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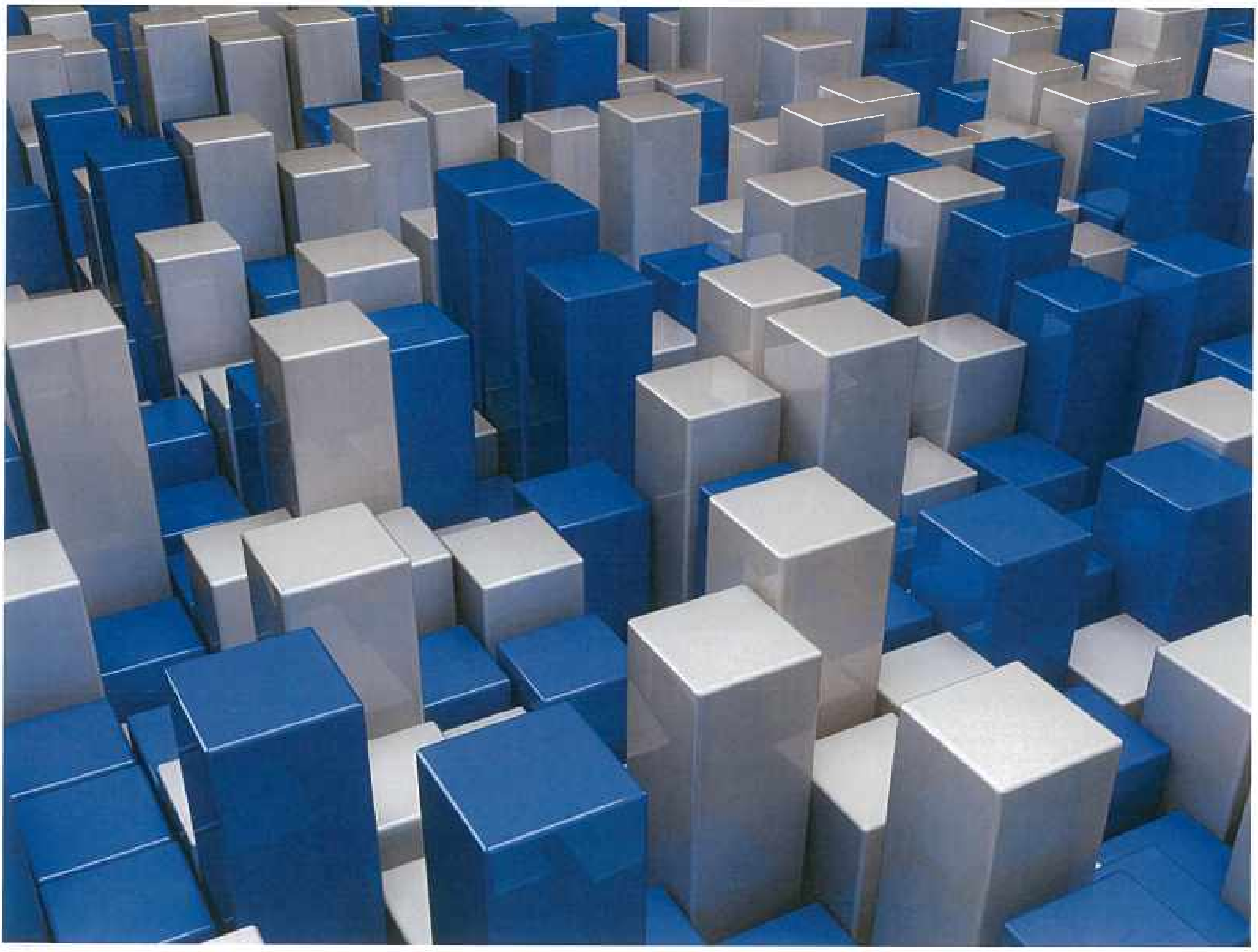

'NO QUESTIONS, YOUR HONOUR'— THE FUTURE OF EVIDENCE AND PROOF IN CONSTRUCTION CLAIMS AND DISPUTES

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INTRODUCTION

The last few years has seen much written about the impact new technologies will have on the construction industry. Their implementation paves the path for streamlining workflows, reducing labour and improving the monitoring of work progress. How this technology might affect the practice of construction lawyers has, however, received less attention. This paper seeks to go some way towards filling this lacuna by examining the role these technologies will foreseeably play in generating evidence relevant to claims and disputes typically arising on construction sites. It does so in three broad parts.

First, three of the most common construction claims, being claims for (i) extensions of time and prolongation costs; (ii) latent conditions; and (iii) variations—are outlined and the typical issues which arise and current methodologies employed to marshal evidence in respect of each explained.

Second, a number of nascent technologies currently available and being utilised (to varying degrees) by the construction market are identified. Their application (or predicted application) in assisting with gathering evidence is then analysed.

