptive event or condition (either owner- or contractor-responsible) caused what amount of rework.

'System dynamics' recognises the challenges posed by having to address rework, and puts the latter at the heart of the methodology's causal framework: 'system dynamics'

simulation models include mathematical formulations that capture how (and when) rework is created, discovered and executed.

Applicability to the whole project

Considering the number and temporally/spatially 'expansive' nature of disruptive events, nearly all areas of the project will be impacted. For this reason, disruption claims should address the totality of the works so as to recover the sum total of disruption costs suffered.

Given also that the 'measured mile' requires the baseline be 'unimpacted', it is evident that the applicability of the method would be limited; and almost certainly rarely able to address the entire project.

'System dynamics' is based on the ability of its simulation models to faithfully reproduce the actual performance of entire construction projects. To achieve this, models capture ripple effects of causal events and project decisions, showing how any change eventually impacts all subsequent areas/period of the project. In brief then:

Challenge 2: establishing causation

Quantification issues	Measured mile	System dynamics
Use of productivity data	Productivity losses based on actual project data	Productivity rates calculated from calibrated as-built model
Accounting for rework	Does not account for rework	Rework dynamics are at the heart of the models used
Applicability to entire project	Analysis limited to works comparable to those performed in the 'unimpacted mile'	Models capture disruption across the whole project

In disruption claims, it is essential to establish a causal nexus for productivity losses; retrospective reliance on contemporary records to try to establish causation (cause and effect) is inadequate for evidencing a loss of productivity claim because of the very nature of disruption, such as the ripple effects and multiple causes that are not readily demonstrated by documentation.

Providing a causal narrative

It is necessary for a contractor to prove that an employer's actions resulted in disruption, and then to prove the effect and costs of the disruption. This involves an analysis of the sequence of events and the causal processes that connect the occurrence of events to their intricate outcomes, within a set of initial conditions.

'Measured mile' itself does not deal with causation,[17,18] it simply compares the difference between impacted and unimpacted productivities. To bridge this gap, proponents of 'measured mile' warn about the need to offer some indication of causation and, sometimes, propose to combine this method with others; for example, 'standards' for productivity losses caused by certain types of events.[19] This is a limitation of the 'measured mile' approach.

'System dynamics' is based on a causal framework that describes how project conditions, decisions and changes interact, and how these interactions determine project performance, causing disruption. As such, 'system dynamics' can deliver assessments for causal narratives explaining, step-by-step, how they caused the losses being claimed and how much any given unplanned event impacted project productivity.

Differentiating disruptive impact by event

A court will not deny a claim for damages on the ground that it is difficult to establish the exact amount of the loss. However, a contractor has to establish the cause of the losses event by event. Given that the inability to separately account for contractor inefficiency is one of the key criticisms of global claims,[20] it is essential that the methods demonstrate the causal link although calculating damages may be complicated. The ability to attribute disruptive events individually is a critical requirement of a robust claim: thus, the damages being sought are specifically linked to the events forming the basis of the claim.

Moreover, as a practical matter, the ability

The ability to attribute disruptive events individually is a critical requirement of a robust claim.

to attribute and assess disruptive events individually allows for greater flexibility in the analysis, making it faster and easier to adapt to new data or new circumstances (for example, if liability for the disruption is in fact the contractor's and not the employer's).

'Measured mile' compares the 'as-built' productivity with an 'unimpacted baseline' – and is thus only able to determine the combined impact of all disruptive events that occurred in the unimpacted period.

'System dynamics' models are fed with data describing each disruptive event, and the analysis process can separately keep track of the disruptive impact of each one. The non-linearity of the equations used in 'System dynamic' simulation models also allows them to effectively (and consistently) deal with the cumulative impact of any combination of any number of events.

Accounting for contractor disruption

Some amount of disruption will always be a contractor's own responsibility. Thus, assessment of disruption must be able to account for this. As aptly stated by Lord Macfadyen:[21] 'If the causal events include events for which the defender bears no liability, the effect of upholding the global claim is to impose on the defender a liability which, in part, is not legally his. That is unjustified.'

The 'measured mile' compares productivity between the impacted and unimpacted periods and works, with the loss of productivity being the 'disruptive impact'. The approach is unable to differentiate between employer and contractor-caused disruption.

In 'system dynamics', the as-built model includes all disruptive events and conditions, including the contractor's own productivity losses. The 'but-for' simulation will eliminate only the impact of the employer-risk events causing disruption; that is, the contractor's own productivity losses and disruption remain the contractor's and are excluded from quantification.

Challenge 3: applicability and acceptance

In addition to legal challenges, there are such practical issues as availability of data, validation of results, disruption considerations of time, when methods can be applied, how they are perceived by courts, and so on; these are also relevant

Data availability

'Measured mile' relies on the availability of an 'unimpacted period' – and these 'clean miles' are not always readily available: real projects are usually subjected to changes, and finding any unimpacted periods can be extremely difficult.

> 'It is also true that [Measured Mile] cannot be applied on many construction projects for a host of reasons, two being the lack of detailed productivity record keeping and the lack of suitable or comparable unimpacted areas or time frames.'[22]

Data availability is also of concern to 'system dynamics', which deals much more flexibly with this issue: beyond data for the unplanned events and conditions, the methodology can be applied with a minimum amount of basic historical data, which should easily be available (time series for actual manpower and progress achieved.)

