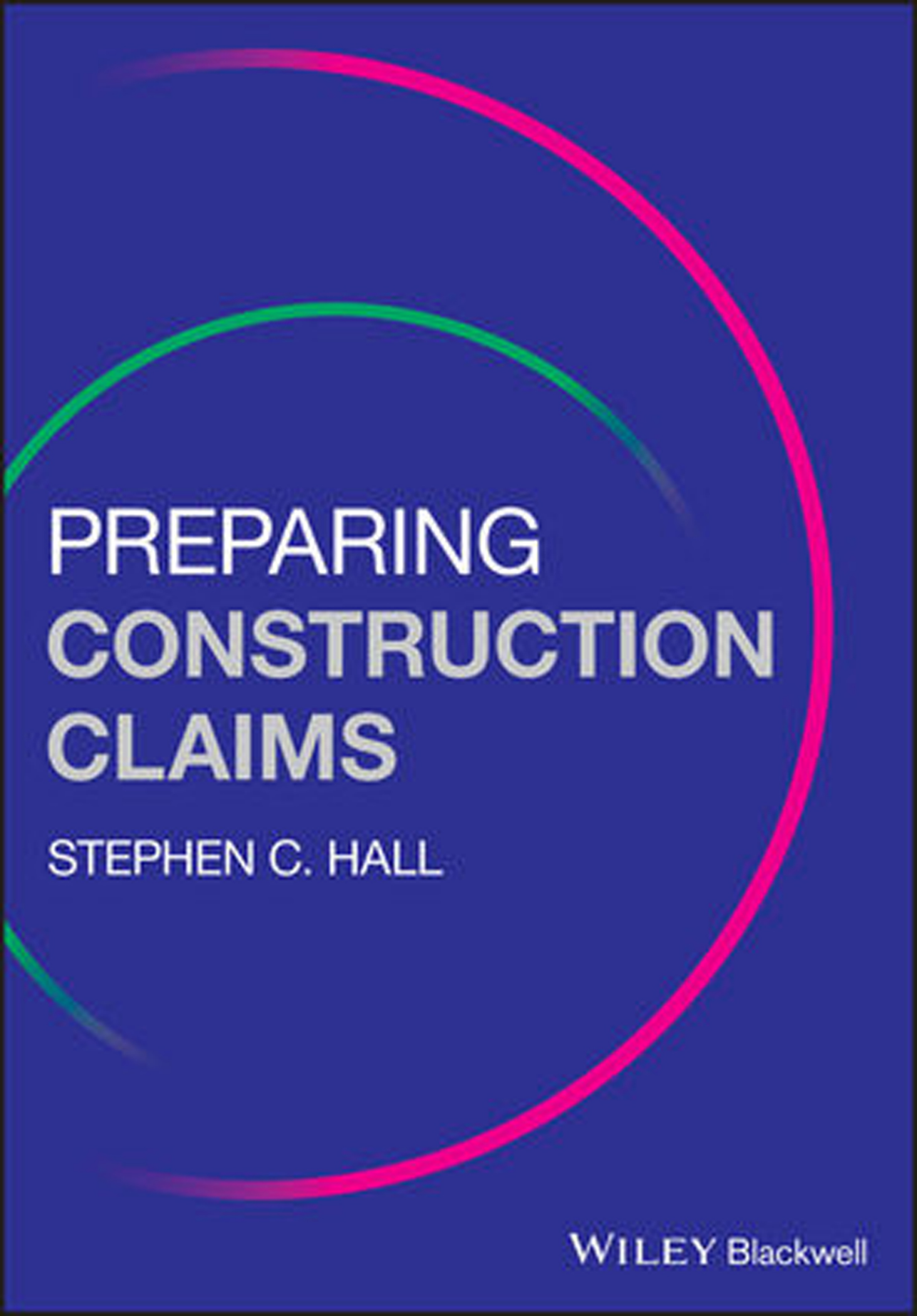




PREPARING CONSTRUCTION CLAIMS

STEPHEN C. HALL

WILEY Blackwell

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Preface

When I decided to write this book, the main purpose was to pass on my many years of experience to a new audience and provide a manual for identifying and producing construction claims from first principles. This book sets out techniques and advice – it is not intended to be a treatise on the various forms of contracts that exist, as the main elements required to make and successfully prosecute a claim are contained in all forms of construction contracts.

My aim is to simplify and explain a complex subject, and to provide the tools to research and present any construction claim.

Two quotations were my mantra while writing this book:

An expert is someone who has succeeded in making decisions and judgements simpler through knowing what to pay attention to and what to ignore –

Edward De Bono

If you can't explain it simply, you don't understand it well enough –

Albert Einstein

There are many learned books on construction claims that concentrate on understanding the legal entitlement to making a claim under the various contract terms and conditions of contract used in the industry.

This book tries to answer the following questions:

I know I have a claim, but what caused the delay or extra cost, what type of claim is it and what do I need to prepare the claim?

All construction contracts experience changes and unforeseen events that cause the Contractor to suffer delay or incur additional cost. Whether that change event is claimable relies on an understanding of the contract terms. However, preparing and making a successful claim is reliant on the collection of facts and other supporting evidence to prove what happened and detail the additional costs involved. Without evidence to prove the damage suffered, and the delay or additional costs incurred, the claim will fail.

On design-and-construct/turnkey-type projects, there is another obstacle to overcome – the belief by many staff that all events are the Contractor's liability, and hence that there is no need to keep records. This culture is incorrect because, even if there is

no entitlement to make a claim against the Employer, records are required to avoid or defend against claims from subcontractors.

The research and collection of evidence and facts is closer to a mixture of detective work and the logical presentation of this evidence to demonstrate what happened, how it affected the construction process and why it is claimable. It requires experience and tenacity, as the personnel involved will often be defensive, feeling guilty about not overcoming the problem. When staff do not understand the requirements of the contract, or are inexperienced, there is often a reluctance to admit failure, or perhaps the mistaken belief that the event is not claimable. The inexperience of site staff can be overcome by education and an explanation of why there are clauses that entitle the Contractor to make claims for additional payment and extensions of time, all of which commonly occur on construction projects. The presentation of the facts uncovered is an art form akin to storytelling. It is more of a narrative skill than a technical construction skill in terms of organising the information and writing the claim to show a logical progression of facts and events leading to the conclusion. Successful presentation of the facts in a lucid, clear manner should ensure that your claim is taken seriously and lead to a realistic settlement.

However, all forms of contracts contain a requirement for the Contractor to give some form of written notice of the intent to make a claim, and it is of little value to later learn that you have a valid contractual right to make a claim if no one kept any records, no research was done and, more importantly, no notice of claim was served. Once the contractual entitlement has been established and notice given of the intent to make a claim, the success or failure of almost every claim relies on producing contemporary records to prove what the event actually did. This part of the process relies heavily on gathering facts and records of what happened, and what impact the event or series of events had on the regular and planned progress of the works. The key facts to determine for any claim are: 'What?', 'Why?', 'When?', 'How?', 'Where?' and 'Who?'. The application of these six questions to any task form the ground rules for investigating any potential claim event. Once the answers to these six questions are found, all the facts needed to support the claim will have been assembled.

One of the major problems with construction sites is their complexity and the number of different trades and specialities employed on the site. No single construction project is identical to the next, and each project is essentially a one-off unique design. While this singular design may contain many elements and trades, which have all been carried out before, the details of each element will be different and designed to suit that project alone. Even with something as repetitive as major road construction projects, while there are numerous standard details and specifications, each project will also contain specific changes to the standard documents, and each element will be unique to that project in some way or other, often driven by the geography of the site.

Claims arise owing to changes from the project as envisaged at tender stage compared to what happened on site. Claims have many sources of change, such as varied ground conditions, late design information, correction of errors and/or supply of missing or additional information, site instructions and variation orders, adverse weather, etc.

Other claims arise from disputes about how work is measured, or changes to the content or character of work from that originally indicated. Some claims relate to how additional work instructions should be valued – whether to use existing Bill of Materials rates or some new rates and prices to be agreed on. Most, but not all, of these

measurement disputes will get resolved after discussions, and a complete understanding of the correct measurement rules to apply is paramount when arguing such matters.

The larger contractual claims and disputes mainly relate to changes to the timing, sequence and duration of work and any resulting delays to completion. Most major disputes arise more about delay claims involving extensions of time and additional payment for delay and disruption than any other cause. Delay claims require detailed research to determine the impact an event had on progress, or whether it caused delay to completion, disruption/production losses and increased site overheads.

The purpose of this book is to provide ideas and guide you through some techniques for finding and uncovering the answers to these questions – and, having gathered all the facts, how to use them to present the argument: concisely, clearly and forcefully.

Introduction

All construction contracts have claims of one form or another. This is driven by the unique nature of the industry, as most major construction projects are one-off singular designs – unlike manufacturing, where a design can be fine-tuned to resolve any issues and production optimised to ensure that efficient and regular output is achieved. All forms of construction contracts contain clauses dealing with additional or varied works, delay events and recovery of additional costs. These are needed to accommodate the impact of design changes, errors or omissions, variations and other changes that occur. There are, of course, various types of changes that occur on all construction projects, and the majority of these are resolved without submission of claims or recourse to a formal dispute resolution process.

The practice of making claims is not due to the belligerence of contractors; it is the nature of the construction process itself. All building and civil engineering projects suffer from unexpected events, design revisions and changes during the course of construction. This is not something new; claims for additional payment or extensions of time have been documented and recorded in Case Law for over 100 years. Sometimes the changes that form the root cause of a claim could and should be avoided by more diligence during the design phase, but others are due to unforeseen circumstances or events that can arise during any construction project. Claims are part of the fabric of the contract and arise from the construction process, wherein a design is translated from the two-dimensional drawings into a three-dimensional finished project. The various forms of contracts in use all deal with changes to the original project during the construction process and contain rules stipulating the notification and valuation of such changes. Such clauses are wide-ranging and have evolved into the modern contract forms, which are designed to avoid claims being founded outside the terms of the contract.

Construction projects necessarily involve risks, and the various forms of contracts allocate responsibility for those risks: for example, unforeseen ground conditions, adverse weather, strikes, lockouts, etc., for which each party has obligations under the contract. The original designs, documents, information and tender estimates often contain mistakes. The contract clauses relating to claims, valuation of variations and entitlement to extensions of time all evolved to allocate the liability for such errors or omissions. Some contracts call variations and claims different names (e.g. ‘compensation events’ and ‘change orders’), but ‘what is a claim?’ The answer is simple: a *claim* is any change to a project that in some way results in additional costs and/or delays that entitle a Contractor to additional payment or an extension of time where a delay to completion has occurred.

Another source of claims is a failure by the Employer to make payments for additional measured works or other valid items claimed in the measured account. If these issues are not resolved, they also become a claim arising from a disputed item or measurement and, at the very least, adversely affect cash flow. In other words, if a new item is claimed in the monthly valuation, and the Contract Administrator agrees with it and, after some negotiations about the price, makes payment, then this is not a claim. If, however, he disagrees and crosses the item out or writes rejecting the item and will not pay for the work claimed, then it is a disputed item and, therefore, a claim – unless, of course, the Contractor withdraws the claim, having accepted the decision of the Contract Administrator. Withholding of payment for works done is also dealt with under all the common forms of contracts as a claim for interest on outstanding payments for work done.

This issue is compounded by the fact that, while many changes and variations can be agreed on with respect to the direct effect of the additional work instructed, the subsequent impact on the programme and overall completion date for the project is more difficult to determine and agree on without further detailed analyses. Claims can sometimes become very emotive, and the Contract Administrator might take the matter personally, especially if it arises from some oversight or poor wording in the contract documents or an error on the drawings. However, a claim should be approached with the same professional manner as all other issues on a construction contract.

Similarly, giving notice of a claim situation should not be shied away from. Most forms of contracts have a procedure that requires the Contractor to give notice. Under certain contracts, failure to give notice within a set timescale can result in the contractor losing all rights to additional payment and extensions of time. Therefore, the contractor should not avoid giving notice; it is not to be viewed as an aggressive act or threat – if a notice has to be given under the terms of the contract, it is merely compliance with that term, and nothing more.

Dealing with claims has always been a case of two distinct views. Those who prefer to deal with any issues as and when they arise, and those who prefer to argue and procrastinate. The parties to contracts often seem to prefer to postpone discussion of an issue, or would rather argue than resolve matters (despite all the hype about ‘partnering’ and various other ‘new’ approaches for cooperation between the parties). The problem may be personal to some construction professionals. It starts with embarrassment at having a claim situation arise, perhaps having believed that the contract was ‘iron-clad’ or ‘claims-proof’ and having advised the client of this belief. This denial is then followed by a stubborn refusal to accept the reality of the situation and deal with it. Later, when a formal claim is submitted, it is then a case of ‘too little too late’, as the realisation dawns that they have a serious problem that should have been resolved. The newer forms of contract all advocate dealing with claims quickly as and when they arise, resolving issues long before they become disputes. Of course, the better Contract Administrators always took this approach, and their contracts were managed in a fair and reasonable manner, with all changes and claims being resolved without the need for litigation.

The advent of the New Engineering Contract (NEC) in the UK does not alter the basic requirements of giving notice and keeping records. Furthermore, the NEC does not preclude claims for additional costs and extensions of time; it deals with them in a different way – by calling all of them ‘compensation events’. The main difference is that the impact of instructions or changes that result in a revised completion date, disruption and prolongation costs must be included in the quotation for the compensation event.