The third part offers suggestions on what the foregoing may mean for the future conduct of managing claims and resolving disputes, including revisiting the proof methodologies for each of the three claims and predicting the key changes.

At the outset we note that a comprehensive examination of each of the technologies' capabilities and their potential impact on proof and evidence is beyond the scope of this paper. Our intention is to instead present a brief overview of selected issues for nominated technologies which may be expected to arise as their prevalence on project sites increase.

CURRENT PROOF METHODOLOGIES

The resolution of the majority of construction claims and disputes predominantly turn, it is submitted, on proof of facts. Whilst legal issues, such as the correct interpretation of a contractual clause or the existence and scope of an alleged duty, frequently arise, the 'bread and butter' of construction claims and disputes remains the adduction and substantiation of factual evidence. Contracts will typically require contractors to notify, quantify and document all materials relevant to its claims.[1] It follows that preservation of up-to-date and accurate records is critical for proving entitlement to, defending against or settling claims.[2]

All too often, however, claims lack this adequate supporting evidence.[3] This is in part due to the labour-intensiveness of both the data-collection and data-analysis processes. Maintaining cost records and accurate, detailed and up-to-date programs, methodically filing relevant correspondence, photographing work progress and keeping detailed journals and records of site meetings is onerous and time-consuming.

Even where such records do exist, they commonly contain material errors or omissions. Where paper trails are mismanaged, parties will usually be left with no choice but to expend significant time and resources retrospectively collating them. Locating relevant documentation on computer devices—often scattered throughout spreadsheets, folders and email chains—is a 'formidable' exercise which 'can greatly increase the cost of assembling the evidence to support a claim'.[4] The cost and complexity associated with analysis and reporting tend to result in incomplete and infrequent monitoring.

CLAIMS FOR EXTENSIONS OF TIME (EOTS) AND PROLONGATION COSTS BASED ON QUALIFYING CAUSES OF DELAY

The facts a claimant will be required to prove in a typical contested delay and prolongation or disruption claim may include:

(a) the delay event relied upon, its occurrence and cause;

(b) the planned and actual construction sequencing and methodology;

(c) the actual progress of the design, procurement and construction activities;

(d) the actual causative impacts of the delay event on the allegedly impacted design, procurement and construction activities;

(e) the critical delay, given the progress of all other relevant activities;

(f) the specific actual labour, plant and other onsite and offsite resources which are prolonged; and

(g) the incurred costs of those resources.

The primary evidence relied upon by a claimant is its periodically–statused programs. Often those programs will fail to:

(a) contain sufficient detail to record all relevant activities;

(b) represent the actual construction sequencing or methodology; and/or

(c) accurately report the true status of progress.

Accordingly, the parties then look to contemporaneous evidence of the actual activities, progress, sequence and methodology. This evidence typically includes photographs, monthly progress reports, project control group meetings and information contained in emails often stored on personal email accounts and communications in project communication tools.

Whilst finding evidence of progress at particular stages is often not difficult, there is rarely evidence of the progress of all activities, design procurement and construction progress at specific points in time. When the claim is disputed it is the oral evidence of project personnel that is relied upon in proceedings concerning delay causation. Expert evidence analysing the cause of any alleged delay impact to the progress of the works will often be adduced. However, such analysis is 'ultimately only as reliable or accurate as the data upon which it is based'.[5]

CLAIMS FOR LATENT CONDITIONS

The encountering of ground conditions on or under a construction site which differ from those anticipated by the contractor is a common source of claims.

Contractors are usually requested to tender based on site conditions information (SCI) provided in the tender phase, which may include geotechnical reports concerning the characterisation of subsurface conditions based on borehole samples.[6] The SCI may also contain drawings provided by utility and service owners depicting the likely location of services. Often those services were constructed decades earlier and the drawings may be unreliable. It is not uncommon for services to not be recorded on drawings at all.

The latent conditions that may be the subject of contractor claims might include services, or services in locations that were not reasonably foreseeable, or geotechnical conditions that were not reasonably foreseeable including rock, excessively wet or soft material or contamination.

As an example of a claim, the facts that an earthworks claimant contractor engaged on a cut and fill road project will be required to prove in a latent conditions claim as a result of encountering excessive quantities of material that is unsuitable to be used as compliant subgrade material will include:

(a) the site conditions information;

(b) the volume of compliant material that a reasonable contractor would have anticipated;

(c) the allowance the contractor made for encountering unsuitable material in its tender;

(d) the dates upon which, and locations where, non–compliant material was encountered along the project alignment;

(e) that material was non–compliant and could not be utilised within the road construction;

(f) the quantum of replacement material that was either excavated on site or imported from off site; and

(g) the costs of the movement of unsuitable material and of the replacement material.

A contractor will plan to construct an earthworks cut and fill project according to a mass haul plan, which records the movement of cut to fill locations based on the characterisation of the material anticipated to be encountered.