Validation of results

Disruption assessments must meet admissibility requirements as experts or 'opinion evidence' by tribunals or courts (see for example

Causation issues	Measured Mile	System Dynamics
Providing a causal narrative	Does not help establish a causal narrative	Models recreate causal mechanisms driving efficiency, supporting a causal narrative for losses
Differentiating impacts by event	Does not allocate overall disruption to different events	Explicitly allocates disruption to each event
Accounting for contractor disruption	Does not account for contractor disruption	Contractor's self-inflicted disruption accounted for separately

Applicability and acceptance	Measured mile	System dynamics
Providing a causal narrative	Applicable as long as a relevant 'unimpacted mile' can be found	Applicable with a minimum of available historical data, confidence in results increases with availability of additional hard and soft data
Validation of results	No obvious mechanism exists to validate the accuracy of claim estimates	Modelling process follows the scientific method, confidence range surrounding claim estimates can be determined
Interaction of disruption and delay	Does not deal with delays	Models simulate all major aspects of project performance, including schedule issues and delays
General acceptance	Recommended by SCL Protocol and AACEI RP25R-03	Included in rev2 of the SCL Protocol

Daubert[23] in the United States, and *Kennedy v Cordia*[24] in the United Kingdom). For their conclusions to be accepted, the results must be credible, objective, robust, and able to withstand scrutiny and detailed examination. In practice, this means that the closer the methodology follows the 'scientific method', the greater the likelihood of its analyses being accepted. A key element of the 'scientific method' is that hypotheses (here the alleged 'cause and effect' of a disruption event) can be tested, falsified and corrected or improved.

The results of the 'measured mile' are based on the comparison between two project periods, but the methodology cannot test the validity of its assumptions; for example, the impacted and unimpacted periods are hardly ever 100 per cent comparable, and there is no way for 'measured mile' to determine how this affects the accuracy and validity of the analysis results.

In 'system dynamics', the analysis accords with the scientific method: the simulation model is, in effect, a 'recreation' of what caused the project to perform as it did. This hypothesis is tested by requiring that the model's 'as-built' simulation be consistent with all relevant information about the project. Moreover, 'system dynamics' can quantify the accuracy ('90 per cent confidence range') of its claim estimates.[25]

Interaction of disruption and delay

In practice, the distinction between delay and disruption is often misunderstood; for example, sometimes delay and disruption are considered to be unrelated and, at other times, disruption is deemed to be caused by delays.

In reality, disruption and delay events are part of a continuum: any disruptive event will cause at least some amount of delay to some of the works, and any delaying event will cause at least some amount of disruption to some of the works. Indeed, it is often the case that large amounts of the 'as-built' schedule delay will have been caused by a multitude of small disruptive changes, which is typically not considered during more traditional time impact analyses.

While 'measured mile' does not address delays, 'system dynamics' recognises the interconnectedness of delay and disruption: its simulation models include variables representing schedule and delay, and these factors have an impact on efficiency, and are in turn indirectly impacted by it as well.

General acceptance

The 'measured mile' approach is generally accepted, although it has historically still suffered from acceptance problems in the courts.

The use of 'system dynamics' is increasing, and the industry's awareness of this methodology is growing (as evidenced by its inclusion as one of the generally accepted methods of disruption analysis listed in the SCL Protocol.

In brief

Figure 3 compares the reliance and performance of 'measured mile' and 'system dynamics' in addressing the challenges inherent to determining causation and quantifying damages in disruption claims:

…the results must be credible, objective, robust and able to withstand scrutiny and detailed examination…

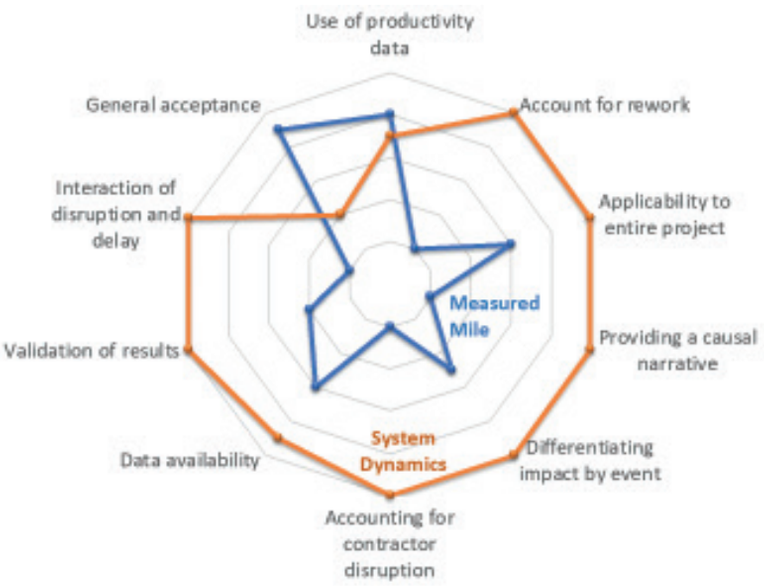

Figure 3: comparison of 'measured mile' v 'system dynamics'

Clearly, the 'Measured Mile' method has significant challenges in how appropriate, or correct, or effective, or defensible it is when applied to calculate loss caused by disruption and/or in demonstrating causation.

The ability of 'system dynamics' to establish causation and to quantify losses separately for each causing event (regardless of the party responsible) appears to be leading to more assured defensibility, significantly higher recovery rates and greater acceptance in the legal community and in courts and tribunals.

Simulation software is becoming much more transparent and easier to use, and accordingly the use of 'system dynamics' in disruption claims is likely to continue to grow, especially since it complies fully with the criteria for evidentiary admissibility and the requirements to prove a disruption claim.