There are many forms of claims, and I will differentiate between matters more properly described as ‘variations’ and those that are ‘claims’, requiring more formal submissions and procedures. A claim is any item of additional expense or delay, which the other side refuses to accept. Claims are avoided altogether when the item raised is accepted; it only remains to be priced and agreed on in the time-honoured fashion. There are matters that have to be investigated before the content or form of claim can be determined. All claim issues require the answer to the same six questions: ‘What happened?’, ‘How did it happen?’, ‘Why did it happen?’, ‘Where did it happen?’, ‘When did it happen?’, and ‘Who is responsible?’.

Starting with these six questions, let us address the fundamentals first:

- *What happened?* Money is invariably involved, and often time as well. Some event has occurred that has caused additional cost, and potentially a delay as well.
- *How did it happen?* This is a larger question and requires discussion with the site team to find out the facts. It could simply be the issue of site instructions or the discovery of some unexpected event – for example, uncovering an old pipe and discovering asbestos lagging.
- *Why did it happen?* Was the event unknown to the Contractor, was it due to instructions or was something else to blame – for example, a fire or flood that destroys a section of work that has to be repaired?
- *Where did it happen?* This is usually easier to find out, and interviewing the site team will resolve where the event was – for example, which floor, or the chainage along the site.
- *When did it happen?* May not be quite as obvious; it may take time for the realisation that an element of work had cost a lot more or had been delayed.
- *Who is responsible?* This question requires detailed knowledge of the contract, its terms, work scope, exclusions, etc.

So, having had a progress meeting with the site staff, or having discovered a hole in the finances at the end of the month when the cost reports are published, how do we go about making a claim?

First, and foremost, it does not matter what type of claim we are talking about – claims against the Employer, insurance claims, contra charges or counterclaims against a subcontractor. There is one fundamental thing that must be done immediately when a claim situation arises: ‘*Give written notice of intent to make that claim*’. All forms of contract and subcontract contain notice provisions, and the worst thing you can do is to find out later that you had a great claim, but that, because you failed to give proper and timely notice, you have lost all rights to make that claim. There are numerous examples of new contracts where the use of ‘time bars or condition precedents’ is becoming more common. These obstacles to payment, etc., may be written into the Standard Form of Contract, or they may have been incorporated by Employer amendments bound into the final contract documents. The incidence of such time-bar clauses is widespread, and careful note must be made of the contract terms and of any time limits for notice and submission of claims to ensure that they are adhered to, so that the time-bar clause cannot be invoked. For example, FIDIC Clause 20.1, Contractors Claims, states that failure to give written notice within 28 days of ‘becoming aware’ of a claim issue results in the claim being invalidated, and all rights to additional payment or extension of time are lost. Having given our notice of claim, what do we do next? The purpose of this book is to explain how to go about successfully identifying, recording and making a claim.

Finally, throughout this book, I will emphasise the importance of keeping records to support the claims that may be made by the Contractor, or for use in defending claims from subcontractors. In recent years, with the increasing use of 'turnkey' or 'design-and-construct' forms of contracts, I have noticed that the staff on such projects fail to see the need to keep records, adopting a false view that, because of the nature of the contract, everything is the Contractor's fault. This cannot be further from the truth, since, even with such design-and-construct versions of contracts, the Contractor still has rights to make claims for Employer risk events and defend itself from claims made by others – for example, weather delays or force majeure events may still happen, variations to the scope of work may occur and approvals can be delayed.

Of course, there are many circumstances where the employment of experts and specialists, of various disciplines, is essential to winning the day. However, many simpler claims can be successfully prosecuted and suitable 'negotiated' settlements achieved by following the basic principles set out in this book. The adage that 'the better the records, the better the claim submission will be, and hence the better the settlement' always applies.

1

Types of Claims

1.1 What Are Claims?

A claim is an application for additional payment and/or request for an extension of the time for completion due to some change that has affected the construction process, content or timing of the works, and caused additional costs for which recompense is sought. Most internationally recognised standard forms of contract and bespoke forms of contract contain similar clauses that detail the Contractor's entitlement to make a claim for additional payment and/or an extension to the time for completion for any variation or change that was not of its own volition and which causes additional costs or delays and is the liability of the Employer/Owner. Variations and instructions issued by the Owner or its representative may result in a change to the contract scope either by requiring additional work or changing the constituents of the work already included – for example, by varying the specified materials that are to be used. Changes to the design may also affect the complexity of the construction process, making the work more difficult, or perhaps altering the planned method of construction and temporary works required. Changes may also be made to the timing of work and sequence of construction. The typical sources of claim can arise from any one or a combination of the following:

- Instructions and variations issued.
- Late provision of design information or correction of information.
- Revised specifications for materials.
- Stoppages or suspension of work instructed.
- Changes to the access to and egress from the works.
- The impact of adverse weather.
- Increased quantities of work as compared to those set out in the contract.
- Incorrect descriptions of work items in the Bills of Quantities.
- Changes in the laws and customs of the country where the project is being built will also result in claims for payment or additional time.
- Claims may also arise where the Employer instructs the Contractor to accelerate the works either to recover lost time caused by variations or some other reason (perhaps even political).

The Conditions of Contract will detail what type of events enable the Contractor to pursue claims for extension of time and/or additional payment from the Employer. Some contracts do not recognise claims but deal with them either as variations or by calling them different names such as 'compensation events' or 'change orders'. All forms

of contract require two things to be established for a claim to succeed: first and foremost, it must be notified as soon as possible and certainly within any period stipulated under the terms of the contract; and, second, adequate contemporary records must be kept in order to prove the impact of the event in terms of costs and time. The following is a typical list of events or changes that entitle the Contractor to make a claim for time, extra payment or both, that are included in most forms of contract:

- a) An instruction, variation or other substantial change in the quantity of an item of work included in the contract.
- b) A cause of delay giving entitlement to an extension of time.
- c) Unforeseen physical conditions or artificial obstructions (e.g. changes to the ground conditions from those described in the contract or perhaps the discovery of some artefact that has to be preserved).
- d) Adverse or exceptionally adverse climatic conditions.
- e) Unforeseeable shortages in the availability of personnel or goods caused by government actions (e.g. changes in the law, customs regulations, or visa requirements).
- f) Any delay, impediment or prevention caused by or attributable to the Employer, the Employer's personnel or the Employer's other contractors on the site.
- g) Strikes, lockouts, civil unrest or similar unexpected 'neutral' events that may entitle the Contractor to an extension of time but not to any reimbursement for the costs associated with the delay.

The important point is that any source of change or delay to the works must be reviewed and a notice given, since, under most forms of contract, there are strict time limits within which a claim notice must be made in order to preserve the Contractor's rights to make a claim for time or money. It is becoming more common to find that many standard contracts contain (or have inserted under amendment clauses) more stringent time bar clauses or condition precedent clauses that, if not complied with, result in the Contractor forfeiting its rights to an extension of time and payment of additional costs. Therefore, it is imperative that, on starting any new contract, the Conditions of Contract be examined to see what amendments have been made to the standard forms of contract.

1.2 Measurement Claims

These are claims arising from incorrect measurement of the works or incorrect quantities stated on which the tender bid was based and which may change the integrity of the rates and prices for the work. For example:

- Incorrect application of any standard method of measurement specified in the contract.
- Incorrect or misleading descriptions of the work.
- Major differences between the original and actual quantities of work to be performed.

Measurement disputes are no longer as common as they once were as many modern contracts are made using a design-and-build form of contract. These do not rely on measurement (or re-measurement of the works performed) and Bills of Quantities; instead,

they stipulate the Employer's requirements and specifications for quality and end performance to be met. In such contracts, there are no formal Bills of Quantities, and it is left to the Contractor to provide its own quantities and estimate its price for the scheme. Previously, most construction contracts included references to methods of measurement, Bills of Quantities and the rules of measurement that applied. This still occurs in some contracts, particularly large civil engineering works where the quantities given in the Bill of Quantities are approximate and must be re-measured on completion based on drawings, instructions and the actual quantity of work performed. While measurement is a practical, partly academic process, the application of measurement rules can cause disputes to arise if the original Bill of Quantities was incorrectly drawn; items for work performed are found to be missing; or misleading descriptions were used, resulting in arguments about the description quality and quantity of work and the requirement for revised rates and prices. Measurement claims also deal with events that arise because of either a change in the character, quantity, timing or nature of the work, or because of considerable differences between the works described in the Bill of Quantities and the work carried out. When disputes arise, these claims rely either on a proper interpretation of the measurement rules applicable to the work, or on the impact of a change that has occurred which has affected the timing, quantity, quality, and price of the item concerned. Correct measurement and/or application of the rules governing measurement of the work is usually a straightforward issue to determine. However, such matters can easily become a large dispute, depending on the quantity of work, the degree of change imposed or revised prices sought for the actual work performed.

1.3 Changes to the Character Timing, Quality and Content

Some contracts contain restrictions on the entitlement to claim revised prices depending on the proportion of increase or decrease in quantities or other changes that occur. The Contractor must make out a case for new rates and prices for the work as actually performed due to the differences identified. These differences can be a change in the timing, season or alterations from the envisaged method of work due to some imposed restraint on how or when the work can be done. Generally, claims for new rates are based on alterations to the character, quantity, quality, timing or method of working. When the Contractor claims that the work has varied, or that the method of work has been changed, this is usually caused by some alteration to the anticipated production rate. The rates and prices can also be affected by the height above ground, the depth below ground, access and egress, and any other relevant factors that would change the price per unit for that work, providing the change was not made by the Contractor or was due to it misinterpreting the type of work described in the contract.

1.4 Revised Rates and Prices

Every rate or price in a Bill of Quantities or estimate is comprised of the following:

- Labour.
- Plant and equipment (including temporary works equipment).

- Materials
- Risk.
- Overheads and profit.

To derive a unit rate for an item from first principles, there are two main elements/methods used:

1. Work out a production rate or factor for the type of work using 'norms' obtained either from internal records and historical project information, or from industry norms, and use that to calculate the unit cost.
2. Work out how long the operation is expected to take for the entire quantity of work described based on experience and norms. Then, by using the cost of the chosen resources, divide the answer by the total quantity to obtain the unit cost. This would be useful for calculation of a long-term operation such as concrete work on a major project where the concrete gang, plant and equipment (batching plant, distribution plant, vibrating pokers, pumps, etc.) have to be on site from the first pour to the last, and the overall duration divided by the total quantity will provide a more realistic answer than a basic unit rate using norms.

The common factor is always the time required for the work described to derive the unit rate. If the quantity is understated, then, depending on the degree of error, the unit rate may not recover the actual costs. If the design changes (shape height, width, depth, etc.), this may affect the planned temporary works (e.g. formwork and falsework support or perhaps pumping and shoring activities). Other constituents may also change the price per unit as described earlier; changes to the diameter and shape of bar reinforcement or a concrete design mix and aggregate sizes can all influence the unit cost.

Changes within bulk earthworks can also dramatically affect the unit cost. For example, on a major road scheme, the earthworks pricing will depend on the anticipated materials to be excavated and embankment construction volumes. Unforeseen changes in the volumes of suitable fill material, unsuitable material, contaminated material, rock, etc., will affect the work carried out, the haul distances and perhaps the equipment being used. Most bulk earthworks projects are priced based on a mass haul diagram that shows where the cuts and fills are located, what they contain and where the material is to be deposited. This provides a method statement in a tabular format that describes the volume, distance travelled and plant used for each material. Changes to the constituents may dramatically change the unit cost and result in a claim for a revised rate for the work. I had a project where the embankments had been overstated in the Bills of Quantities; when this was discovered during construction, it dramatically increased the volume of material to be disposed of in off-site tips. The volume change represented a little over 10% of the original figures, but when you are dealing with a major project that has a total of 2 200 000 m³ of cut to fill, then suddenly discovering that there is, in fact, a surplus of nearly 250 000 m³ to be removed from site presents a major challenge.

1.5 Access and Possession of the Site

All contracts generally provide for the Contractor to be given unrestricted access to and possession of the site, although this may not be sole possession, as access may be

required for the Employer's other contractors and artisans deployed on the project. However, on a complex project where there are several other contractors, access and egress can become a battle for space and progress, as all the contractors want to progress their own part of the works. This is a common issue on major infrastructure or energy projects where there are vast mechanical, electrical, building and civil engineering works, all being carried out concurrently. Typically, claims for interrupted access or delayed access arise for the following reasons:

- Delayed or late possession of the site, or parts of the site, contrary to the dates and periods stipulated in the contract.
- Disrupted access to the site or obstructions or restrictions caused by others affecting part or all of the site. These can be blockages caused by others, the Employer's agents, its other contractors or workmen, all performing work or temporarily blocking or severing access routes or the availability of particular areas of the site.
- Restricted access after work starts may involve altered or restricted working hours imposed.
- Restricted traffic routes and/or changes in specified access routes instructed.

The main issue to establish is the duration of the late provision of access or when access became restricted by others or on instructions from the Employer. Written notice of the event, together with documentary evidence for it, is essential where a blockage has occurred because of the occupation of the site or part of the site by another Contractor. It is wise to take photographs showing the blockage and recording the date and time of the incident, and including such pictures in the letter of notice, so there can be no confusion about where and what happened, and it will help prevent the Employer later denying that the incident occurred. The next matter is to record the effect that the loss of access had on the progress of the works, and finally to record the costs incurred due to standing time or relocation of resources while access was not available. If access to the site is stopped for any considerable period, it may be grounds for renegotiation of the contract or termination, depending on the length of the stoppage and the impact it has on the performance of the work.