It may survey the progress of the earthworks monthly or even fortnightly. If it encounters unsuitable material it will usually push that material aside, place it in stockpiles or create earth mounds of unsuitable material. Stockpiles may receive material from numerous locations and may be moved from location to location as the work progresses.

The contractor will not place obviously unsuitable material in formation, meaning such material is not subjected to laboratory testing for compliance. If replacement material is excavated from within the project site, survey records may disclose the volume ultimately excavated. If material is imported, trucking dockets and weighbridge records at quarries may evidence the volume of material imported, but not the reasons for importation or the location of placement. In summary, whilst the contractor may have intended to construct to a carefully planned and documented mass haul, it will have few records to prove the day–to–day movement of material.

As a result, the evidence that a claimant may rely upon to establish the facts to substantiate a latent conditions earthworks claim will often be anecdotal and incomplete.

CLAIMS FOR VARIATIONS

The most common claim made by contractors is for payment for extra work or variations and the time consequences of that additional work. Often the issue in dispute turns on the language used in the technical documents of the contract concerning contested scope. The facts that a claimant will be required to prove in a typical variation claim include:

(a) the original scope of the work provided for by the contract;

(b) that the principal or its agent issued a direction for additional or varied work;

(c) that work was performed; and

(d) the valuation of the additional or varied works assessed in accordance with the contractual terms and the delay impacts.

The evidence usually relied upon will include:

(a) the contract, including its technical documents, the contractor's tender and tender clarifications;

(b) project correspondence, Aconex communications, site meeting minutes and emails;

(c) photographs of the work;

(d) professional valuation evidence; and

(e) concerning delay, the evidence referred to above.

CURRENT TECHNOLOGIES

While having for years worn the reputation of an industry markedly resistant to transformation, the winds of change have well and truly arrived.[7] The uptake of technology within the construction industry has largely been driven by two interrelated events, being the substantial drop in the expense of its deployment and the rise of 'smart' software able to autonomously interpret and synthesise the datasets the technologies create. While the technologies identified below operate independently of each other, their true value is realised from the integration of their respective captured datasets. The potential to present this data in a single federated platform offers the promise of being able to precisely identify, analyse and record the impact of changes on project design, cost and scheduling in real–time.

BUILDING INFORMATION MODELLING (BIM)

Shortly stated, BIM refers to the process of creating and managing information on a construction project across the project lifecycle.[8] BIM is the 'center point for a connected data across the digital ecosystem'[9] with its 'key output'—the 'BIM model'—being a digital representation of this data[10] in the form of the physical and functional elements of an asset.[11]

All project participants (for example, owners, architects, engineers and builders) are able to upload, share, coordinate and view this data in a central repository known as a common data environment (CDE). The BIM model can be continuously adjusted at all stages throughout the lifecycle of the project's delivery. The model not only records and displays an asset's physical information,[12] but also the 'intelligence' associated with it.[13] BIM systems are also able to interface with programming software to record the progress of the works.[14]

BIM has multiple dimensions based on the functionality it covers. 'BIM 3D' provides virtual three–dimensional parametric modelling. 'BIM 4D' refers to a process where three–dimensional model objects are linked to time or activity–based scheduling data.[15] It can be used for construction scheduling analysis and management, as well as to create animations of construction processes.[16] 'BIM 5D' incorporates BIM 4D functionality plus an estimating (cost) function, allowing expenditure to be mapped against the project program for cash flow analysis. When all data is synchronised correctly, a change in any of the attributes within any of the dimensions results in an automatic change to the linked information for all other dimensions.[17] This enables parties 'to identify, analyse, and record the impact of proposed changes on project costs and scheduling'[18] while reducing the risk of design, cost and programming disputes arising. This 'intelligent' coordination function makes BIM a 'key enabler and facilitator for many other technologies'.[19]

LASER–SCANNING

Laser–scanning is a form of three–dimensional imaging which uses specialised instruments to rapidly capture existing conditions in the built or natural environment. This is done by measuring 'the range and bearing to and/or the 3D coordinates of points on an object or within a region of interest'.[20] These measurements can have an error of millimetres and be conducted in short periods of time.

Sophisticated software is able to transform sets of point measurements (point clouds) into a highly accurate model suitable for reproduction in BIM.[21] While this 'scan-to-BIM process' has traditionally been labour intensive, recently there have been several reports of automation of this practice leading to trials being able to model a space in one to two hours which would previously have taken a day to complete manually.[22] This enables comparison between the BIM model and the as-built model to detect any deviances.

Given few constructed facilities have complete as-built records, laser-scanning is increasingly being accepted by the construction industry for this purpose and can help significantly shorten the time required to develop an as-built BIM model.[23]

RADIO FREQUENCY IDENTIFICATION (RFID)

RFID refers to a wireless non-contact technology which transmits a unique serial number that can be used to identify the location of an object or person using radio frequency signals.[24] It acts as an electronic label for data systems, enabling instant tracking of materials, equipment and labour without line-of-sight restrictions.