Notes

1 *Santos Ltd v Fluor Australia Pty Ltd* [2017] QSC 153 at [111] – [112]; quoted by Matthias Cheung in 'Taking the measured mile' in Construction Law November 2017.

2 Society of Construction Law Delay and Disruption Protocol (2nd edn), February 2017, p 47.

3 William Ibbs, Nguyen, Long Dee, and Seulkee Lee, (2007) Quantified Impacts of Project Change; Journal of Professional Issues in Engineering Education and Practice, Vol 133, No 1.

4 SCL Op Cit (2), p 48.

5 Keating on Construction Contracts, [10th edn, 2016], para 8-062: 'Disruption claims are often difficult to establish and the evidential requirements for proving disruption claims should not be underestimated. In short the contractor must establish: (a) that there was disruption of its activities, (b) that the disruption was caused by a matter which attracts liability under the contract or for its breach, (c) how much disruption was caused, and (d) what sum is required either pursuant to the contract or as damages for its breach to recompense the contractor for the disruption.
In practice these stages are often elided. Thus primary evidence will be required explaining the nature of the disruption and its cause. In general the closer this evidence is to the "coal face" the more convincing it is likely to be. However once such evidence is given, and assuming it is compelling, considerable work will still be required measuring the extent of the disruption and its financial effect (i.e. stages (c) and d)).'

6 Reginald M Jones 'Claims for the Cumulative Impact of Multiple Change Orders' cites the case '*Centex Bateson Construction Co, VABCA* No 4613, 99-1 BCA para 30,153, at 149,259, 1998. Jones 2001': 'Despite a general recognition of the legal entitlement, little agreement exists as to how the claim should be characterized and what the contractor must prove in order to prevail on such a claim. In general, a contractor seeking to recover for the impact costs of numerous changes on unchanged work must prove three essential elements: liability, causation, and resultant injury. Of these three elements, causation and resultant injury present the largest obstacles to recovery.'

7 Lord Macfadyen in *John Doyle Construction Ltd v Laing Management (Scotland) Ltd* [20012] BLR 393 at para 35 stated: Ordinarily, in order to make a relevant claim for contractual loss and expense under a construction contract [...] the pursuer must aver (1) the occurrence of an event for which the defender bears legal responsibility, (2) that he has suffered loss or incurred expense, and (3) that the loss or expense was caused by the event.

8 *Warwick Construction Inc, GSBCA* Nos 5070 et al, 82-2 BCA 16,091 at 79,854: It has always been the law that in order to prove entitlement to an adjustment under the contract or for its breach, a contractor must establish the fundamental facts of liability, causation, and damage.

9 Shea, Thomas E, Proving Productivity Losses in Government Contracts, 18 Pub Contract LJ 414 (1989).

10 SCL Op Cit (2), p 46

11 Association for the Advancement of Cost Engineering (AACE) International, 'Estimating Lost Labor Productivity in Construction Claims' Recommended Practice No 25R-03

12 Robert Gemmell, (2016), 'The quantification of loss caused by disruption – how appropriate is the measured mile?' Survey extracted from 'Masters in Construction Law and Practice' at The University of Salford, UK.

13 Dwight A Zink, (1986), 'The measured mile: Proving construction inefficiency costs', 28(4), Cost Eng, 19.

14 SCL Op Cit (2), p 48.

15 SCL Op Cit (2), p 48.

16 SP Dozzi and Simaan M AbouRizk (1993) 'Productivity in Construction Institute for Research' in Construction, National Research Council of Canada, NRCC 37001.

17 H Randolph Thomas, (2010) 'Quantification of Losses of Labor Efficiencies: Innovations in and Improvements to the Measured Mile', (2 2) (2010) Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, ©ASCE, ISSN 1943-4162/2010/22/106/7/: 'Using this approach is often unsuccessful, especially with juries because no cause-effect relationship can be established.'

18 Mechanical Contractors Association of America (MCAA), 'Change Orders, Overtime and Productivity' (2016), p144: 'The [Measured Mile] analysis should be accompanied by a cogently written narrative that connects the causes with the effects.'
19 *Ibid.*
20 Keating on Construction Contracts, [10th edn, 2016], para 19-038: '*[A composite financial claim] might also conceivably fail if the court were to find that proper separate identification and linking of the factual consequences constituting the contractor's entitlement to claim and his losses could have been made.*'
21 *John Doyle Construction Ltd v Laing Management (Scotland) Ltd* [2002] BLR 393.
22 MCAA Op Cit (19) p 102.
23 *Daubert v Merrell Dow Pharmaceuticals, Inc*, 509 US 579, 113 S Ct 2786, 125 L Ed 2d 469 (1993)
24 *Kennedy v Cordia (Services) LLP* [2016] UKSC 6
25 James M Lyneis and David N Ford, 'System dynamics applied to project management: a survey, assessment, and directions for future research'; (23 2/3) (2007) System Dynamics Review 157.

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Continuity in analysing delay

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There is a basic misinterpretation of data in delay analysis that is common practice in assessing delays. Specifically, it is to quantify delay using the estimated per cent complete of ongoing work found in progress updates. In doing this, an inconsistent unit of measure is being introduced, and the results can cause a premature assessment of delay or recovery and a breakdown of continuity. This practice is derived from confusing per cent work (an integral measure in planning) with per cent time (an integral measure in delay analysis). Although both the work and time for an activity start simultaneously at zero per cent and end at 100 per cent, their paths along the way are typically very different. It is a common misconception that because the work done for an activity does not necessarily progress linearly, using a linear distribution of time in delay analysis poorly approximates the work. On closer inspection, the exact opposite is true: using the per cent work poorly approximates the time. This is because time is the fundamental unit in the critical path method (CPM) and it progresses linearly (actually, time does not exactly progress linearly, but close enough if you are not approaching the speed of light or under the influence of an intense gravitational field where you would probably have things other than delay analysis on your mind anyway).