1.6 Changes

1.6.1 Varied Works

All forms of construction contracts contain clauses about changes and other instructions, and these are variously described in forms of contract as 'Variation Orders', 'Change Orders', 'Compensation Events', 'Site Instructions' and so on. They may have slightly different names but they all have one thing in common: they change the scope, quality, quantity, method of working, timing and/or duration of work.

There are two elements under the heading of 'varied works':

- Claims arising from variation orders instructed, and the timing of such instructions.
- Claims arising from work that the Contractor claims have been varied and should properly be dealt with by a variation order.

Types of variation:

- Instructions requiring additional work and/or changes to the type or scope of work required.
- Changes to workmanship or material specifications from those defined in the contract.
- Increases in performance requirements for the scheme.
- Changes in the laws of the country, which may alter taxes, import levies, labour costs, etc.

Some of the preceding claims are self-evident – for example, a change in the labour taxes, VAT (value added tax), and increases in the rate of fuel taxes or import levies by the relevant government. The impact of these changes should be relatively simple to identify as the tax increase would be part of materials invoices or wages costs.

1.6.2 Changes to Scope

Changes in quality, scope, quantity, timing and/or character of work are raised where the Contractor believes that the work has been varied from that envisaged at the time of tender. In other words, a claim is made that there was a change between the work described in the contract and the actual work performed, or the conditions under which it was performed. This is a claim for an alleged change, which has been caused or imposed on the Contractor, sometimes by the Employer's agent/Engineer, demanding the use of materials of a higher quality or altering work methods to suit personal preferences. The Contractor must first set out what the change is as compared to what was stated in the contract in the drawings and specifications, or set out in the Employer's Requirements, and ensure that records are kept justifying the additional costs claimed. By way of an example, there was a case¹ where such issues were resolved in arbitration by the arbitrator awarding sums for the extra work and variations that the Engineer had failed or refused to instruct. This was taken to the Court of Appeal on the grounds that, unless the Engineer had instructed work, an arbitrator could not award payment. However, the Contractor won its case for additional payment as the Court determined that the arbitration clause allowed the arbitrator to rectify the deficiency by awarding that such instructions should have been confirmed. Consequently, the Contractor was awarded payment for the variations that the Engineer had refused to instruct. The changes complained of included payment for higher-quality materials that had been insisted upon, and for additional work that had been carried out, all of which were beyond what was set out in the original contract.

1.6.3 Quality of Materials

The reasons for such imposed changes can be specification errors or the insistence of the Contract Administrator on something more than was specified in the original contract documents – for example, materials of a higher quality than originally specified or reasonably implied by the contract. It is not uncommon to find the Contract Administrator insisting on the use of a material from a preferred source, or preferring another (alternative) material that is better or of higher quality or price than was detailed in the Specification. Where this occurs, it should be a matter of determining what material was

¹ *Brodie v Corporation of Cardiff* [1919] AC 337.

used and/or instructed as compared to the material described in the original specification on which the Contractor priced the works. This type of claim requires disclosure of the Contractor's tender information and quotations, together with details of the specifications used for materials to compare with the cost of the alleged alternative materials procured based on the alleged instructions or directions of the Contract Administrator.

1.6.4 Design Changes/Increased Scope of Work

Design claims usually arise where the Engineer or Architect issues a new or revised drawing that changes some aspect of the work. Such changes should require a variation order, but sometimes are merely issued and not always with a covering letter or instruction asking the Contractor to comply with the new drawing.

For example:

- Additional quantities of work to be performed or changes to its location.
- Increased depths or height of work that may also change the temporary works needed during construction.
- Delays caused by the time taken for the Engineer/Architect to respond to queries about design errors or omissions.
- Delays caused by scheduling errors relating to reinforcing bar.

One of the more difficult arguments to manage is a claim for what is termed 'scope creep', especially where the project is a design-and-build contract and the Employer or its agent want more work or an increased quantity of work or higher-quality materials than detailed in the original Contract Specification and/or implied by the Employer's Requirements documents. It is not unusual for a Contractor to pursue a claim for increased scope and/or increased complexity as compared to the information available at the time of tender. However, as with all claims, this argument must be proven, and the change identified and linked to the effect it causes. It is vital to see the original contract information to establish the type of work required, and its quantity and complexity in terms of the shapes to be constructed and their constituents. If, at the time of tender, the Contractor has drawings, specifications, Bills of Quantities and bending schedules that clearly depict the work required, these can be compared to the drawings issued for construction to show whether the work content has changed. Increased complexity can be caused by several factors – for example:

Reinforcement changes:

- Changes to the mix of diameters of reinforcing bars, their shape codes and sizes.
- Changes to the number of bars or weight/per cubic metre of concrete may increase disproportionately (smaller diameters).
- Change in the ratio of straight bars to bent bars and overall bar lengths may differ.

These changes must be carefully analysed to show how the alterations made would impact on the time required for installation and/or the costs of the material. The shape code of reinforcement may change, resulting in more bent steel than originally envisaged; or, for example, the introduction of smaller-diameter closed links may make the installation slower and reduce production, consequently increasing the man hours per ton.

Formwork changes:

- Sizes of shutters measured as compared to those used may change.
- More small-section formwork than previously indicated; subtle small elements that were not envisaged at the time of tender.
- The ratio of formwork to concrete volumes will indicate if the overall size of concrete pours has changed.
- Shapes to be constructed may become more complex, perhaps requiring more or varied temporary support work than envisaged.

Changes can be very subtle, but may still cause problems, especially where the form of contract places an obligation on the Contractor to notify its intention to claim within a specified period of receiving new drawings or instructions. The revisions box or table on drawings is a notorious place for understatement or obfuscation; it is not uncommon to receive a new drawing which simply states 'Various revisions' in the revisions box, or merely 'Issued for construction'. The Contractor must be on the alert for drawing changes and increased scope or varied scope of works being slipped in under the cover of a general revision to a drawing with only that all-too-common 'Minor changes' note in the revisions box. Situations can occur that, on the face of it, are not major changes, but which manifest when the work commences as events causing delay and/or additional costs. The main problem in these circumstances is one of knowledge and notice of claim. At what point did the Contractor become aware of the event or change, and when did he give contractual notice of intention to make a claim? Where there are significant time bar clauses in a contract, it is important to establish the theoretical point at which the Contractor became aware that a (major) change has been instructed.

Here is an example: A new drawing added a small additional tonnage of reinforcement for the construction of a cattle underpass (an increase of 10% by weight). However, when the new drawing and accompanying bending schedules were examined, it was found that the entire concept of the reinforcement had changed. Instead of walls and roof slab with vertical and horizontal bars, it had been converted into a wall that had an additional 1000 closed links (8 mm, shape code 35) added to the vertical reinforcement at 200 mm centres, with similar detailing for the roof slab. This caused the steel fixing to take much longer than planned as each link had to be lowered onto the vertical steel and fixed at the same time as the horizontal bar at the same level, since otherwise these links would have to be threaded in between the wall steel afterwards, which would have taken even longer. Therefore, although the additional weight of reinforcement was approximately 10% of the original total, the impact of the small bar size and change to the configuration caused by the variation greatly extended the duration for fixing the reinforcement and added over 2 weeks to the construction programme.

If a formal variation order had been issued, this matter would have been much easier to resolve, as the claim element would only concern any alleged delay or disruption to the works, arising from the impact of the variation, and not a dispute over whether the work was indeed a variation in the first place. When the matter relates to an alleged variation, it is more complex, since the claim submission must first clear the hurdle of showing that the subject work was in fact varied somehow from the work originally contemplated by the contract, either relating to the specification or the drawings on which the bid was based.

1.6.5 Value Engineering

Essentially, this is where the Contractor may put forward proposals for alternative designs that may be easier and/or quicker to build, thus saving time and costs as compared to the original design. In theory, this saves the Employer money, in addition to making the construction easier for the Contractor. In contracts where the concept of value engineering is written into the form of contract, it is usual to describe how the proposal is to be reviewed and what happens to the financial saving identified due to the speedier construction duration. In the FIDIC (*Fédération Internationale Des Ingénieurs-Conseils*) suite of contracts, the concept of value engineering is detailed under Sub-clause 13.2, and there is a prescribed mechanism for dealing with payment of the saving/value proportion earned by the Contractor's expertise and detailed within its value engineering proposal.

1.6.6 Preferential Engineering

This term covers the situation where a Contractor is responsible for a portion or all of the design, and has to have its design details vetted by a third-party checking engineer. This often causes issues when the independent checking engineer asks for changes to the design to suit his/her personal preference for a method of construction or type of design. If the change is minimal, it may not cause an issue, but delays to the approval of drawings will inevitably delay construction on site. Such changes and modifications required by a third-party checking engineer have no contractual basis unless the checking engineer can show that his/her changes allow the design to meet the Employer's requirements and/or design standards as stipulated in the contract, whereas the proposal from the Contractor did not. If it is just the checker's personal preference, and this change causes additional costs or delay, then the Contractor must notify this change as a variation, or at the very least insist that a variation order be issued before the changes are implemented. Such changes may also affect the temporary works designs as well as the final permanent work design.

1.6.7 Varied Temporary Works

Changes to temporary works can arise from:

- Late information, resulting in changes to methods of construction.
- Changes to temporary works caused by varied or unforeseen ground conditions. This may involve additional propping work or pumping of excavations, etc.
- Changes to temporary works caused by design changes shown on revised or construction issue drawings. For example, changes to the shape or configuration of a structure that alters the formwork required.

Here is an example: In a water treatment plant, a revised drawing added a 1.5 m-long, 'L'-shaped continuity reinforcement between an adjacent wall and a supporting floor for water nozzles approximately 1.0 m above the base level. The length and positioning of these bars meant that the wall formwork had to be changed and the wall poured on two lifts instead of one. After a detailed analysis, this was found to add 1 week to the duration of each section of the unit, and there were 20 identical sections. The Contractor had

planned to construct these walls re-using the formwork from each pour, but, because of the change, it chose to make an additional set of shutters, thus reducing the delay from 20 weeks to 10 weeks. As part of the claim for the 10-week delay, the Contractor also claimed for the additional set of shutters. The Contractor received payment for the additional formwork costs and an extension of time for the delay to completion, together with reimbursement of its prolongation costs arising from the delayed completion.

Most contracts require the Contractor to issue method statements for each major operation undertaken. However, it is common to find the Contract Administrator discussing the method statement and then asking the Contractor to modify its submission in some way to secure approval before work can commence. This may be to mask the time needed for the Contract Administrator to reconsider the design, and for altering something that he/she only realised was incorrect or incomplete when the method statement was received. If method statement approvals are withheld without good reason, it is a delay caused by the acts or omissions of the Contract Administrator, and the Contractor should be able to make a claim for the delay and/or additional costs incurred.

1.6.8 Unforeseen Conditions

Claims for unforeseen ground conditions are common in civil engineering projects, especially those that cover a large geographical area – for example, tunnels, roads, pipelines, and railways. The Employer may have provided a Ground Investigation Report or similar geotechnical information at the time of tender but, due to the physical size of these projects, the boreholes and trial pits can miss isolated variances in the ground conditions – for example, encountering materials not shown or known about at the time of tender, such as rock, unsuitable materials, running sand, contaminated materials, excessive groundwater (higher water table, perched water table, artesian water), etc.

Claims for the discovery of unforeseen ground conditions require careful examination of the site investigation data provided at the time of tender and any notes of site inspections or tests undertaken by the Contractor during the tendering period. This is necessary to provide the basis for claiming that a change has occurred from what could reasonably be foreseen from the information provided at the time of tender. As soon as any change in the ground conditions is encountered, it is vital to give notice to the Engineer and keep records of what has been observed and any action that was taken – for example, surveys, trial holes, photographs, site tests or laboratory tests, any standing time recorded, measures taken (e.g. pumping) and/or sheet piling/propping/similar additional work caused by the unforeseen condition. It is important that the Engineer be asked to visit the offending area and determine what the change is and any actions to be taken to overcome the varied ground conditions. This visit is important not only to ensure that the Engineer is fully aware of the conditions, but also to establish records of what has been encountered and the measures to be taken to overcome the problem. It may also be necessary for the Engineer to check and ensure that the original design is still appropriate and sound due to the potential effects of the ground conditions encountered. Of course, it may be that the Engineer immediately agrees that the ground is unsuitable and different from what was envisaged, instructs a change to the design and participates in discussions about how to overcome the problem. In this case, the event is not really a claim anymore, but the valuation of a variation.

Nevertheless, detailed records need to be kept to ensure recovery of additional costs, but there would be no argument over whether the ground was unforeseen. If the alleged unforeseen ground conditions are disputed, this may require an inspection and report by an independent expert/geotechnical engineer to record and report on the conditions and advise on whether they constitute a change from that interpreted from the ground investigation data.

1.6.9 Contaminated Materials (e.g. Asbestos or Hydrocarbons)

Within existing buildings to be demolished or refurbished, there could be asbestos or wildlife (e.g. rare species of bats living in the loft) that were not identified or dealt with by the Employer. Any rare animals discovered must be reported as there are strict statutory rules governing how and when they may be disturbed. Discovery of any potentially hazardous materials requires immediate notification of the suspected hazardous material encountered, followed by stoppage of all work surrounding the area. In the case of asbestos within existing structures or pipework, this will require laboratory testing and removal by trained and properly equipped specialists (containment suits and covered vehicles to take the material to a licenced disposal facility). Similarly, hydrocarbons or heavy metals discovered in or beneath the existing ground will require testing and identification, as specialist disposal facilities will need this information before accepting that it can be processed at their site.