The basic technology consists of a tag which is attached to an object and a reader that identifies the tag when within range.

RFID can be integrated with a range of technologies, including BIM. This enables real-time visualisation of the location of resources and labour (including name, company and trade), providing proof of what resources a contractor had at a particular date and the corresponding whereabouts of employees.[25]

It also provides the required data for activity analyses, scheduling and inventory management, allowing project managers to plan and coordinate future work.[26]

UNMANNED AERIAL VEHICLES (UAVS)

Popularly known as drones,[27] UAVs are compact pilotless aircraft able to be flown remotely to specific altitudes and locations. The innovation of UAVs lies 'not [in] flight but information' with the data able to be collected by UAVs having limitless applications across myriad industries.[28] As the industry predicted to become the largest commercial user of UAVs by 2020,[29] those in the construction sector are expected to develop a greater familiarity than most with the technology's capabilities.

Two notable applications of UAVs for construction professionals are surveying and monitoring.

Unlike traditional site survey methods which require significant time to be expended at both the data collection and processing stages, camera-equipped UAVs utilise photogrammetry to survey a site in considerably less time and quickly generate a precise three-dimensional point cloud representation of existing conditions.[30] This data can then be processed with BIM 4D to generate an accurate as-built model of the surveyed site, providing a near real-time visualisation of the status of the works.[31] When fitted with LiDAR technology,[32] UAVs may be used to measure civil works activities (for example, the depth of a trench or changes in the height of cut piles) with cubic metre precision.

UAVs can also be used to aerially monitor construction sites with high-definition cameras, such that site conditions, task durations, progress of works and the presence of labourers, materials and equipment are continuously recorded, time-stamped and logged. Studies have also examined the possibility of UAVs being fitted with RFID readers to locate material and resources on site,[33] with expected application to labourers. Their mobility means UAVs are especially suited to detecting defects that would ordinarily be incapable of discovery due to their location.[34]

GROUND PENETRATING RADAR (GPR)

GPR is a device used at the surface of the ground to build up a picture of the subsurface conditions. It operates by transmitting pulses of electromagnetic energy at microwave frequencies into the ground, with an attached receiver then measuring the amplitude and time travel of the return signals.[35] While GPR technology has been utilised by civil engineers since at least the 1960s, it has experienced tremendous progress over the last 20 years, both in its range of applications and data processing capabilities.[36] GPR can be used to locate and map objects such as pipes, drums, tanks cables and underground features or detect subsurface voids relating to subsidence and erosion of ground materials.[37] Deploying GPR methods prior to directional drilling prevents damage to existing utilities and other subsurface objects.[38]

A relatively new phenomenon in this field is three-dimensional GPR (3D-GPR). A historic limitation of GPR-captured subsurface data was its inability to be presented in optical form, leaving much room for error in its analysis. By comparison, 3D-GPR is able to produce precise images of underground assets and a range of materials.[39] The typical process involves a specialist contractor entering the project site, locating the services using electromagnetic interference and 3D-GPR devices, surveying the located information and processing it to generate the final deliverable. This deliverable can then be tailored to a client's needs, including being formatted to allow compatibility with BIM or GIS software packages. 3D-GPR is especially valuable for underground utilities given the historically poor mapping practices for installed assets.

CLOUD COMPUTING

'Cloud computing' allows users to access software or data stored on and operated by another's computer systems, rather than their own IT infrastructure.[40] Having a single, integrated and paperless repository enables centralised access to data for all project participants and third parties, rather than it being the case of each having individually-operated systems.[41] While the possible applications of cloud computing across the project lifecycle are many and varied, it is particularly effective in assisting with data retrieval, claims notification and payment. Though security concerns remain prevalent,[42] the construction industry has embraced cloud computing and views the software as a key component of its operations in the future.[43]

FUTURE PROOF METHODOLOGIES

CLAIMS FOR EOTS AND PROLONGATION COSTS BASED ON QUALIFYING CAUSES OF DELAY

Many large Australian construction projects:

(a) are currently using BIM 3D systems, UAV-captured photogrammetric surveys and three-dimensional laser scanning imaging; and

(b) have RFIDs installed on plant and equipment.

It is only a matter of time until the data collected from these technologies is capable of being collated in a single, federated platform for use as the primary evidence in a delay and prolongation costs claim.

Having regard to the above, a future claimant may rely upon:

(a) a four-dimensional programming model produced from the three-dimensional civil design to establish its planned construction sequence and methodology;

(b) real time surveys of the progress of construction from data collected daily or even hourly by UAV flights and/or laser scanning, which shows the progress of the works against the BIM 3D design;

(c) a BIM 4D model to demonstrate the actual impacts of delay events; and

(d) a BIM 5D model (including RFID-captured data) to provide evidence of the actual costs of schedule changes and impacts.