To have reliable results in any nested calculation, it is important to use consistent units of measure and apply them uniformly over the scope of an analysis. In quantifying impacts, the use of per cent complete values based on the work accomplished involves using data with a different unit of measure than initially used in the baseline plan. Also, it is being applied in a non-uniform manner and is based on needlessly subjective data. The per cent complete of in-progress activities already has an objective quantification based on its allotted time. The CPM at the heart of planning software has only one original and fundamental unit of measure, and that is time (planned duration). To hold the units consistent, as an activity progresses, the per cent of the planned duration is the most reliable unit of measure to use when analysing delay.

To understand why this is so important, it is first essential to understand how the CPM computer model measures project time. The CPM is used in almost every form of forensic delay analysis. It is the basic model used by nearly all planning software. At its heart is a simple path finding algorithm that has nodes

that are point-in-time events, and a distance between nodes that is measured in time. An activity in the CPM does not measure an amount of work; it measures the amount of time to do that work. More specifically, it measures the amount of time to get from one node, the start, to another, the finish. The plan is made up of either the measure of time between the start and finish of an activity, or the measure of time between activities, which is known as lag. Together, they make up the core of the network.

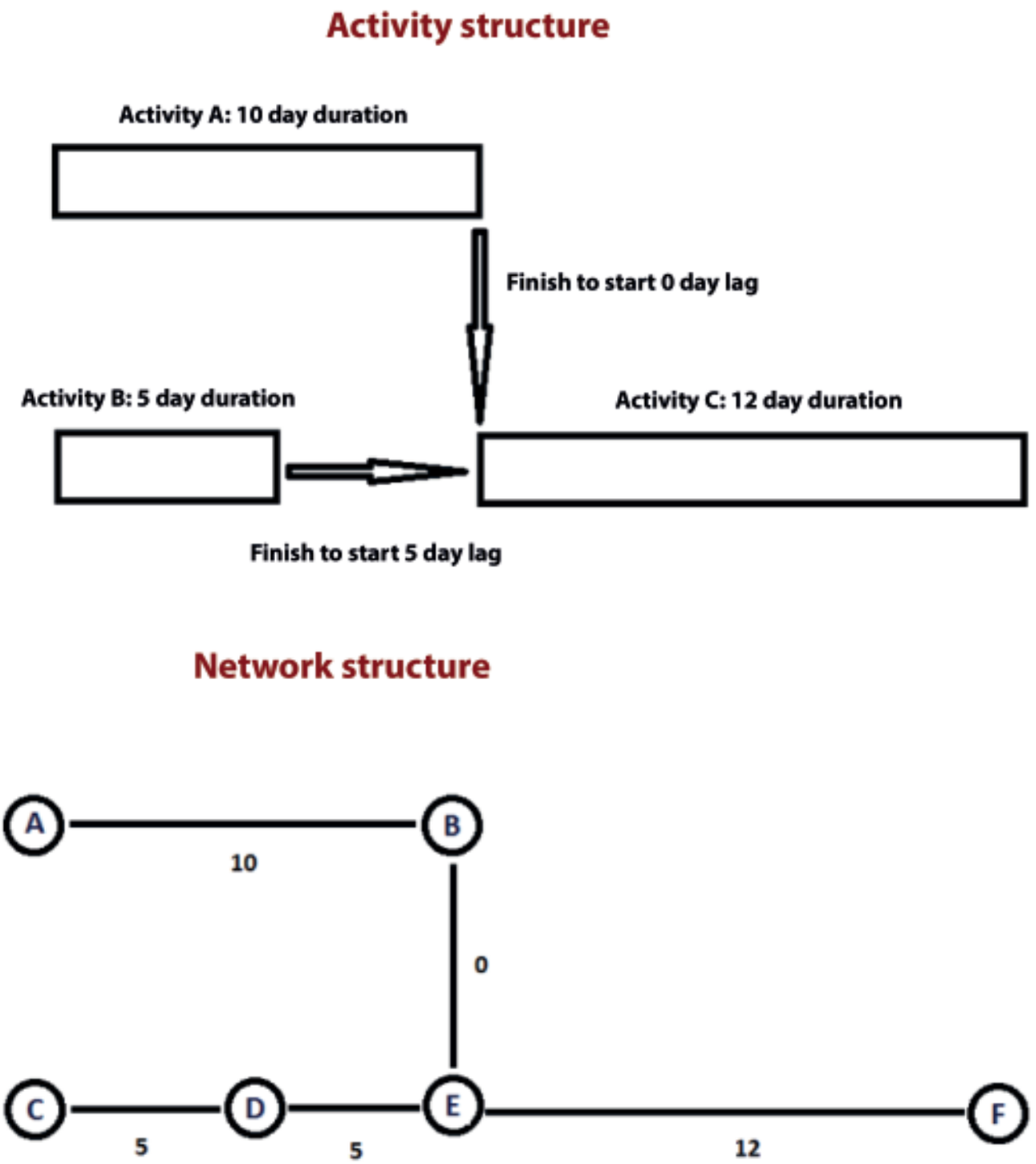


Figure 1: node structure of the CPM computer model

The computer travels down every possible path of this network, primarily to find the sequence of nodes with the longest duration. This longest chain is the critical path, which is the barometer of how long the project will take to complete at any given point in time. Because the measure between the start and finish nodes of an activity is the allotted time between them, to maintain continuity, the per cent complete value for in-progress activities should be the per cent complete of the allotted time and not the per cent complete of the allotted work.