1.6.10 Adverse Weather

Delays caused by adverse weather are slightly more complicated to define as it depends on the form of contract and the particular amendments to the Conditions of Contract in respect of calculations, nomination of weather stations, and the average weather or normal weather anticipated for the site location.

- For example, the NEC (New Engineering Contract) uses a formula to assess adverse weather delays.
- The JCT (Joint Contracts Tribunal) only considers exceptionally adverse weather, leading to arguments about what is meant by 'exceptional'.
- FIDIC leaves it to the 'Particular Conditions' to insert clauses dealing with nominated weather stations and weather records for the purposes of claiming delay due to adverse weather events.

Adverse weather, sometimes referred to as 'exceptionally adverse weather', is a claimable event under most forms of contract. However, arguments arise over what is meant by 'exceptionally adverse weather'. This is a vague term, but it cannot mean extreme weather conditions such as severe flooding, hurricanes, tornados, tsunamis, etc., as these would be so extreme as to be considered a force majeure event. Generally, adverse weather claims are founded on the difference between the 'normal' or 10-year average weather conditions for the site location and any weather conditions that exceed this average, and are considered as adverse weather that was not contemplated by the contract and included as part of the Contractor's risk. Adverse weather may not just mean increased rainfall; it could mean the incidence of very high temperatures, freezing temperatures, exceptionally high winds (which prevent cranes from working),

heavy snowfall, drought or some other phenomenon over and above what is usually expected for the location. Some forms of contract set out very clearly what constitutes adverse weather conditions for them to be considered, together with the location of the meteorological weather station applicable for obtaining records of actual weather during the contract, to compare with the normal (10-year average) weather at the site location.

On larger projects, most contractors will set up some form of temporary weather monitoring station on site to record the weather, rainfall, winds, temperatures, etc. This may be different from that recorded at the designated measuring station, which is often several miles away. Weather is extremely localised, and the site may be on top of a hill or in a valley. In some mountainous areas, the weather can change quickly and be completely different from that experienced a few miles away. Very few contracts allow the Contractor to claim additional payment for the delay caused by adverse weather; it is usually treated as a neutral event, meaning that neither party should take advantage of the matter. The Contractor would get an extension of time for completion but would not be entitled to any additional payment for prolongation costs arising from the weather delay, and the Employer would be prevented from deducting liquidated damages for delay. However, where the adverse weather results in damage to the works, this is a different matter, and the costs incurred in rectifying such damage are usually covered by contract insurances. However, weather delays can result in unusual circumstances if the contract depended on earthworks operations, and there is a large amount of cutting material or borrow pit material needed to form embankments, and this material deteriorates due to exceptional adverse weather conditions. If it can be determined that the weather so affected the properties of the indigenous material that it rendered it unsuitable for use in the works, such an event may entitle the Contractor to both an extension of time and payment of additional costs in supplying/importing suitable material from an alternative source.

1.6.11 Force Majeure Events

'Force majeure' is a French term meaning an irresistible compulsion or coercion. The phrase is used in commercial contracts to describe events that might affect the contract and which are completely outside the parties' control. It has been interpreted to mean all circumstances outside the will of man, and which are not in his power to control (*Lebeaupin v. Crispin* [1920] 2 KB 714 per McCardie J.).

Force majeure is generally taken to mean one of the following events: an act of God, inevitable accident, unavoidable catastrophe, major calamity, cataclysm, disaster and/or tragedy. Its meaning is wider than just an act of God, but it is also restricted in construction contracts because most standard forms of contract contain provisions for such matters as the outbreak of war, strikes and lockouts, fire and adverse weather events. In construction contracts, there are specific clauses that deal with this type of events, but, as a general comment, 'force majeure' means an exceptional event of circumstance:

- a) Which is beyond a party's control.
- b) Which the party or parties could not reasonably have provided against before entering into the contract.
- c) Which, having arisen, the party could not reasonably have avoided or overcome.
- d) Which is not substantially attributable to the other party.

Force majeure may include, but is not limited to, exceptional events or circumstances of the kind listed in the following:

- (i) Wars, hostilities (whether war is declared or not), invasions and acts of foreign enemies.
- (ii) Rebellion, terrorism, revolution, insurrection, military or usurped power or civil war.
- (iii) Riot, commotion, disorder, strike or lockout by persons other than the Contractor's personnel and other employees of the Contractor and sub-contractors,
- (iv) Munitions of war, explosive materials, ionising radiation or contamination by radioactivity, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radioactivity.
- (v) Natural catastrophes such as earthquake, hurricane, typhoon or volcanic activity,

As can be seen from the preceding example, 'force majeure' is meant to be for unforeseen exceptional events or catastrophes. Normal events that happen regularly – for example, gales and wet weather – are not 'force majeure', so if it rains more than the 10-year average on the site, it may be classed as adverse weather, but it is not 'force majeure'.

1.6.12 Suspension Orders/Stop Work Orders

When the Contract Administrator/Engineer issues a suspension order or stop work order, this may be for several reasons – for example:

- Isolated stoppages instructed by the Employer or his agent for reasons which are not the Contractor's responsibility.
- Stoppages for safety violations.

Suspension of works by the Employer or its agents result in the Contractor being entitled to an extension of time for completion, unless the Employer or its agent can show that they had to stop the work due to unsafe working practices or similar issues.

Generally, contracts contain clauses that allow the Contract Administrator to stop work for a variety of reasons, and most of these entitle the Contractor to claim additional cost and extension of time, unless the stoppage is due to some fault on the part of the Contractor (e.g. a safety violation). Where the stoppage is a suspension lasting more than several months, the Contractor may be entitled to terminate the contract or renegotiate for demobilisation and remobilisation at a later date, if this is acceptable. For example, under FIDIC, a suspension of work lasting more than 3 months is one of the grounds for termination of the contract and/or the opportunity for the Contractor to renegotiate the contract price and time for completion.

1.6.13 Late Approval/Failure to Approve

The following are some examples of this:

- Failure to approve or late approval of method statements, temporary works designs or fabrication drawings.
- Failure to approve permits, for example, hot work permits, excavation permits or access permits to restricted areas of the site.

Most contracts stipulate that the Contract Administrator has the right to check and approve submissions (method statements, access permits, excavation permits, electrical isolation permits, etc.) before work can progress. However, such approvals must not be unreasonably delayed or withheld, otherwise the Contractor will be entitled to claim for the delay in approval due to an act or omission of the Engineer or the Employer. In modern contracts, there is usually a set period for the Contract Administrator to reply and a process of re-application by the Contractor in the event of rejection of a drawing, permit or method statement for any valid reason. For example, see FIDIC Sub-clause 8.4, as this would be a delay caused by or attributable to the Employer, and/or the Employer's personnel. A detailed schedule of all submissions and responses together with re-submissions should be maintained, so that any unreasonable delay in response can be identified and its impact assessed.

1.6.14 Late Information/Revised Information

Most construction contracts have provisions for the issue of further drawings or instructions during the progress of the works. However, arguments regularly arise about the timing of the issue of such instructions and whether the Contractor should have asked questions sooner. The fundamental point to remember is that, if additional information is needed and/or revisions to drawings are required for construction to proceed, the Contract Administrator must respond within a reasonable time in all the circumstances. While the contract may allow revisions to the drawings, the essential point is that the drawings are deemed to be correct when issued. Errors or omissions that must be corrected after issue, but perhaps immediately prior to or during construction, cause delay. It is not the Contractor's responsibility to check the drawings for errors months in advance. The Contractor is entitled to believe that the drawings are correct until an error manifests itself. One of the most common errors involve inconsistencies between the reinforcement and the concrete drawings, resulting in errors or changes to the reinforcement bending schedules. This type of error tends to arise during installation of the reinforcement and requires an urgent answer to avoid unnecessary delays. Some Engineers will try to defend any delay arising from such an error by arguing the Contractor should have noticed it sooner, but the fundamental point is that the design error rests with the Engineer, who should have checked and ensured that his/her design was correct prior to issuing the drawings and schedules.

1.6.15 Antiquities or Archaeological Discoveries

The discovery of ancient graves or artefacts may require access for archaeologists to examine and retrieve precious samples of ancient civilisations before work can continue. This is normally stipulated in the contract as a potential claim occurrence, and the Contractor must allow access for such specialists to examine artefacts before continuing construction. If the Contractor is required to provide access and attendance while archaeologists perform their work, this may be recovered on a time and material basis, depending on the wording of the contract. If this work is in a critical location, most contracts allow for an extension of time to be awarded to the Contractor (with costs).

1.6.16 The Prevention Principle

This forms the basis of a claim for relief from delay damages where the Contractor can show that it was prevented from completing the work on time by the acts or omissions of the Employer. The judgements in two notable cases that state this principle are briefly outlined in the following text:

In *Trollope and Coles v. North West Regional Hospital* 1973 1WLR601(HL), by Lord Denning:

... it is well settled that in building contracts and other contracts too when there is a stipulation for work to be done in a limited time, if one party by his conduct – it may be quite legitimate conduct, such as ordering extra work – renders it impossible for the other party to do his work within the stipulated time then the one whose conduct caused the trouble can no longer insist upon strict adherence to the time stated. He cannot claim any penalties or liquidated damages for non-completion in that time.

This was restated in *Multiplex Construction (UK) Limited v. Honeywell Control Systems Limited* (2007 EWHC 447) by Justice Jackson:

... The essence of the prevention principle is that the promisee cannot insist upon the performance of an obligation which he has prevented the promisor from performing.

However, even if the prevention principle is accepted, it does not mean that a Contractor can take as long as it likes to finish the works; it is still obliged to complete the works within a reasonable time. What this means is that, while a delay has occurred which entitles the Contractor to relief from delay damages for the late completion caused by the event, the other terms of the contract remain in force – namely, that the works should progress with due diligence.

1.6.17 Tolerance Creep

Where the Employer or its Engineer or Architect undertakes the design of the works, this would be a claim for delay or additional costs caused by differing tolerances between design elements that cause clashes in the installation of the works – for example, tolerances for reinforced concrete bases being different from the tolerance allowed for structural steel fabrication, which may affect the positioning of holding down bolts where there is a long span (e.g. in the case of steel sign gantries or similar). This can result in both the fabricated steelwork being in accordance with the specification and the foundation bases being correctly positioned, both within their respective tolerances, but if both were at opposing ends of the tolerance (one at the extreme of the plus side and the other the negative side), the holding down bolts and structural bolt holes may not match.

1.6.18 Utilities and Services

Most contracts include reference to utility providers (water, gas, electricity, telephone, oil pipelines, CCTV, Cable TV, etc.) that are located near or on the site, and whether such services must be diverted during or prior to construction. Generally, such services diversions are organised by the Employer, and a schedule of diversions is incorporated into the specification or Employer's requirements. Where these diversions take longer or interfere with the Contractor's operations, the contract should specify who is liable for managing the interface, and if the Employer is liable for any delays caused. Utility providers tend to operate under their own processes and procedures and cannot be managed by the Employer or the Contractor. Therefore, records need to be kept of the locations and duration of such diversion works, so that any delay can be established, and a claim prepared where such prolongation of the diversions causes delay or additional cost. Additionally, there may be services that cannot be diverted, but which must be protected during construction by the Contractor – for example, placing a reinforced concrete pad over a gas main or oil pipeline to protect it from construction traffic. Some services have specific shutdown periods when they are scheduled for maintenance, and access over and near such services may only be permitted during these shutdowns and may otherwise be prohibited during their normal operating periods. The contract should schedule such matters so that the Contractor can incorporate this obstruction into the programme of works.

1.6.19 Insurance Matters

All forms of contracts require insurances for the works under construction, and whether this is to be effected by the Employer or the Contractor is dependent on the wording of the contract. Such insurances cover, for example, weather damage, fire damage, flooding and the like, but not Contractor errors. The wording of the insurance clause in the contract and details of the policy will dictate what can be claimed and what is not covered. There are circumstances where the insurance will cover the direct costs of an event but will not reimburse the prolongation costs of the delay to the project – for example, severe storm damage, where the insurance will cover some of the costs of the damage repairs, but the Contractor must claim an extension of time for the delay caused. If the Contractor has to effect the insurance, the amount or proportion of costs that can be claimed will depend on the uninsured losses figure (policy excess) before any claim can be made. Insurance policies always limit claims or require the insured to accept part of the costs of repair. On major projects, this may be a fairly high figure before the costs incurred due to any damage or insured incidents exceeds the policy excess.

1.6.20 Disruption Claims

Disruption is generally a loss of production and/or increased costs incurred due to changes in the sequence, timing and duration of works caused by an Employer event. This means that the planned sequence is lost, and production levels are not achieved, causing interrupted or fragmented working and resulting in an increased unit cost beyond the allowances made in the original tender calculations. Disruption may also affect other operations not directly altered by the claimable events, but which also

suffer a loss of production. Claims of this nature are usually termed 'Global Claims', 'Cardinal Change'² or 'Cumulative Impact Claims'. Where the disruption is extensive, and numerous changes and delays have destroyed the planned sequence, timing and duration of the works, it is common to find that the Contractor will increase resources to mitigate the impact on the works. Such increases may be required merely to cope with the interaction of numerous events or the absorption of resources by numerous overlapping delayed operations. This leads to more work activities being undertaken each week than was planned, had the delays not occurred. On congested sites, this may lead to further production losses due to the 'stacking of resources' and/or 'crowding' at the work face.