CLAIMS FOR LATENT CONDITIONS

As the use of 3D-GPR becomes more widespread, claims concerning latent conditions are likely to become less common. If a client has undertaken a 3D-GPR survey of a site and a contractor encounters conditions that it did not anticipate, it must be less likely that it could be said that a reasonably competent contractor should have anticipated the encountered conditions. The data collected by the other technologies may provide evidence of an earthworks contractor's claim as discussed above. For example, a claimant may rely upon:

(a) its BIM model to establish its mass haul cut and fill methodology, all relevant survey levels, the source of its cut, the location of the fill and the estimated cost of that work;

(b) LiDAR or photogrammetric survey evidence—obtained from regular UAV flights—of the location and depth of actual excavations and the daily creation, movement and volume of stockpiled material. The high-definition images created will enable geotechnical experts to characterise the material that is excavated and stockpiled;

(c) RFID tags on machinery used to excavate and transport cut. The data collected can be used to produce a map of the movement of all material throughout the project; and

(d) its BIM 5D model to provide the actual costs of the material which was moved or imported as a result of any latent conditions.

Most of the matters of usual factual contest will be resolved by the datasets available to all parties in the CDE.

CLAIMS FOR VARIATIONS

There have been recent projects where BIM 3D models have been contractually referenced as the scope of the works. It is suggested that it will become increasingly uncommon for scope to be defined by a written set of two-dimensional drawings, preliminaries and specifications. The scope will more likely be defined by a BIM 3D model, prepared to the state of design development at the date of the contract. For 'construct only' contracts, the three-dimensional model will include identifiers (descriptions and specifications) of every individual supply item. Engineering and processing plants are being designed in accordance with, and the scope defined by, digital three-dimensional models which interface with the client's plant automation systems.

Given the level of detail that digital three-dimensional models may accommodate, including all specific items of scope and supply, differences between contractual scope and supplied scope will be a matter of model comparison.

To establish a variation claim the evidence that a claimant may rely upon:

(a) the BIM 3D model of the contractual scope;

(b) a direction to perform additional scope located in the cloud-based collaboration platform;

(c) the contractual notifications generated in the cloud-based collaboration platform;

(d) the 'as-built' BIM 3D model created from the real time surveys of the progress of construction, produced by the data collected by the technologies discussed;

(e) a BIM 4D model to highlight any delay impacts caused by any variations; and

(f) a BIM 5D model to establish the actual costs of any variations and the associated delay or disruption costs.

FUTURE ISSUES

Whilst the above developments are generally welcomed, the fresh challenges they pose must also be recognised. Issues such as the protection of copyright and IP rights in BIM projects, the discovery and subpoena of cloud-stored documents held in foreign jurisdictions and difficulties collecting digital evidence have been examined elsewhere. The below explores some further consequences expected to arise as deployment of these technologies becomes more widespread.

LAWYERS MUST UNDERSTAND THE DATA BEING COLLECTED

To continue to provide value to clients, it is incumbent upon construction practitioners to remain abreast of technological developments. As new technology continues to enter the market, having an understanding of its existence, capabilities, capacity to be integrated with other technology as well as an awareness of key providers will become indispensable.

As recently recognised, law is fast becoming a 'data-aggregation business'.[44] The ability to harness and use data to predict outcomes and reduce the scope of issues over which there can be sensible factual disagreement is a key skill for today's lawyer. While clients will understand how the technology they use assists with achieving project execution or commercial objectives, they may have little if any appreciation of how it might aid them in legal disputes.

WHO CONTROLS 'SHARED' DATA?

The shift away from industry fragmentation towards collective data amalgamation by stakeholders heralds undeniable opportunities for improved productivity. However, while collaboration might be the méthode du jour for construction practice, the legal implications attending information-sharing protocols bear careful consideration. This was recently highlighted in *Trant Engineering Ltd v Mott MacDonald Ltd*,[45] an interlocutory decision delivered last year by the United Kingdom's High Court which dealt with the rights of a head contractor to access data stored in a CDE hosted by a consultant.

TRANT ENGINEERING

Trant Engineering Ltd (Trant), a bidder for a contract to construct a power station in the Falkland Islands, engaged Mott MacDonald Ltd (MML) under a consultancy agreement to provide initial project design services with a view to providing a more complete suite of services in the event its bid was successful. Relevantly, these services included the 'preparation and implementation of BIM'. MML held the design data on software called ProjectWise, which acted as the CDE for the project. Trant was awarded the tender and MML commenced carrying out design services.

The parties soon fell into dispute over unpaid invoices and the scope of services agreed upon. MML proceeded to suspend its services and block Trant's access to ProjectWise by revoking the passwords needed for access. Trant applied for a mandatory iterim injunction to compel MML to provide it with access to the CDE and sought orders to the effect that it be permitted to use all design data either by itself or in conjunction with other third parties.