The concept of updating in-progress activities using time goes against the grain of how project controls are taught, which is often projected onto delay analysis. It seems counterintuitive, as an example, if almost no work has been done on an activity, to declare it 90 per cent complete just because 90 per cent of the time has expired. But for reliable results in delay analysis, that is precisely the appropriate measure to use. In delay analysis, to say that an activity is 90 per cent complete does not mean the work is 90 per cent complete, but that the allotted time is 90 per cent complete. That is what you are measuring in a CPM schedule when using it for delay analysis. The amount of work does not have a bearing on quantifying actual impact until it crosses the threshold of the allotted time or it finishes. You lose sight of that threshold if the units in your calculations change from allotted time to allotted work. That is a subtle difference between planning and delay analysis. And that is why, for delay analysis, it is important to keep the units you are measuring consistent. To be clear, it is *not* being stated here that the per cent work of an in-progress activity is immaterial. In planning, it is essential to know where you are, and for progress payments, resource allocation, earned value, cost and project controls. However, it is not a consistent unit of measure for quantifying impacts in forensic delay analysis. This is because, in switching units to work, essentially lateness or potential earliness is being assessed before an activity is due. To express the difference simply, it is like any assignment with a due date, for example, a homework assignment: if you have ten days to do it, then you can do essentially nothing for nine days and pull an 'all-nighter' on day nine. If you can deliver it by the due date, then no harm is done. It's not late, until it's late. Using per cent work on in-progress activities is analogous to the teacher looking at your work on day five, noting that you are running five days behind and marking your paper down for being five days late before it is even due. By contrast, by using per cent time of planned duration, at the end of day one, you have exhausted ten per cent of the time and have nine days to complete the assignment. On day two you have exhausted 20 per cent and have eight days to complete it. If you have not completed it by day 11, then you are one day late; by day 12, two days late, etc. Once consistent units of measure are used in delay analysis, continuity is exposed, which can uncover not only a clear and precise quantification of impact, but if used actively in planning alongside the per cent work, it can expose potential delays virtually in real time, and often before they impact a project.

As an example of why this is important in analysing delay, consider the following scenario of a simplified plan for building a wall with only three activities: wall permit, material delivery and wall building. In this example, we assume that once the wall permit is submitted, it is typically approved in 18 days. Let's also say it will take 20 days for the materials to be delivered to the site, and once you have both the permit and materials, you can build the wall, which takes 15 days.

This baseline plan would appear as illustrated, with the wall permit activity initially having two days of float (time before the activity becomes critical). Let's assume the following progress: on day one, the permit was not submitted because there was a disparity in the survey. Let's also assume that the truck was loaded with the materials for delivery on the first day, but on the following morning, because of a mechanical failure, it was stuck at the warehouse until the end of day 19. On day 20, the materials were put on a plane and flown to the site, arriving as agreed in the baseline plan. On the permit side, let's assume that the resolution of the survey problem did not occur until day 20. The application was received on that day and approved 18 days later, and the wall construction began.

If this plan was updated and impact was assessed using per cent work, the finish of the material delivery would be responsible for all of the delay, despite it starting and finishing on time. In addition, using the per cent work, the permit application was never responsible for any delay. This is despite the obvious fact that