1.6.21 Mitigation Claims

These are usually claims made for reimbursement of additional costs incurred by the Contractor for taking measures to reduce or overcome a delay; they can be:

- Measures that were taken to mitigate or reduce a delay caused by the Employer.
- Taking measures to comply with the wording of a 'best endeavours' clause and what this means in terms of the duty to mitigate a claimable delay.

1.6.22 Acceleration Claims

These claims fall into two categories:

- Instructed (agreed) acceleration, where a price and target are agreed for the Contractor to recover an earlier delay which the Employer wishes to overcome rather than award an extension of time for completion.
- Uninstructed acceleration – sometimes referred to as 'constructive acceleration', where the Contractor chooses to put in place measures intended to recover all or part of a delay for which an extension of time has not been granted. Where this delay was caused by the Employer, the Contractor may have requested for an extension of time, or perhaps such a claim has been rejected, leaving the Contractor with the choice to either stand his ground and fight for the extension of time to which he believes he is entitled, or alternatively take action, and, introduce acceleration measures. This type of claim is difficult under most forms of contract, as there are clauses for extensions of time, but, other than a variation instruction requiring acceleration, there are no clauses that deal with constructive acceleration per se. Therefore, it is vital for the Contractor to have issued the extension of time request and then confirmed that, in the absence of any award of time or following the rejection of his claim, he is implementing measures to avoid the risks of overrun and deductions of liquidated damages for late completion.

² In the United States, a cardinal change is typically a fundamental breach of contract by the Owner, and a contractor is not obligated to proceed with a cardinal change if directed to do so by the Owner. 'A cardinal change occurs when one party affects an alteration in the work so drastic that it effectively requires the contractor to perform duties materially different from those originally bargained for'. *Rumsfeld v. Freedom NY, Inc.*, 329 F.3d 1320, 1332 (Fed. Cir. 2003).

- Historically, any claim for constructive acceleration was rejected, but the Courts have accepted the argument in principle, but the claim still has to be proven to the same degree as any other claim for additional costs. Notices must have been issued, and records maintained to support the case (see *Motherwell Bridge v. Micafil (2002) CILL 1913*).

An acceleration claim will normally include claims for reimbursement of costs arising from:

- Additional resources deployed
- Other measures that were taken to accelerate the works – for example, expediting deliveries of imported materials
- Overtime working – extended working hours
- Weekend working
- Introduction of night shift working
- Changes to timing and sequence of work to side-step or mitigate a delay in one area which may involve additional costs and return visits to complete work.

1.6.23 Delayed or Wrongful Withholding of Payment by the Employer

Where the Employer fails to make payment for the work undertaken and certified for payment, the contract may stipulate what happens. For example, claims for:

- Interest – claims for late payment of certified monies due where such interest is a term of the contract.
- Financing charges – claimed for late payment of contractual claims up to the date when litigation begins, and thereafter until a payment is made on the justifiable amount due.
- Entitlement to terminate the contract due to the Employer failing to pay or being unable to pay for work done.

1.6.24 Termination of the Contract

One particular comment is regarding claims for termination, or alleged wrongful termination, of the contract. These are usually subject to litigation long after the event, but the important point to remember is the need to record the following:

- a) The status of the project at the date of termination – a detailed report of the physical progress of work, including photographs, measurements and surveys of the remaining work required.
- b) A quantified schedule of all materials delivered to the site and stored ready for incorporation into the works – this would include reinforcement, loose material stored in stockpiles (fill material or topsoil), aggregates, stone or bricks, steelwork, precast concrete units, etc.
- c) Details of the site establishment mobilised at the date of termination – including personnel, offices, stores, utilities, welfare facilities, major items of plant and equipment – for example, batching plants, satellite communications equipment, generators, waste material disposal, etc.

- d) Details of temporary works constructed – haul roads, fabrication shops, falsework, scaffolding erected, etc.
- e) Details of materials procured but not yet delivered, and any cancellation charges arising from cancelled fabrication orders, equipment suppliers, etc.

In addition to the preceding status records, claims for wrongful termination require evidence of performance achieved at the date of termination, measured against the programme and details of any claim events suffered but not resolved. Details must show that the Contractor's performance of the contract was hindered or prevented by the acts or omissions of the Employer or its agent, whether contemplated within the contract (e.g. variations and instructions) or resulting from other actions, such as lack of access or stoppages or suspension of work by the Employer.

Claims for wrongful termination include claims for general damages for the losses incurred at the date of termination – for example, redundancy payments for labour and staff laid off, loss of profit, etc. – due to the cancellation of the contract, and claims for financing and/or interest charges incurred on any unpaid sums or expenses incurred prior to termination.

2

Basis of Claims

2.1 Contractual Basis

The starting point for any claim is the contract, which sets out those matters that entitle the Contractor to claim for an extension of time or additional costs for specified events that are the Employer's risk. A claim must be founded on certain things:

1. Contractual entitlement (under the contract terms).
2. Legal entitlement (Common Law claims or claims for changes in the Applicable Law enacted after the contract was formed that are not covered by a clause or term of the contract).
3. Factual evidence (records, notices, correspondence).

The contract sets out the risks and liabilities between the parties and details the circumstances whereby a Contractor may make claims for varied and additional work, delays and other events that entitle it to additional payment and/or an extension of time for completion. Therefore, having determined that some form of delay or additional cost event has occurred, the contractor must review the term or terms of the contract that entitle him to claim an extension of time or reimbursement of additional costs. This will be due to one of the events noted in the previous chapter dealing with types of claim. It is often the case that more than one clause of the contract may be at the root of entitlement (variations, ground conditions, adverse weather or other sources of change or delay suffered), and it may be that a more detailed investigation is required to determine the extent to which recompense may be sought.

2.2 Initial Investigation

Before embarking on a full-scale major investigation of any claim, it is advisable to carry out a preliminary assessment of the matter; this is sensible because:

- a) It will familiarise you with the alleged claim and its effects, and what may be needed to prove the issue.
- b) If it is found that, while there may be an argument that an event is a claim, but no formal notice was given, the event might be 'time-barred' by the terms of the contract.
- c) There may be no grounds for a claim under the contract if the event was deemed a contractor's risk under the contract.

Therefore, a brief review can save a lot of time and costs of investigating a lost cause. The golden rule should always be: 'If in doubt, ask'. Some claims are not always obvious at the first glance. Hence, an initial appraisal of a claim is needed to establish the grounds for the claim and to determine what evidence and records will be required to justify the claim. This preliminary assessment should also provide some guidance as to the claim's likely value and potential recovery, so that a realistic budget can be set that is not disproportionate the value of the claim. It is not economical to spend £50 000 on a claim investigation and presentation if the claim is only worth £25 000. In such circumstances, a simplified approach is warranted, with a simple straightforward submission and some negotiations around the facts.

Further, on any major project, there are usually dozens if not hundreds of claim events to be considered. Where this is the case, a more efficient strategy is required, so that effort is concentrated on the claims with the largest value and potential for success, following the Pareto principle¹ – that 80% of the value will be in 20% of the items.

2.3 Causation and Liability

Causation is the key component to consider; this is the variation instruction or discovery of an event or series of events that result in legal liability or entitlement from one party to another under a contract. Under construction contracts, the Contractor has to establish that the Employer is liable for the delay and/or additional costs incurred for which the Contractor is seeking recompense. To do this, the Contractor must show that the event is one contemplated by one or more of the terms of the contract, and that the Employer is in breach of that term. This all sounds very legalistic, but it must be rooted in the contract between the parties. The application of the legal principle of causation is a relatively simple matter. The real problem is not in establishing that there is a breach that entitles the Contractor to make a claim, it is in proving the consequences of that breach.

In most construction claims, the cause of delay or additional cost is relatively easy to identify – for example, variations, late release of information, prevention of access to the works or part of the works, suspension of work, adverse weather, poor ground conditions, etc. The problem that most contractors face is the failure to keep adequate records and other evidence necessary to prove that the event caused delay and/or disruption to the regular and planned progress of the works. The subject of records is dealt with separately in this book.

The golden rule is that, when an event occurs, the Contractor must do three very important things:

- 1) It must realise that it has or will suffer delay or incur additional costs due to a claimable event under the terms of the contract.
- 2) It must immediately give notice to the Employer's Contract Administrator (Architect/Engineer/Project Manager) to ensure that it complies with any notice constraints embodied in the contract. Such notice must be given as soon as the Contractor becomes aware or should have become aware of the event.

1 Vilfredo Pareto (1848–1923), although his original proposition, based on a survey, was that 80% of the wealth (land ownership) was controlled by 20% of the population.

- 3) It must ensure that sufficient contemporary records are kept to prove the impact in terms of time and cost that it intends to claim.

The key to success in all claims is to keep detailed records to prove the costs incurred and the extent of delay suffered.

2.4 Review of Contract Clauses

As soon as a tender document arrives, a Contractor should ensure someone within its organisation vets the document for any amendments to the standard form of contract on which it is based. If it is not based on a standard form (sometimes called a 'bespoke contract'), the entire contract should be reviewed by a competent contractual/legal advisor. It is essential that the contract presented by the Employer be examined in detail, and any unacceptable or onerous clauses or requirements noted and brought to the attention of the tender team. It is too late after a contract is awarded and signed to suddenly realise that the contract terms impose prescriptive obligations that would cause the Contractor to suffer financially. Obligations might be imposed that require additional resources, staff and/or documentation, or which may delay or impede access or progress of the works if compliance with certain terms is not met.

One of the most common amendments to contracts concerns restrictions on the Contractor's entitlement to additional payment and/or extensions of time for completion. These types of amendments impose a time limit between an event occurring and the period thereafter for giving notice to the Employer, failing which, a claim can be rejected. These 'time bar' clauses, as they are known, are becoming increasingly popular and more onerous as Employers or their legal teams seek to avoid claims from Contractors. Compliance with such terms may need additional staff to monitor events, issue notices and follow these with claim submissions to meet an onerous time scale in order to preserve the Contractor's rights to payment and extensions of time for completion.

For example:

- Notice requirements for claims may be very short in terms of the time for giving such notice from the date when the Contractor 'became aware' or should have become aware of the event in question.
- Time limit after an event is notified within which a claim submission or particulars of it must be submitted. Failing to meet these time limits may restrict or severely reduce the Contractor's claim.
- Stringent rules and timescales for the submission of variation proposals or new rates.
- Bureaucratic rules for submission and approval of method statements which may delay or prolong the approval process and affect the commencement of work.
- Rules and content requirements for submission and updating of programmes – sometimes with financial penalties if the programme is not received within the prescribed period.
- Notice requirements affecting requests for further drawings or information missing from the original construction issue documents.
- Approval regimes, for example:
 - Approval procedures requiring inspections before a concrete pour is allowed to be poured (perhaps stringent notice periods before an inspection can be requested).

- Access permits and hot work permits.
- Excavation permit procedures.

All of these may impose a time period during which the Engineer/Contract Administrator can review such applications before work can commence, and these periods need to be considered within the programme for the works. For example, if the contract states that the contractor must notify the engineer that an item of work is ready for inspection at least 24 hours prior to an inspection taking place, it is no good requesting an inspection of the work in the morning for a pour planned the same day.

3

Contracts

3.1 The Construction and Interpretation of Contracts

While this book is not intended to be a legal treatise, it is important for anyone preparing a claim to have some knowledge of how the courts will interpret a contract. In his judgement in the case *Kitsons Sheet Metal v. Matthew Hall* (1989), the Official Referee HH Judge Newey QC gave an instructional dissertation on the rules for construction of written contracts, as follows:

Firstly, ... the Literal Construction: Where words of any written instrument are free from ambiguity in themselves and where external circumstances do not create any doubt or difficulty as to the proper application of those words ... such instrument/document is always to be construed according to the strict ordinary plain common meaning of the words themselves.

Secondly, ... what is meant by the intention of the Parties: In examining this issue one is speaking objectively, the parties themselves cannot give evidence of what their intentions were. What must be ascertained is what is to be taken as the intention which reasonable people would have had if placed in the situation of the parties. Similarly, when one is speaking of aim or object, or commercial purpose, one is speaking objectively of what reasonable persons would have in mind in the situation of the parties.

Thirdly, ... the extent to which construing a contract regard may be had to the context in which it was made. In order that a contract may be understood it must be placed in its context – it cannot be isolated from the matrix of facts in which (it is) set and interpreted purely on linguistic considerations. No contracts are made in a vacuum, there is always a setting in which they have to be placed. Context does not however include negotiations, because it would be unhelpful to take them into account ‘because the parties’ positions alter during exchanges’. The acts of parties after they have concluded a contract cannot form part of the context in which it was made and must be disregarded.

Fourth, ... the extent to which words in contracts may be given meanings different from those, which they normally bear. It is clear that oral evidence cannot be used to give express words meanings different from those, which they normally bear, but where words are susceptible of more than one meaning, extrinsic evidence is admissible to show what the parties meant. The fact that a contract is badly drafted affords no reason to depart from the fundamental

rule of construction of contractual documents that the intention of the parties must be ascertained from the language they have used interpreted in the light of the relevant factual situation in which the contract was made. But the poorer the quality of the drafting, the less willing any court should be to be driven by semantic niceties to attribute to the parties and improbable and un-business-like intention, if the language used, whatever it may lack in precision, is reasonably capable of an interpretation which attributes to the parties an intention to make provision for contingencies inherent in the work contracted for on a sensible and business-like basis.