Justice O'Farrell determined Trant had made out its case for an injunction pending trial. Her Honour found that damages would be an inadequate remedy for Trant in circumstances where MML's contractual liability was limited to £1 million, a figure likely to have been far exceeded by any delays to the £55 million project resulting from inaccessible design data.[46] Her Honour also considered there was 'a high degree of assurance' that Trant was contractually entitled to the design data which it had previously had access to prior to.[47] In result, MML was ordered to provide Trant with access to design information contained in public folders which were intended for use by Trant subject to provision of the usual undertaking as to damages.[48]

The decision signals the importance of construction contracts making clear provision for parties' rights and obligations concerning access to CDEs utilised on BIM projects.[49] Drafters should, for example, ensure their client continues to obtain the benefit of a CDE in circumstances where relationships between other project participants break down or insolvency issues arise.

PRESENTATION OF EVIDENCE

IDENTITY OF THOSE GIVING EVIDENCE WILL CHANGE

Traditionally, the evidence led in construction disputes comes from both technical experts and lay witnesses of fact. The former typically adduces evidence on cause and effect (e.g. delay analysts), quantum (e.g. estimators and quantity surveyors) and project–specific issues (e.g. engineers) while the latter's testimony purports to establish what happened on site and when (e.g. superintendents, project managers and miscellaneous site personnel).

As lay witnesses will usually give evidence long after the relevant events in issue occurred, their recollection is susceptible to error.[50]

The enhanced data–collecting abilities of the technologies discussed above calls into question the utility of relying on these individuals, at least in so far as their evidence relates to contests of fact.[51]

The real battleground of the future will be over proving the veracity of the datasets captured by the technologies: for example, how accurately does the output of a piece of software reflect the entered data? How precise are the measurements produced by a device? Answering such questions will require adducing evidence from persons with expertise in the technologies used.

It might be ventured that the identity of those asked to decide the disputes will also change. For example, if, as some have persuasively suggested,[52] the appetite for expert determination will continue to grow to reflect parties' increasing desire for hearings to be conducted 'on the papers', it may be supposed that parties will look to appoint practitioners with proficiency in the technology where it is in issue, rather than simply knowledge of the subject matter underlying the dispute.

INCREASINGLY VISUAL

As data collected by technology becomes more amenable to graphic representation, parties will foreseeably seek to exploit its visual component in formal dispute proceedings. Courts and tribunals welcome the presentation of visual evidence in appropriate cases.[53] Under uniform evidence legislation, a court may in its discretion order that 'a demonstration, experiment or inspection be held'.[54] Arbitral tribunals generally accept the evidence submitted to them but retain the discretion to evaluate its probative value. The usefulness of computer–generated exhibits in supporting construction claims has been previously acknowledged.[55] Some of the evidentiary tools parties have at their disposal will include UAV–obtained footage and virtual scheduling models which depict progress of the works.

UAV–OBTAINED FOOTAGE AND PHOTOGRAPHY

Traditionally, aerial images relied upon as evidence are captured by satellite. These images are typically of low–resolution and may fail to convey the intended detail. UAV–captured footage and photography address this deficiency and are poised to replace satellite imagery as the conventional form of aerial evidence. Unless there is reason to suspect otherwise, the accuracy of UAV–captured footage will doubtful prove a common ground of challenge.[56]

Although there remains the risk that such imagery may be manipulated, this is the case for any other type of document, photograph or piece of footage. Aerial photographs taken by a UAV were recently received without issue by the Supreme Court of New South Wales.[57] In a taxation of costs decision published last year, a Canadian regulator commended the assistance provided by UAV footage in the substantive proceeding, ruling that the costs incurred in its production were reasonable and remarking that 'it was more effective to view the aerial video than follow a witness' verbal, written, still photographic mapping evidence of distances, location and size of impacted land features'.[58]

VIRTUAL SCHEDULING MODELS

Properly conducted demonstrations become part of the evidence in litigation.[59] A comprehensible presentation of delay impacts is an invaluable asset for any claimant seeking entitlement to an extension of time.[60] Rather than relying on a fact–finder's ability to interpret Gantt chart information, the animated sequences of a BIM 4D model can be used to make such material more intelligible.

By visually representing the impact an alleged delay event had on a project, claimants are better able to demonstrate complex cause–and–effect relationships. Although this form of evidence is not without its limitations, notably the cost involved in producing a BIM 4D model,[61] its potential to illuminate the 'dark arts' of scheduling in ways documents and static exhibits cannot will likely lead to its increased use.

HEARING VENUES

A related subject deserving mention is the capabilities of dispute resolution facilities to accommodate this evidence. Whilst the procedural flexibility of arbitration is frequently touted as a key advantage enjoyed over litigation, its flexibility with respect to hearing venues may prove a further attraction to disputants. At least in relation to many court buildings, historically designed without excessive concern for the exigencies of visual evidence presentation (think narrow bar tables and scarce USB ports), their capacity to accommodate the type of evidence referred to above is wanting. Modern dispute resolution centres of the kind utilised by the arbitration community offer more promise in this regard.