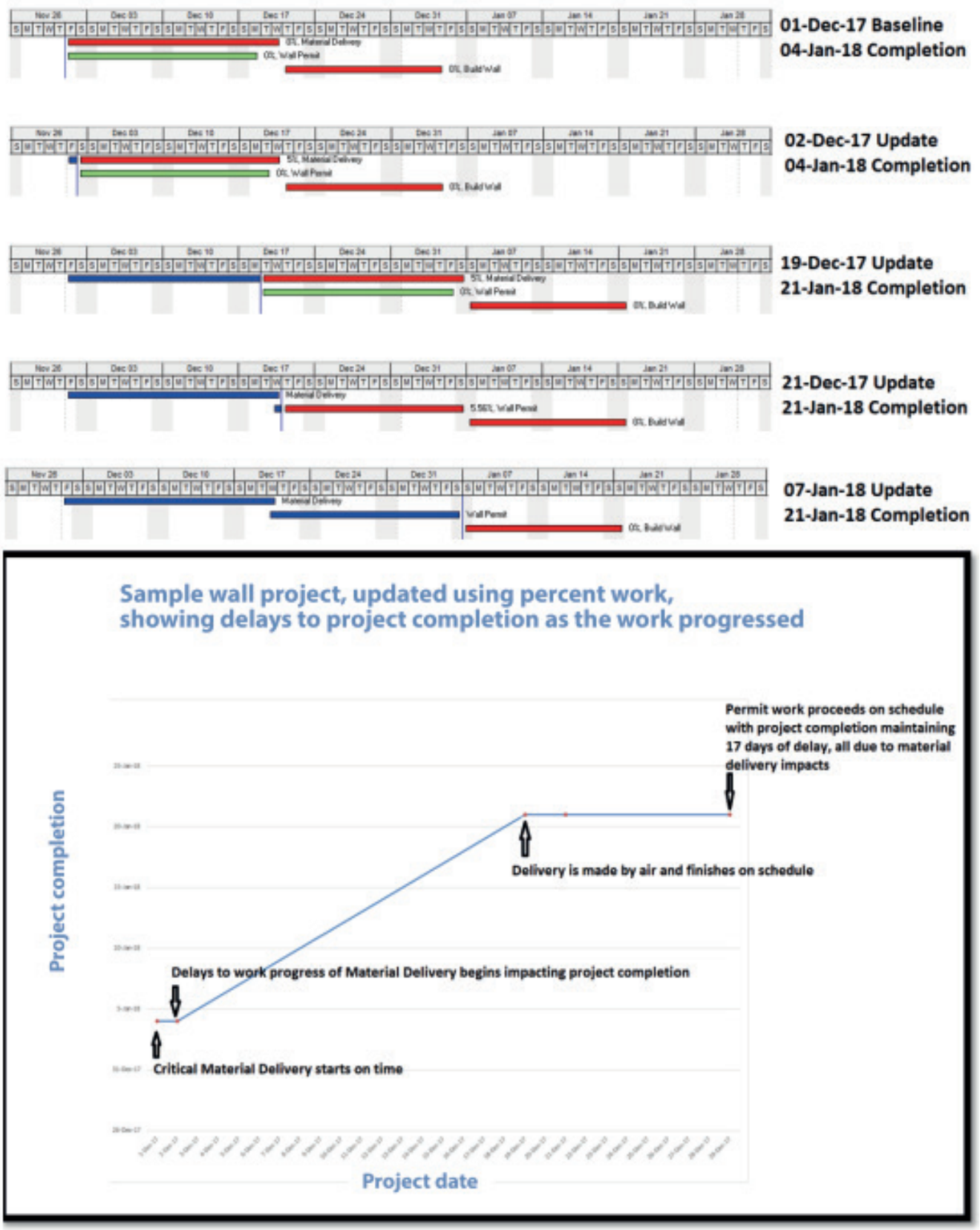


Figure 2: impact analysis using % work for in-progress activities

the permit approval was the sole reason for the delayed start of the wall, because the materials were on site, but wall construction could not begin because of a wait of 17 days for the permit. The reason the delay analysis is flawed is because, although a critical activity (material delivery) was 18 days behind schedule at a certain point in its progress, it could not have impacted the project at that time for the simple reason that it was not yet due. But the due date is lost in the calculus if you are updating progress using the estimated per cent of the work rather than the per cent of the time. Using per cent work, the impact is assessed before the time has expired to do the work. There is no commitment in a plan to have 60 per cent of the work done when 60 per cent of the time has expired; the commitment is to

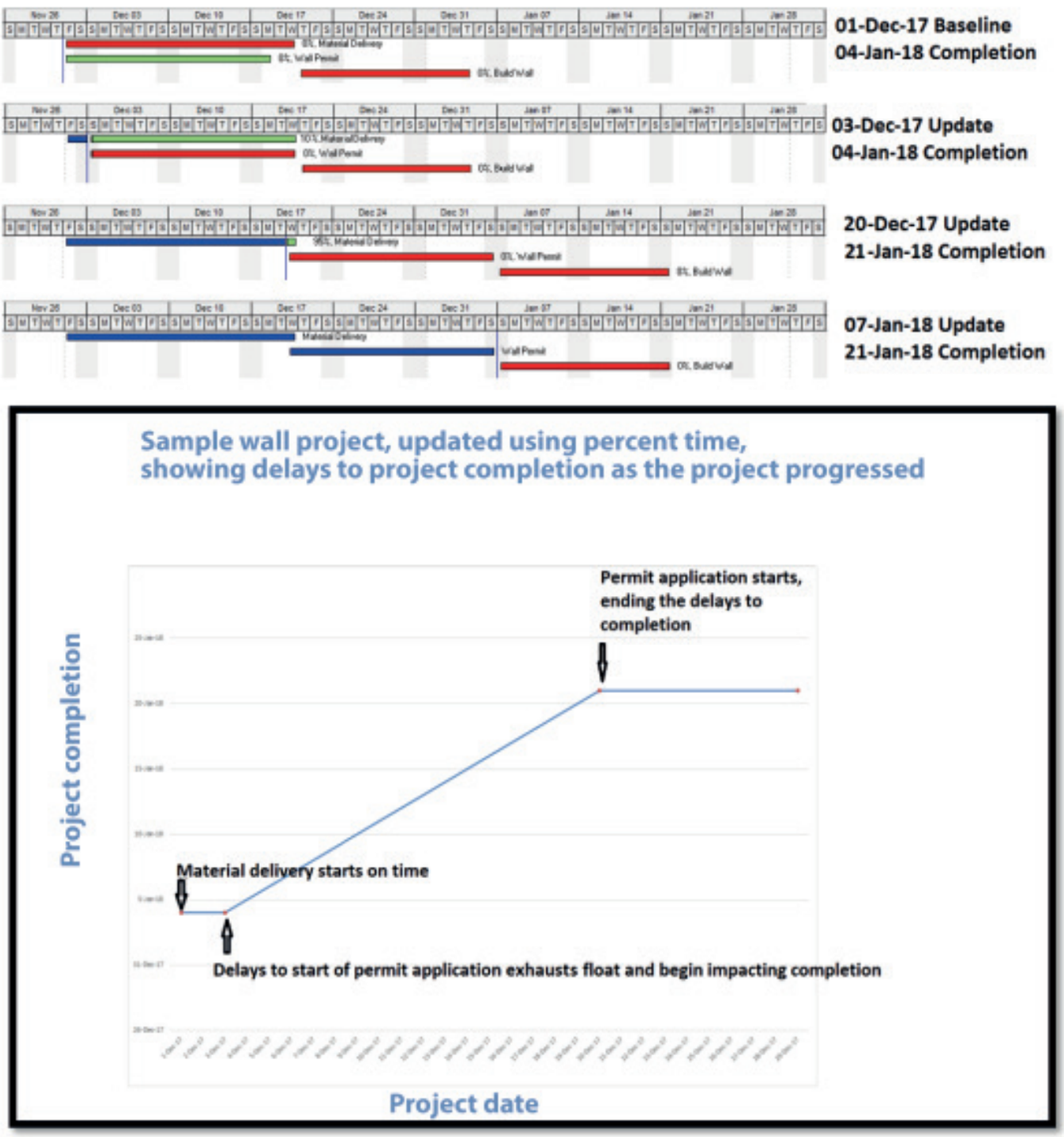


Figure 3: impact analysis using % time for in-progress activities

have 100 per cent of the work done when 100 per cent of the time has expired.