For example, the phrase ‘a baker’s dozen’ was always accepted not to mean 12 but at least 13 buns.

Fifth, written words in a contract may prevail over printed. Where a contract is contained in a printed form with writing added, if there is doubt about the meaning of the whole, greater effect is given to the writing than the printed words. This is because written words are taken to express more immediately the intention of the parties. Presumably, in appropriate circumstances, typed words may be preferred to those contained in a printed standard form of contract for the same reasons.

This means what is says – that written words prevail over the printed ones in standard printed forms, sometimes referred to as ‘the specific overrides the general’; any form of contract dictates that special conditions ‘written in’ shall override general printed terms.

Sixth, the *contra proferentem* rule: where words are ambiguous and the ambiguity cannot otherwise be resolved, the contract is to be construed against the maker in accordance with the *contra proferentem* rule.

Seventh, to what extent can a contract be taken to apply retrospectively. If during the course of negotiations, and at other times before a contract is made, parties act on the understanding and in the anticipation that a contract is to be made, that contract will govern what has been done on the meanwhile, then on completion of the contract it will operate retrospectively.

Finally, to what extent can assistance be obtained in construing a contract by comparing it with another. Both Lord Wright in *Luxor (Eastbourne) Ltd v Cooper* (1941) and Lord Bridge in *Mitsui* at page 18 gave warnings against such comparisons. Obviously, each contract has its own context.

In *Kitson*, reference was not made to the *Tersons v. Stevenage* case, in which it was doubted that a standard form, which had been produced by both sides of an industry, could be construed *contra proferentem*. Moreover, the *eiusdem generis* rule (only like things shall follow), one of lawyers’ favourites, did not seem to find a place in the arguments.

3.1.1 A Note on Eiusdem Generis

A law dictionary definition of this rule would describe it as follows: where particular words are followed by general words, the general words are limited to the same kind as the particular words. This means that, where a series of words comprises a class and is followed by general words, the general words cover only things of that class.

An example would be where a list states ‘... iron, steel, brass, lead and other materials’. These words could be construed to include copper, for example, since the class is one of a list of metals, but it would not include wood, brick or stone.

A case was held concerning Sunday Observance Act 1677, s 1, which provided that ‘no tradesman, artificer, workman, labourer or other person whatsoever shall do or exercise any worldly labour, business or work of their ordinary callings upon the Lord’s Day (works of necessity or charity excepted)’. The words ‘or other person whatsoever’ are to be construed *eiusdem generis* with those which precede them, so that an estate agent is not within the section (*Gregory v. Fearn* (1953) 1 WLR 974).

This rule is often cited where a contract clause or section of a document (Bill of Quantities, specifications, etc.) includes a list of items deemed included, and one party attempts to argue that other things were also to be included in the items or prices concerned. What this rule means in such circumstances is that only like items to those already in the list would be considered part of that list; some other issue not associated with the listed matters is excluded.

3.2 Formation of the Contract and Disputed Terms

Where there is a dispute arising from the interpretation of a particular term or terms, or an item in the specification, if it comes to court, it may require the admission of extrinsic evidence to clarify what the parties meant at the time the contract was formed. *Extrinsic evidence* is evidence of matters not referred to in a document that is later offered in evidence to explain, vary or contradict its meaning. Its admissibility is governed by the ‘parol evidence rule’, which states that parol evidence (i.e. oral evidence) cannot be given to contradict, alter or vary a written document (such as a judicial record or a contract) unless there are allegations of fraud or mistake.

3.2.1 Judicial Implied Terms

An *implied term* is the provision of a contract not agreed to by the parties in words but either regarded by the courts as necessary to give effect to their presumed intentions or introduced into the contract by statute (as in the case of contracts for the sale of goods). An implied term may constitute either a condition of the contract or a warranty; if it is introduced by statute, it often cannot be expressly excluded.

Where appropriate and within strictly limited rules, the courts may imply terms into a contract. In plain English, an implied term is one written into a contract in order to make it commercially effective. However, where the terms of a contract are clear and unambiguous, the courts will *not* imply further terms simply to extricate a party from some difficulty, as in the case of *Trollope & Colls Ltd v. North-West Metropolitan Regional Hospital Board* (1973).

Where terms are implied in order to give 'business efficacy' to a contract, they are written in under what is known as the 'Moorcock doctrine', after a case of that name (a ship called the *Moorcock*) that was decided in 1889. It is commonly accepted that the following terms will be imported into any contract:

- The Employer should not interfere with the proper performance by the Engineer of the duties imposed upon him by the contract.
- The Employer is bound to ensure that the Engineer performs the various duties imposed upon him by the contract, per *Perini Corporation v. Commonwealth of Australia* (1969).

And further:

- The Employer would not hinder or prevent the Contractor from carrying out its obligations in accordance with the terms of the contract.
- The Employer would take all steps reasonably necessary to enable the Contractor to discharge its contractual obligations and to execute the works in a regular and orderly manner, per *London Borough of Merton v. Stanley Hugh Leach Ltd* (1985).

For example, an act of prevention could be the removal of access or failure to give access to allow the works to commence or continue.

3.3 Interpretation of Statutes

In the United Kingdom, the interpretation of the Acts of Parliament and Statutes is governed by the Interpretation Act 1889, and all subsequent amendments or re-enactment of that Act. Therefore, in the event a claim is concerned with any Act, it would be sensible to seek legal advice.

3.4 Standard Forms

There are many standard forms of construction contract, but their essence is a contract document prepared after years of consultation between Contractors, Consulting Engineers/Architects and Employer organisations to distil a form of contract that bears the risks of the venture evenly and allows both parties their rights without undue bias.

3.5 Modifications to Standard Forms

The problem in the current competitive contracting environment (especially during a time of worldwide recession in construction projects) is that the Employer or its advisors tend to modify these standard forms to make them more onerous for the Contractor. The most common change involves inserting a time bar provision, owing to which a Contractor's claim may fail if it has not given the requisite notice within the (*amended*) period stated. One common modification to a contract relates to the incorporation of a local method of measurement, labour laws or by-laws that impinge on the construction of the works – for example, employment of a prescribed proportion of local labour.

Another amendment can be the imposition of excessively long payment regimes, changing the contract from a typical 30-day payment term and increasing this to 60 or 90 days. This means that the Contractor is always behind incurring the cost long before he gets paid. Other changes relate to site safety and/or special requirements of particular bodies which may be affected by the works – for example, utilities, railways, canals, airports, pipelines (for gas, water or oil), planning permissions or other statutory obligations.

3.6 Bespoke/Unique Contracts

These are not as common as standard form contracts, but they tend to occur in certain industries or environments – for example, power, oil and gas, chemical plants, concession agreements (build–own–operate–transfer contracts), private finance initiatives and so on.

While many of these bespoke contracts contain clauses similar to standard form contracts, they are not the same in terms of the rights and obligations of the parties. Where a bespoke form of one-off contract is encountered, the Contractor should seek legal advice to ensure that the entitlement to claims, variations and other matters does not fall foul of some clause that seeks to limit or exclude what would be considered a Contractor's normal rights to payment and time.

4

Available Documents

4.1 Documents Likely to Be Available

Most contracts have a wealth of documentary and other evidence that records the formation of the contract between the parties, the changes made and subsequent progress on site. To establish the foundation of any claim, these documents need to be reviewed. Not all the following would be relevant to claims but, typically, the information available would be some or all the following.

4.1.1 Tender Information

The original tender document and sometimes a supplementary document called *Instructions for Tenderers* need to be found. Typically, the type of tender information provided contains one or all the following information and restrictions that affect the works:

- Site investigation and ground conditions reports.
- Permitted working hours and weekend or night work restrictions.
- Permitted access routes.
- Location of utilities and other services known to be on the site.
- Power, water and gas lines, other services, etc.
- Details of any planned service diversions and their timing
- Special interest groups – local residents or councils, adjacent properties and shared users of public and private access routes.
- Restrictions on noise and access to certain areas (sites of special scientific interest, bird sanctuaries, other protected animal species, etc.).

4.1.2 Tender and Final Contract

Almost all contracts are brought into being after some negotiations have taken place between the parties. It is common to find the Employer or its Advisors issuing amendments or answering questions from the various tendering contractors, and these exchanges would affect the final bargain. Therefore, it is vital to check what correspondence or exchanges took place and, of those, which documents were finally incorporated into the final signed version of the contract.

- The tender estimate and programmes (where these exist).
- Notes of any site visit during or before tender submission.
- Pre-contract photographs taken during the site visit.

4.1.3 Contract Documents

- Conditions of contract.
- Amendments to standard form of contract/conditions of particular application.
- Notice requirements, and whether these are different from the standard form of contract.
- Specifications/Employer's Requirements.
- Appendices to the contract Specification and any amendments and additions.
- Bills of Quantities
- Boreholes and site investigation reports
- Drawings
- Payment terms

When viewing contract provisions and amendments, make a careful note of any changes to the contract that insert or alter principle provisions (including the insertion of time bars for giving notices, etc.).

It is paramount to obtain a copy of the final signed version of the contract and examine any additions or amendments made to incorporate correspondence, etc. A copy of an earlier version is not the contract that was concluded, as negotiations often change contract terms and provisions as the parties negotiate and together formulate the final agreement (legally known as the *consensus ad idem*).

4.1.4 Commencement and Access

At the start of the contract, once an agreement has been reached, it is usual to find that some form of formal notice to commence has been issued, and perhaps also details or notices for access to the site where this is released in tranches. Such documents must be checked as they will dictate the formal start date and hence determine the completion date where this is specified as a set number of weeks or months after commencement. Notices of site access are vital, since any default or change to the specified dates for access in the contract may cause a delay to the contract programme and affect the planned completion date.

4.1.5 Contract Records

Contractors should ensure that good record keeping is imbued into all their site staff. The importance of clear, concise records of events and/or when work was carried out cannot be overemphasised. There are some basic documents that all sites should maintain.

4.1.5.1 Correspondence

Most contracts contain requirements for formal communications to be in writing; some stipulate what 'in writing' means, while others leave this vague. Traditionally, all formal exchanges and communications between the Contractor and the Employer and its Agents (Engineer, Architect Quantity Surveyor, etc.) were in the form of formal letters

delivered to the relevant addresses for the personnel concerned. Latterly, email has taken over much of the day-to-day communication between the parties and their Agents or Advisors. Email is a wonderful invention in terms of the speed with which communications take place and the exchange of documents, drawings, etc., that it allows virtually instantaneously. However, the contract may stipulate certain procedures to be followed for formal notices of claims, etc., and this may require formal letters using 'snail mail'. Therefore, before assuming email is fine for all forms of communication, the contract must be examined to ensure that the other party cannot revoke or reject a claim due to a notice being given using the wrong form of communication.

Email is a blessing, and it is also a curse in terms of the volume of exchanges and communications it induces. This becomes an issue when a dispute arises, due to the practice of printing out (or, more correctly, dumping) all the emails into a file to be used as evidence. This is exacerbated by the inclusion of not only all the relevant emails but also the all preceding emails and forwarded documents, together with the exchanges included with every email, so that the file is full of duplicates and extraneous documents. The biggest danger with emails is the lack of control or supervision regarding which subordinate staff may contact their opposite number and what their authorised parameters are for agreeing to matters or proposing deals. It is common to find that such arrangements were not sanctioned by management, or that they are beyond someone's delegated authority, so that these 'deals' or agreements only become apparent much later when they are an issue that should have been dealt with in formal correspondence.

4.1.5.2 Minutes of Meetings

These are usually formal documents recording discussions at monthly project meetings, both internal and external. They can be a vital source of information relating to delays or matters that have arisen during construction that affected the works. It is common to find they include a programme update and procurement schedule reporting where the project is in terms of progress and major deliveries of materials and equipment. Whether the minutes of a meeting can also constitute a formal contractual notice is often debated. The golden rule of all parties should be to confirm in correspondence and critical notices to avoid a later argument over the validity of such a notice.

Contractors should also be vigilant to ensure that any minutes produced by the other parties attending the meetings are fair and reasonable representations of the discussions that took place. I have come across minutes issued moments before the next meeting that contain matters that were not discussed at the time, or which have, with hindsight, been recorded in a biased manner.

4.1.5.3 Construction Records

- Site instructions
- Variation orders
- New and/or revised drawings
- Technical queries/requests for information
- Sketches issued
- Non-conformance reports/defects notices
- Signed measurement sheets/quantity changes
- Daily and weekly diaries
- Agreed daywork sheets/records of works

- Ground conditions discovered and reports
- Progress photos
- Marked-up progress drawings
- Marked-up progressed programmes
- Factory acceptance tests
- Suspension orders and stop work orders
- Safety violations and accidents impacting on the progress of works
- Strikes and lockouts
- Snagging lists/defect inspections
- Termination orders/forfeiture notices/liquidation or administration notices and rights to terminate a contract.
- Dispute or notices of dissatisfaction

4.1.5.4 Drawing Registers

- Revised drawings issued (timing and dates)
- Site sketches issued (timing and dates)
- Workshop drawings and Engineers' responses (timing and dates)

4.1.6 Approval/Acceptance of Submissions

4.1.6.1 Programmes, Method Statements and Temporary Works Designs

The Contractor's programme(s) should be formally issued with a covering letter or other agreed form of document transmittal, together with any written acceptance or approvals confirmed in the same manner. Similarly, any method statements or other temporary works designs are usually subject to a procedure requiring submission to and approval by the Contract Administrator or Engineer for the project. All submissions should be recorded in a register, noting the submission date and approval, and any issues to the workforce and subcontractors. A register is also vital evidence if there is any delay in reply or alterations required to these documents before approval is given. Further, such submissions must be kept safe, and hard and soft copies filed in separate locations, so that they are not overwritten by mistake when used for an updated submission.