'VIRTUAL VIEWS'

Given hearings are usually the most expensive part of any dispute, there can often be a reluctance from parties to lengthen their duration beyond what is considered necessary to present their respective cases. This aversion to prolonging hearing times is one possible reason why site views[62] are not readily embraced despite their potential for enhancing the strength of a party's evidence. In the context of construction disputes, views have traditionally been considered useful for the purpose of obtaining an understanding of the scope and nature of the works and to assist the fact-finder to better understand the evidence.[63] While views have historically entailed the judge or tribunal member and parties physically visiting a location outside the court, UAV technology allows for views to be conducted from within the confines of the hearing venue.[64] This is especially advantageous where the site is not within close proximity as is often the case for oil and gas, mining and large-scale engineering projects.

CONCLUSION

Granted that change is an almost inevitable consequence of undertaking construction work, it is unlikely that the technologies canvassed above will lead to a reduction in the number of claims being made; rather, the data they produce will alter the type of evidence adduced to substantiate these claims.

The ability to interrogate and understand this data will be limited only by the capacity of the project participants' computing systems. It is predicted that the largest engineering and building contractors will invest heavily in both increasing computing capacity to operate federated platforms and possibly artificial intelligence to analyse the data to inform, or possibly even make, project execution decisions.

Construction lawyers cannot afford to be left behind in this period of transformation. Having a sound knowledge of the nature of the data being collected and its utility, proficiency in the software available to interrogate and federate this data, skills in extracting and presenting the data in compelling three-dimensional, four-dimensional and five-dimensional forms and an understanding of the grounds for challenging the reliability of the data will become the stock-in-trade of competent construction practitioners.

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19. World Economic Forum, Shaping the Future of Construction: A Breakthrough in Mindset and Technology (May 2016) <http://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_full_report__.pdf> 10.

20. Above n 15, 226.

21. Alexander Symonds, Laser Scanning and BIM < https://www.alexander.com.au/services/laser-scanning/>.

22. Above n 15, 226.

23. Above n 15, 226.

24.Above n 15, 272.

25. The number of workers on site is a sizeable issue in the much publicised dispute between the New South Wales Government and its head contractor concerning the construction of the Sydney Light Rail project: Jenny Wiggins, 'Sydney Light Rail Faces One-Year Delay, NSW Government Confirms', *The Australian Financial Review* (online), 19 April 2018 <https://www.afr.com/business/sydney-light-rail-project-faces-oneyear-delay-nsw-government-confirms-20180419-h0yzm3>.

26. Aaron M Costin, Jochen Teizer and Bernd Schoner, 'RFID and BIM-enabled worker location tracking to support real-time building protocol control and data visualisation' (2015) 20 *Journal of Information Technology in Construction* 495.

27. Referred to as 'remotely piloted aircraft' (RPA) under Australian regulations: Civil Aviation Safety Regulations 1998 (Cth) reg 101.F.

28. Timothy M Ravich, 'Courts in the drone age' (2015) 42 *Northern Kentucky Law Review* 161, 162-163.

29. Drones: Reporting for Work (2016) Goldman Sachs <http://www.goldmansachs.com/our-thinking/technology-driving-innovation/drones/>.

30. Surveying conducted by drones has been found to be 'comparable in accuracy to ground surveys with the best GPS equipment, but can be done far more quickly and cheaply': Kim Sorvig and J William Thompson, *Sustainable Landscape Construction: A Guide to Green Building Operations* (Island Press, 3rd ed, 2018) 57.

31. See Kevin K Han, Jacob J Lin and Mani Golparvar-Fard, 'A Formalism for Utilization of Autonomous Vision-Based Systems and Integrated Project Models for Construction Progress Monitoring' (Paper presented at the Conference on Autonomous and Robotic Construction of Infrastructure, Iowa State University of Science and Technology, 2015) 118-131.

32. Light Detection and Ranging (LiDAR) refers to a form of laser-scanning coupled with distance measurement based on time of flight. It can be used for a variety of high-resolution surveying and mapping applications: Andrew Butterfield and John Szymanski, *A Dictionary of Electronics and Electrical Engineering* (Oxford University Press, 5th ed, 2018).

33. See Bryan Hubbard et al, 'Feasibility Study of UAV use for RFID Material Tracking on Construction Sites' (Paper presented at the 51st ASC Annual International Conference Proceedings, 2015).

34. For example, cracking on top of a chimney: *Pirelli General Cable Works Ltd v Oscar Faber & Partners* [1983] 2 AC 1.

35. Christopher Gorse, David Johnstone and Martin Prichard, *A Dictionary of Construction, Surveying and Civil Engineering* (2012, Oxford University Press) 191.

36. Nikos Economou et al, 'GPR Data Processing Techniques' in Andrea Benedetto and Lara Pajewski (eds), *Civil Engineering Applications of Ground Penetrating Radar* (Springer, 2015) 281, 282.