To further underscore the unreliability of using per cent work in delay analysis, suppose the same material delivery activity was represented as two milestones: one for 'begin loading materials' and the other for 'deliver materials on site', with a 20-day lag between them. Under this scenario, it would be updated completely differently than the model that made the same representation using a single activity. This is because lag between activities is progressed using per cent time. In this instance, the method of progress would not be applied uniformly: you would be progressing half the model using per cent work and the other half using per cent time, with completely different outcomes using the same basic data. There is also the matter of the subjective nature of using per cent work. It is an ambiguous unit that is estimated by a person responsible for the data. If one person believes it is ten per cent and another that it is 11 per cent, then the completion date, critical path and impact can be entirely different.

In the wall scenario, if per cent time of the planned duration is used for quantifying impact, the results are consistent and uniform in both measure and application, and they agree with common sense. Namely, delays to submitting the permit were the sole cause of the 17 days of delay, which began after the late start consumed the two days of float, and ended when the permit application was submitted. The findings are the same whether you represent the activities as a single task or two milestones with a lag. But there are considerably more benefits to using a consistent unit of measure for in-progress activities. It opens a whole range of possibilities to impact analysis because it brings speed, accuracy and, especially, continuity to updating and assessing impacts. This is because per cent work is based on a subjective judgement, and it proceeds in a nonlinear manner, whereas time progresses uniformly. This means that between the actual start and actual finish of an activity, you know precisely what the per cent complete is, and so you can use a computation to progress plans through time, instead of stopping at periodical intervals to make a subjective estimate. With less effort and more accuracy, the typical 30-day time windows for analysis can be converted to daily window analysis in a fraction of the time, and quantify exactly how a project loses and gains time. Additionally, if using time impact analysis, it can be performed on the exact day of impact rather than the beginning of a monthly update. In fact, the entire plan, instead of being an aggregate of disconnected updates, can become a single fluid plan, which evolves through time,