4.1.6.2 Construction Permits, Inspections and Approvals

Registers should be kept for inspection of all approval of works forms/records of inspections/sign off sheets – for example, setting out, pre-concrete pour inspections, back-fill, tests, etc. Inspection requests issued prior to concealing or covering up of work (e.g. concreting bases, walls or floors, or closing-up work such as partitions). Tests and inspections (cube tests, welder tests, x-ray inspection of welds, factory acceptance tests, performance tests, etc.) should all be maintained in a file and a note kept in a register, as they are formal records of such inspections or approvals for work to proceed or for defective work to be repaired prior to the next stage continuing. These documents can provide vital evidence of when submissions were made and, more importantly, when the work was performed.

4.1.6.3 Taking-Over Certificates or Completion Certificates for the Works or Sections of the Works

For any project completion, certificates or taking-over certificates should be formal documents, as these will determine when the works were accepted as complete, and hence when the contractor's liability for delayed completion has ended. 'Final completion' of the works will also trigger the date by which insurance of the works passes to the Owner.

5

Records and Notices

5.1 Records

The importance of keeping clear, accurate records cannot be overstressed. Most claims fail, not because the legal principle is incorrect, or because there are no grounds for the claim, but because there are insufficient records to support the alleged costs claimed or the impact of the event on the programme. Records are essential in any contract, whether it is a design and construct project, a major subcontract or a traditional construction project. The same supporting information will be needed to defend claims made to or from the Employer, Designers and/or to and from Main Contractors and Subcontractors.

There are numerous records kept on any site; some are very detailed, and some are left to the individual or a team leader to produce. The problem with records is that the site management/supervisors rarely see the benefit of keeping detailed records and tend to give it little attention. It is only when a claim is received or a claim submission is needed to recover additional costs that the importance of records is realised. Records are the foundation blocks of any successful claim, whether it is a claim for new rates and prices on varied works, a delay and disruption claim or a claim for an extension of time.

One of the most important pieces of evidence is the Contractor's programme submission, including any updates and covering documents issued with them. Most contracts require the Contractor to produce a programme for construction to show that the Contractor has planned the work and can meet the completion date. Programmes are also essential for managing the provision of information, and submission and receipt of necessary approvals. Various contracts set out the programme content and format expected, and it is one of the most important documents produced by the Contractor. It should set out the Contractor's planned intentions in terms of:

1. The sequence, timing and duration of the works.
2. The critical path.
3. The dates by which important drawings or information must be provided to allow the works to complete within the specified time.
4. Approval periods for workshop or fabrication drawings, etc.
5. Any special or exceptional temporary works planned – for example, cofferdams, temporary retaining walls, specialist formwork, etc.
6. Mobilisation dates for key resources and equipment (e.g. erection of tower cranes, etc.).

As a minimum, the programme submission should be accompanied by an information request list and/or schedule giving dates by which details must be provided by the Employer or its designers. Ideally, all programmes should also be sent with a written method statement, sometimes called a *project notebook*, setting out a summary of the planned sequence, reasons why it was chosen and a list of the key dates or critical activities identified that must be achieved to complete the works on time.

The initial or baseline programme and records of actual progress are essential to ensure the Contractor is able to prove that production in a particular area suffered delay or disruption, and/or that resources were re-deployed because of an instruction or event. Such documents are fundamental to the successful prosecution of the claim, and they must record the timing and duration of the work and the resources deployed. The better the records, the better and easier it is to make the claim, and the higher the settlement value achieved.

Types of records that are, or should be, commonly available on any construction site:

- Correspondence and emails.
- Daily site diaries.
- Labour hours expended/clock cards/labour-only-Subcontractors' payments.
- Allocation sheets/daily reports for each gang or team deployed, detailing what work was done and its location, and any events that caused work to be cancelled or delayed.
- Plant hire records – on-hire and off-hire dates and costs.
- Weekly reports (internal and external).
- Weekly programmes and updates.
- Monthly progress reports.
- Specific team meeting notes (e.g. erection protocol for major steelwork and crane deployment).
- Programme updates, and percentage complete or remaining duration reports, issued each week/month.
- Internal management reports.
- Progress photographs.
- Drawing registers (including lists of site sketches received or produced).
- Measurements and surveys that were undertaken.
- Production records, reports, S curves, quantities achieved per week, etc.
- Piling logs.
- Inspection reports and records of tests passed (e.g. welder tests, crane safety records, concrete pour inspections, key materials tests).
- Delivery schedules and tickets for materials received (e.g. concrete tickets with volume supplied and type of concrete, steelwork deliveries, reinforcement deliveries).
- Weather records and stoppages, including the effects of weather on the work and remedial work required.
- Insurance claims for Contractor's risk events (weather damage, other accidents and damage caused by members of the public/vehicles colliding with the works).
- Monthly certificates and measurements agreed.
- Access records/permits to work.
- Suspension orders/stoppages/stop work orders.
- Safety reports/accident book.
- Investigations undertaken (including opening up for inspection).

- Changes in ground conditions when encountered, and solutions.
- Costs: wages, materials and plant hire records.
- Subcontractor payments and other disbursements that are part of the overall costs claimed.
- Overhead costs, divided into 'on-site' costs (site establishment and staff, stores, compounds, etc.) and off-site costs (regional and head office costs, etc.).
- Official progress photographs.
- Periodic aerial progress photos.
- Monthly progress photographs.
- Daily/weekly photos taken for information purposes by staff.

5.2 Contemporary Records

The most cited issue resulting in failure or reduction in payment of claims is insufficient records to support the assertions made. To prove a claim, contemporary records and other supporting evidence is required. The collection of evidence is much easier if it is prepared contemporaneously with the claim event. Trawling through diaries and dusty files long after the works are finished, trying to decipher handwriting or remember/piece together what happened, is time-consuming and extremely expensive, and sometimes subjective if the records are limited in content.

Records should be prepared contemporaneously, and not created long after the event. This requirement, in terms of 'primary evidence', was noted in one of the few judgements concerning supporting information required, by Acting Judge Sanders¹, in the 1987 edition of the FIDIC (*Fédération Internationale Des Ingénieurs-Conseils*) Red Book. The judge held that contemporary records are:

... original or primary documents or copies thereof produced or prepared at the time giving rise to the claim whether by or for the contractor or the employer...

The judge further held that contemporary records do not mean:

... witness statements produced after the time giving rise to the claim where such statements cannot be considered to be original or primary documents prepared at or about the time giving rise to the claim...

What this means is that witness statements, etc., produced after the event may not carry the same evidentiary weight as primary contemporaneous documents; it does not mean they are worthless. Many substantial claims rely heavily on witness statements and reports. Often, while there are copious records on site, it may require a detailed witness statement to interpret or explain the operations described and what was happening at the time in question.

The preceding judgement emphasises the need to keep specific detailed records for any claim event. Original documents prepared at the time will be given much more

¹ *Her Majesty's Attorney General for the Falklands v Gordon Forbes Construction (Falklands) Limited* [2003] BLR 280.

evidentiary weight than statements prepared long after the event, which may not be supported by any contemporary documents.

For a claim submission to be successful, the Claimant must answer six questions:

- What happened?
- Why did it happen?
- Where did it happen?
- When did it happen?
- How long did it take?
- Who is liable, or who instructed the work involved?

The main problem with records is one of management. People should be trained to produce suitable records, which should be a standard document for each project, and not just for the purposes of supporting a claim. They must also be told that specific records are required without any general waffle. The records should provide key factual notes of events that occurred and activities that were undertaken each day.

What records do you need? The following are some examples:

- Related correspondence – notices, submissions, exchanges of opinions.
- Instructions received.
- Drawings issued.
- Regular updates of the programme.
- Records of resources employed (staff and labour) and where they were working/what they were doing.
- Material costs or expenses incurred; invoices, receipts and delivery tickets.
- Plant and equipment used, including any specialist plant deployed, and mobilisation costs or the time taken to divert to the location.
- Any recorded standing time or production lost on the original work due to the event.
- Diaries and notebooks.
- Photographs that were taken of the area at the time of the incident.
- Other site records, surveys, diagrams, photographs, sketches and drawings relating to the event.
- Minutes of meetings.
- Internal memos, etc.
- An extremely useful task is to produce marked-up drawings (plans and/or elevations coloured up to show the date work was performed. This simple exercise can aid the understanding of the sequence and direction of workflow during construction, and is simple and quick to produce if done each week.

5.3 Source Data

Numerous sources of information can be explored to obtain the relevant evidence, as discussed in the following text.

5.3.1 Expenditure

What do you need? Simple, concise information is required, and not vast, rambling narratives. To avoid discrepancies between records/diaries, it is suggested that, for each

major project, a brief review be made of the main elements of work and its management. An example diary can be produced, showing what type of information should be recorded by each manager/supervisor/engineer daily, and issued as a template, so that personnel are aware of the requirement.

The following sections list and discuss some examples of topics.

5.3.1.1 People

- Staff, directly employed labour and subcontract labour employed on each main work element; number and trade (including their names).
- Clock cards and/or security records may tell you how many personnel were on site each day.
- Records of resources, either standing or uneconomically employed.
- Allocation sheets or time sheets that record what each team was doing and what happened during the time of the event.
- Wages sheets that record the working hours, overtime payments and bonus earned, etc., during the period.
- Copies of progress and incidental photographs that were taken to record or show the event.
- Site diaries or notebooks that record the event or actions taken.
- Minutes of meetings: these may record the claim event or its effects in general terms, and may provide some evidence of the discussions that took place at the time.
- Progress and programme updates: reports may summarise whether the project was on schedule, although these reports can sometimes be unreliable.

5.3.1.2 Plant and Equipment

- Weekly and/or monthly plant returns for all equipment located and/or working on site – for example, site stores cabins, offices, etc.; all mechanical plants deployed; transport; hoists and scaffolding, etc.

5.3.2 Progress Reports

It is a common failing that Project Managers like to record that the works are on target, rather than admit that they are suffering delays, even where the Employer is responsible for that delay. Project Managers have often gone on record saying that there are no problems and that the works are on schedule when delay events have occurred, and then, much later, they complain of the delay suffered when it becomes clear that the time cannot be recovered. This leads to conflict later when the claim is presented, and the Employer or its advisors point to such comments as part of the rebuttal of the delay subsequently claimed. It is always better to make an honest appraisal of progress and, if work is behind, to record what measures are being taken to recover the programme.

5.4 Other Relevant Evidence

The preparation and collection of relevant evidence to support the claim can consist of many things.

5.4.1 Diaries and Other Records

- Correspondence, notices, diaries, notebooks, programmes, progress reports, hand-over sheets between trades or Contractors, inspection reports, approvals, witness statements.
- Physical records: surveys or measurements, sketches, drawings, photographs, weather reports, samples taken and/or tests performed.
- Costs: purchase orders, plant and material invoices, subcontract payments, wages, rental charges, expenses.

It is no good having site-wide records for the entire project when none of this global information relates to or describes the detail of the event claimed. Many 'contemporary records', as noted in the preceding text, should be in existence as part of the Contractor's normal site management systems, but other more detailed information will have to be prepared to support the claim. Most construction projects have a wealth of information available – sometimes almost too much information when viewed altogether – and, unfortunately, much of this information is often irrelevant.

Good records should answer the six basic questions: what, where, why, when, how and who.

The problem is that records are always required, but often no one knows what constitutes a suitable record. Site supervisors' diaries may contain voluminous notes and information, but this is often not focused on supporting a claim situation. Such notes are often made for personal, production and general management purposes. The use of 'pro forma' diaries is also common, but many supervisors and engineers are not trained in what to record or how to record events. Issuing a blank diary and telling staff to keep a daily diary is not exactly training in record keeping.

5.4.2 Plant and Equipment

- Plant hire invoices will record the on- and off-hire dates of equipment and hours worked, and perhaps the location where the work was done rather than just the name of the site.
- Record what plant and equipment were deployed: make, size and designation (e.g. JCB 3CX, CAT D8, 3" pump, etc.).
- Weekly summaries of plant deployed in each location and hours worked should be produced by the supervisors, or at the very least contained in their diaries/field reports.

5.4.3 Other Records

- Major operations: for example, concrete pours (number, location and size).
- Major material deliveries: larger materials (rebar, sand, stone ballast, bearings, cement, bricks, etc.).
- Weather conditions: cloudy, dry, wet, cold, snow, high winds, etc. These are needed for each location or supervisor to check against official Meteorological Office records, which may be from a station many miles away. Major projects should set up a simple weather station on site to record wind speeds, rainfall, etc. Further, the daily diaries must record time lost due to inclement weather.

- Successful events: major milestones achieved (e.g. topping out, steelwork completed, etc.)
- Problems: issues that arise during the day, delays, material shortages, errors discovered, etc.
- Changes: instructions, drawings issued, etc.
- Completion certificates.