37. Christina Plati and Xavier Dérobert, 'Inspection Procedures for Effective GPR Sensing and Mapping of Underground Utilities, with a Focus to Urban Areas' in Andrea Benedetto and Lara Pajewski (eds), *Civil Engineering Applications of Ground Penetrating Radar* (Springer, 2015) 125, 125.

38. Above n 37, 125.

39. 3D-GPR devices manufactured by Earth Radar Pty Ltd, a private company headquartered in Queensland, can integrate subsurface data to enable three-dimensional visualisation of underground assets: <https://www.earthradar.com.au>.

40. Nicole Black, Cloud Computing for Lawyers (American Bar Association, 2012) 2. A practical effect of cloud computing is the outsourcing of IT resources: see W

Kuan Hon and Christopher Millard, 'Control, Security, and Risk in the Cloud' in Christopher Millard (ed), *Cloud Computing Law* (Oxford University Press, 2013) 18–36.

41. Though estimates predict it will still take between three to ten plus years for the construction industry to become paperless: Alex Gruzska, Julie Jupp and Gerard de Valence, Digital Foundations: How Technology is Transforming Australia's Construction Sector (20 July 2018) StartupAus <https://startupaus.org/document/constructiontech/> 41.

42. Paul Smith, 'Security Concerns about Cloud Services on the Rise as Employees Ignore the Rules' *The Australian Financial Review* (online), 16 April 2018 < https://www.afr.com/technology/web/security/security-concerns-about-cloud-services-on-the-rise-as-employees-ignore-the-rules-20180413-h0yr35>.

43. The Australian-developed Aconex is the most widely-used cloud-based collaboration platform within the construction and infrastructure industry: Above n 42.

44. Michael Pelly, 'Baker McKenzie's Ben Allgrove on why law is now a 'data-aggregation business'', *The Australian Financial Review* (online), 12 July 2018 <https://www.afr.com/business/legal/baker-mckenzies-ben-allgrove-on-why-law-is-now-a-dataaggregation-business-20180711-h12k87>.

45. [2017] EWHC 2061.

46. [2017] EWHC 2061 [31].

47. [2017] EWHC 2061 [36].

48. [2017] EWHC 2061 [38]–[40].

49. Standards Australia have published a standard for BIM data sharing: Standards Australia, Australia Adopts International Standard for BIM (9 March 2017) <https://www.standards.org.au/news/australia-adopts-international-standard-for-bim-data-sharing>.

50. As well as being prone to fabrication or unconscious bias.

51. As opposed to, for example, accepted industry practice.

52. John Sharkey AM, 'The resolution of construction law disputes in the 21st century: A view from the other side of the bar table' (2015) 31 *Building and Construction Law Journal* 351, 363.

53. See, e.g. the comments of Ward LJ at [8] and Arden LJ at [30]–[31] in *Hunte v E Bottomley & Sons Ltd* [2007] EWCA Civ 1168.

54. See, e.g. *Evidence Act 2008* (Vic) section 53(1).

55. David-John Gibbs et al, 'Recommendations on the creation of computer generated exhibits for construction delay claims' (2014) 30 *Construction Law Journal* 236; John Fisher, 'Visualisation of disputes in a BIM world' (2014) 33(2) *The Arbitrator & Mediator* 73.

56. After all, a photograph 'is, at its functional, rather than artistic, level simply a recording of data': *Corsi v Town of Bedford* (2008) 58 AD 3d 225, 229.

57. *Gordon v Lever* [2017] NSWSC 1282. The proceeding concerned an application for the imposition of an easement under section 88K of the *Conveyancing Act 1919* (NSW) in the form of an access road and bridge over farm land in northern New South Wales. On appeal, Sackville AJA remarked that photographs taken by drones were 'very useful in [assisting the court with] understanding the topography of the relevant areas': [2018] NSWCA 43 [76].

58. Decision 22406-D01-2017 of the Alberta Utilities Commission, viewable at: <http://www.auc.ab.ca /regulatory_documents/ProceedingDocuments/2017/22406-D01-2017.pdf>. The relevant comment is made at [56].

59. See, e.g. *Evidence Act 2008* (Vic) section 54.

60. Andrew Burr and Keith Pickavance, 'The use of visualisations in case presentation and evidence' (2010) 26 *Construction Law Journal* 3.

61. Erin Joyce, 4D BIM Has Its Limits with Delay Analysis (May 2014) <https://www.thinkbrg.com/media/news/439_439_Joyce_Nolan_ENR_May2014.pdf>.

62. A view is an inspection of 'any place, process or thing': see, e.g. Supreme Court (General Civil Procedure) Rules 2015 (Vic) rule 40.13.

63. *Alstom Power Ltd v Yokogawa Australia Pty Ltd & Ors* [2006] SASC 74 [22].

64. Veritas Litigation Support, a demonstrative evidence production company based in Canada, specialises in using UAVs to capture photography and footage for use as evidence in legal hearings: <https://www.veritaslitigation.com/drone-video-evidence>.

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