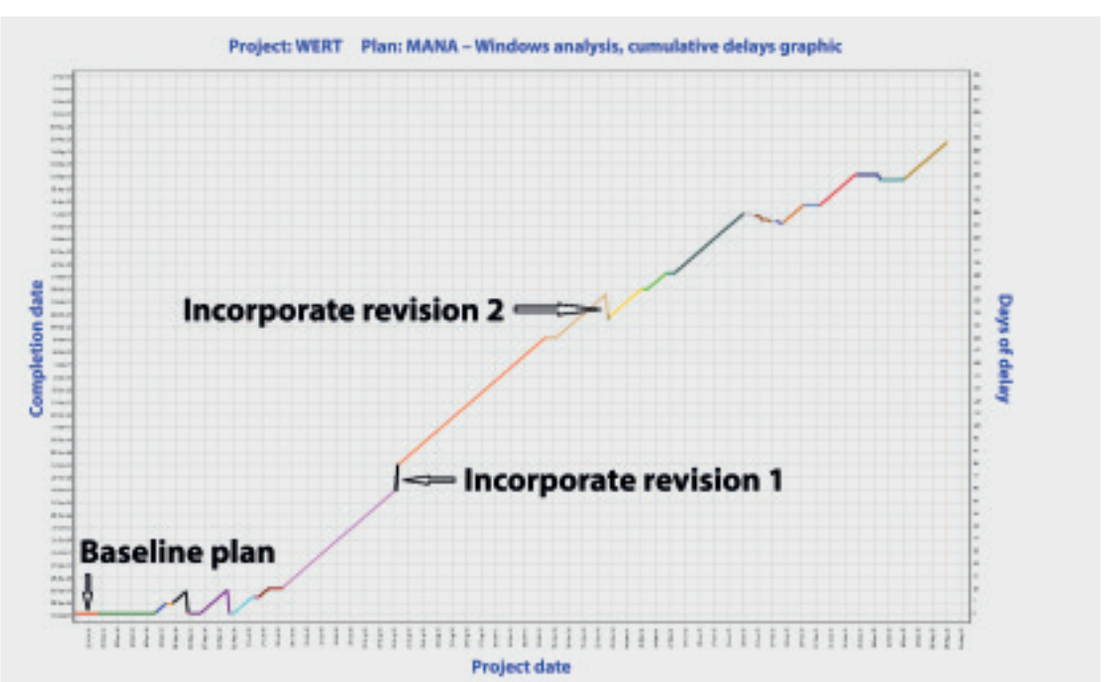
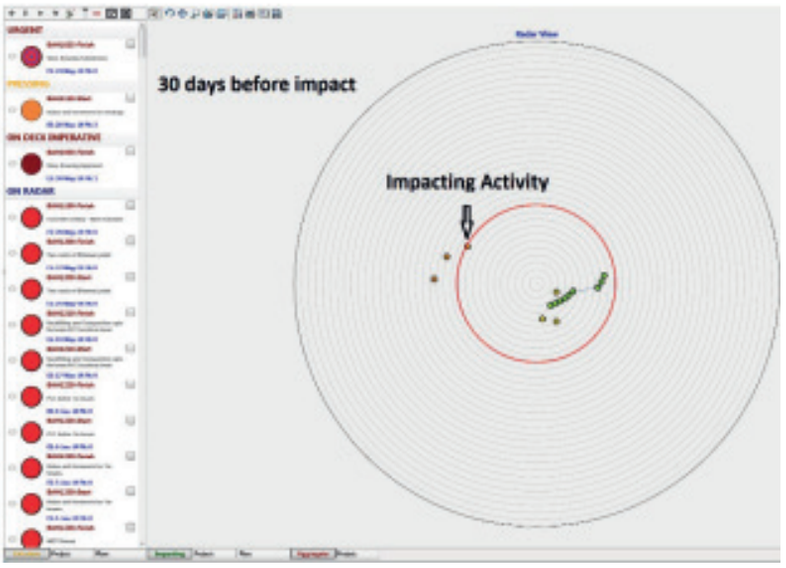
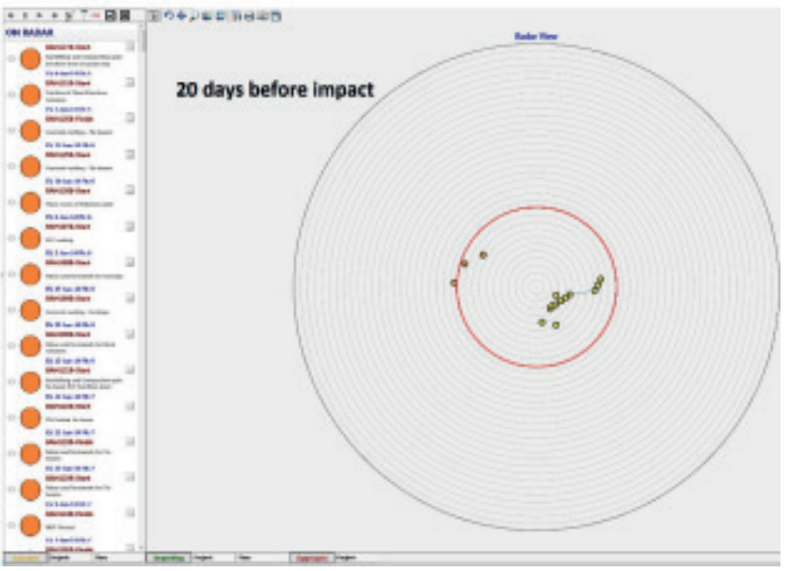
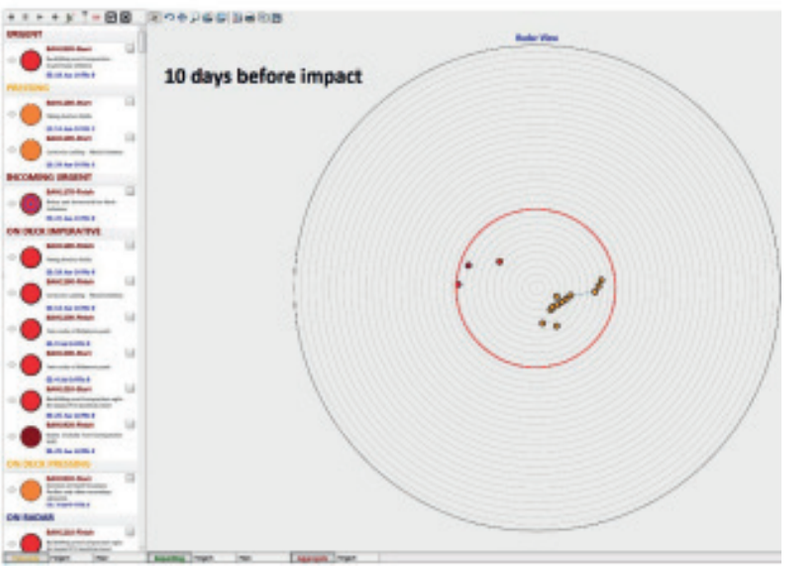


Figure 4: continuity with assessing delays over a project's duration, with revisions incorporated as the project progresses







incorporating revisions and actual dates as it progresses towards completion.

Moreover, because of this continuity, patterns can emerge that can forecast delays before they impact a project. Take, for example, the radar view graphic. Activities are represented by coloured dots. Their location radius in the graph corresponds to the early start date and the colour indicates how critical the activity is: green is non-critical and red is critical. Because of the continuity of using per cent time of the activity's duration, you can view the project status at any time selected or animate project activities as they progress. For most delays, if you move through time from a position prior to an impact, you can often detect a pattern developing that forecasts an impending impact long before it actually occurs. Using the radar graph, this can be detected by seeing critical activities coming in from the side, or rapidly advancing their colour from green to orange to red. A computer algorithm can be used to warn of an impact before it occurs and accurately document it during and after. The screenshots in Figure 5 are of progress on a project 30, 20 and ten days before an activity impacted project completion. The impacting activity can be seen closing in on the centre of the screen and changing colour from orange to red as it is animated through time and comes closer to its due date, and is more critical along the way.

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Printed by Pensord, Wales

Construction Law International

The publication of the IBA International Construction Projects Committee of the Energy, Environment, Natural Resources and Infrastructure Law Section (SEERIL)

NOVEMBER 2018 Vol 13 Issue 3
ISSN 1819-1371
Citation (2018) 13(3) *CLInt*

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