5.4.4 Unexpected Events and/or Ground Conditions

- For example, the discovery of asbestos, running sand, rock, higher-than-anticipated water table (variations to this are artesian water, perched water table), etc.
- Discovery of a rare or protected animal species (e.g. bats, reptiles, etc.). This may require the cessation of work during nesting seasons, hibernation periods, etc.

Good records always come back to reporting answers to the six questions (what, where, why, when, how, who). The collection and interpretation of facts can be carried out later, and, where statements are prepared, the persons can recall what happened using the diary they prepared, but the essential information must be recorded at the time.

5.5 Maximising Recovery

Responsibility for keeping records is always an issue. The problem on a large construction project is communicating to the relevant staff the need to keep such records. If the person affected by the event is not aware it is a potential claim or, has not been told to keep specific records, it is unlikely that any specific records will be made. As soon as a problem occurs and is identified as a claim or potential claim situation, there should be a protocol in place to notify (in written form or by email) the relevant supervisors/Engineers, etc., instructing them to keep specific detailed records of the event. The key to all this is good daily communications between staff in the office and supervisors out on site. Staff must be trained to understand the contract terms and be able to identify potential claims and request and/or keep records. The main reason that suitable records are not kept or claims are not pursued is due to poor training and attitude. If supervisors or engineers believe that it is always someone else's job to make records or identify potential claims, it will not happen. It should be the responsibility of all staff not just to build projects but also to ask themselves the question, 'How do we get paid for this work?' Remember, it is a simple economic fact that the essence of any construction company is the need to make money. Building the project may be how that aim is achieved, but if recovery of additional expenditure is lost due to poor record keeping and lack of timely management of potential claims, the project will lose money.

5.6 Missing Records

If some of the detailed records are missing, there are other means of identifying the additional work and time required for it. An instruction may consist of a new drawing, and this can be used to note the date received and approximately when the work was done,

using the detail within the drawing to quantify the amount of work required. This calculation can provide a reasonable duration for the additional work derived from observed production rates – for example, use of the ‘measured mile’ approach, or from recognised databases and price books, or by using industry norms.

5.7 Notices

Notices are fundamental to all claims. All forms of contract require that a notice of claim be served, and what also must be understood is the amendments made by the parties (normally by the Employer) to the terms of any standard form contract. What the contract calls *claims*, or *extra items*, is irrelevant; the procedure is common to all forms of contract. They require the Contractor to give notice and then submit records, followed later by a detailed statement of claim. This is the action irrespective of whether the contract calls such matter claims, variations, change orders or compensation events. A notice does not have to be complicated or legally drafted; a simple letter setting out the bare facts of an event and stating that the Contractor is intending to claim additional payment and/or extension of time is all that is required. It is now just as common for such notices to be issued by email. However, the contract may stipulate what constitutes a valid communication between the parties. A more detailed analysis of the event and which clauses do or do not apply can be carried out separately, and the most important action is to issue a basic notice of intent to claim.

5.8 Time Bar Provisions and Timing of Notices

Many ‘time bar’ provisions are a true condition precedent to receiving an extension of time or additional payment, and it is essential to ensure that such prescribed provisions are met. This is true whether the event complained of is covered by the conditions of contract, or whether it arises from some breach of contract by one of the parties. Further, it is becoming more common to find that there are pages of amendments to the standard forms of contract, including critical changes to the usual notice provisions, where prescriptive or more onerous ‘time bar’ clauses are inserted with much shorter periods for notification of intent to make a claim. These clauses act as a condition precedent and keep the Contractor from claiming if he does not comply with the more onerous notice provisions. The most important element of the contract to review is the prescribed period for giving notices and the period following such notices when details, records and claim submissions must be made, and whether these matters constitute an effective time bar or condition precedent to making a successful claim. The shortening or imposition of a stringent time period for the giving of notices for claims, and the insertion of a punishment for failure to give such notice that allows the claim to be rejected, must be fully understood, and a system set up to ensure that notices are given as soon as problems and variations occur – otherwise, it may be too late to act. While good management of claims and notices is essential, these ‘time bars’ impose an obligation on the Contractor to give timely notice of intent to make claims or suffer the consequences. This type of amendment is generally sold on the basis that it stops late notification of claims and sudden surprises for the Employer long after the works are completed. While

this makes sense and is in line with the good management of a project, the reality is that such terms are inserted for the sole purpose of making it more difficult for the Contractor to get paid for delays and additional costs caused by changes that occur during the construction. Where the parties have agreed to such terms, a Contractor cannot later complain that the terms were unreasonable and offend the established principle that one party to a contract cannot be allowed to benefit from a situation of its own making (i.e. by the imposition of variations or other stoppages affecting the Contractor's progress). As a defence to such onerous conditions, some Contractors set up a standard form 'letter of notice' containing a bare notice of intent to claim additional payment and any extension of time arising from the event cited. Such notices are then issued for each event that occurs – for example, each site instruction, new drawing, late response to requests for further information, stoppages, weather, unforeseen ground condition encountered, etc. While the issuance of dozens of notices may seem extreme, it may be the only method by which the Contractor can keep its rights to make claims for delay and additional costs alive in the face of draconian time bar provisions. Of course, such blanket notice action can become unwieldy or upset the Employer or its advisors, but it must be tempered with the knowledge that the Employer was the one benefitting from the imposition of the time bar with the intent of avoiding claims caused by changes for which it or its agents were responsible. As such, the Contractor is left in the situation where compliance with the notice provisions must be ensured to retain its entitlement to extensions of time and additional payment, and not worry about the effect such action has on relationships.

5.9 Disclaimers and Reservation of Rights

To ensure that the Contractor's rights are preserved, it is paramount to serve a valid notice, within the prescribed period for such notice and addressed to the correct person and address as stated in the Contract; it should also be copied to the site representative. Further, many Employers try to reduce the likelihood of later disruption claims by inserting a waiver clause on their agreement sheets for variations, change orders, work orders, etc. This would contain wording that states the agreed settlement is in full and final settlement of all direct and indirect costs associated with the variation. Depending on the precise wording on the agreement form or any amendments or reservations noted by the Contractor, such statements could result in a waiver of rights to pursue further payment, as the matter would have been settled by accord and satisfaction. If the Contractor is unsure, it should either seek legal advice or add a statement that it reserves its rights to pursue a subsequent claim for disruption or extension of time once the full effect of the variation has been investigated. The problem is often that the Employer will not release any payment for additional works until there is a signature on its prescribed agreement form, thereby leaving the Contractor in an awkward position where the change involves considerable additional work.

6

Programmes

6.1 Planning and Programming Techniques

6.1.1 Introduction

6.1.1.1 Why Prepare Programmes?

The management of every endeavour requires some form of planning to make it a success. The purpose or 'art' of planning is to organise the work or activity to be done to show what is to be done, by when, by whom and its logical sequence or order, one activity after another until the project is completed. In its basic form, a programme can be little more than a list of key activities to be done and when they need to be finished in order to meet the project deadline. It can then go further and schedule materials and equipment to be purchased, manufactured, delivered and installed, showing the times required for installation. Any major project needs to have a realistic programme that can be used to schedule and monitor progress so that, where possible, adjustments can be made to ensure deadlines are met. The old adage that 'failing to plan is planning to fail' is as true today as it was when originally coined. Without some form of plan or structure to an endeavour, the resulting performance will be haphazard and costly.

6.1.1.2 Methods

The idea of representing a plan for managing work activities as a graphical chart was first developed by Henry Lawrence Gantt (1861–1919). Gantt pioneered the idea of creating various charts to plan and track progress. The bar chart was in existence for some time before Gantt, but he developed a form that showed the planned production against which he plotted the actual production each day, thereby identifying the production losses. The bar–line chart was not the only form of management chart that he invented, but it is the one for which he is most remembered.

Planning now features in almost any form of business activity, from software design to setting up an exhibition. All projects require forward planning to schedule key events, ensuring that work progresses smoothly to a conclusion. Often programmes are prepared to include for planned development meetings, their timing and deadlines for finance arrangements, together with the planned dates for the organisation of sales or marketing venues, etc.,.

The most important function of most planning engineers is to review and update the programme and report on progress. This is often referred to by the grandiose title of 'project controls'. However, deciding what to monitor and how to represent this against

the planned intent is a skill in itself. If too general a basis for monitoring is used, the result can be an unreliable measurement of production achieved. For example, on a complex, large, reinforced concrete project, consisting of several large bases and numerous smaller bases for structures that contain a mixture of mass concrete infilling and more detailed base construction, choosing to only monitor concrete volumes achieved will result in a false picture of the overall project production. Where there is a varied mixture of work elements, a choice of more than one item to monitor will allow a more balanced measurement of progress and production achieved. It is better to derive a comparison perhaps based on the measured quantities for concrete and formwork rather than just the bulk measurement of concrete poured. This is because, on any construction project, the ratio of concrete to formwork and rebar will provide some idea of the complexity of the project design.

This information is needed to keep the plan alive, and monitor areas where work is behind or ahead of schedule, so that adjustments can be made to the operations or resources to maintain progress. The framework or layout of the programme needs to be in a simple format that everyone involved in the project can understand. An elaborately detailed, highly complex programme, running to tens if not hundreds of pages that no one can understand or follow, diminishes the value and role of the programme for the management of the scheme. While a highly-detailed programme running to thousands of activities may allow a source of delay to be identified, the key objectives of the programme are lost. Therefore, it is essential that a summary programme is prepared to ensure that the overall planned intent or the 'big picture' in terms of the sequence and timing of work.

Careful planning helps avoid last-minute panics or at least reduces them to a minimum; without planning, any project is doomed to failure. Chaos or 'panic management' will reign if no thought has been given to the logical sequence and timing of activities in a programme that has clearly defined objectives and is based on achievable durations that can be met. When programmes were hand drawn, there was always one overriding element that controlled the layout and number of items shown on the programme; that was the size of the piece of paper – usually A1, A2 or, at most, A0 size, this was a suitable size for mounting on the Site Manager's wall for ease of reference. The problem created by computer-generated charts is the unlimited number of items and pages that can be produced, all of which tend to confuse and clutter the overall objective and mask the planned intent. Programmes can now be created with literally thousands of activities – for example, software such as Primavera can handle programmes with almost unlimited activities. I have seen charts with more than 10 000 and up to 20 000 activities. This becomes a nightmare for management and understanding of the overall plan. Too many activities obfuscate rather than clarify the objectives. A programme should be capable of being printed out and pinned on the wall, such that the overall objectives are clearly shown, so that progress can be observed and monitored. This enables identification of problem areas and critical delays, so that decisions about corrective action can be made.

There are always complex projects that need to be programmed in a lot of detail in order to ensure that the work can be completed in the required time. However, a simplified summary is always required, and a project notebook or method statement should be prepared that details the perceived critical path and the key milestones leading to completion of the project. A statement detailing these key events will enable people to:

- Assimilate the overall targets.
- Understand where the problems lie.
- Make informed decisions on resource levels or other mitigating measures that may be considered.

The planning engineer may need to expand a basic framework into thousands of activities to be confident that the programme is founded on a sound basis. However, the planner should also set the programme up for summarisation, so that it can still be boiled down to a single high-level summary chart for ease of reference. The danger of having too many activities, all linked in some way, is that this will make the programme so complex and unreadable that even the planner producing the chart can get lost as to which activities are linked to each other and what the driving events are that control the critical path. A common mistake is to keep probing deeper into details and expanding the original outline concept to the point where summarisation becomes impossible without losing the planned intent. Therefore, if more detail is required, it is better to keep separate subsection programmes for elements of the work, or particular teams to manage, rather than clutter the overall programme with too much detail.

The golden rule of all planning, as with all endeavours, should be to follow the 'KISS' principle – Keep It Simple Stupid (KISS) – that is, simplify and summarise for easy dissemination and understanding of the plan by the site construction teams.

A programme must be based upon realistic targets and a logical sequence of events, otherwise chaos will reign: unrealistic targets that are not achievable have the opposite effect, and demoralise the workforce. Personnel need to know what they are supposed to be doing, and where, when and how long they have to do it. If targets that are set by a programme are too tight, the result is that none of them is achieved. When this happens, the supervisors and workforce cease to believe in the programme, and it becomes merely an unrealistic management wish list and is treated as a 'joke' – thereby defeating the whole objective of planning. Whether targets set at the outset were reasonable is not always relevant: things change during the lifetime of a project. The skill in the management of a project is to ensure that reviews of the programme are held regularly, so that targets can be amended if necessary and the programme kept 'alive'. This review should be a team effort to ensure that all managers are aware of the focus and purpose of alterations to the programme and the revised (if they are revised) objectives to move the work forward. The duration allotted to activities on a programme is a calculation of the net time needed for that work using the estimated quantity of work and production norms for that type of work. This is usually based on the anticipated resource levels and relevant production norms for that type of project. These resource levels may have been balanced to ensure there is a reasonable continuity of work for the personnel deployed and the project flows logically to its conclusion. However, unplanned events occur in any project: some activities take longer, equipment malfunctions, staff fall ill, computer systems crash and additional work arises due to changes in the scope of the project. In these circumstances, the purpose of planning is to make adjustments: it may be necessary to increase resources, take other measures to adjust the duration or change the sequence of the programmed events in order to meet the project deadline. In construction contracts, changes to the scope sequence and duration of work are commonplace due to a variety of reasons. The programme has to be modified to reflect these changes to show how the project is progressing and the effect of changes on the planned completion date.

6.1.1.3 Key Aims

Always remember the five P's:

Proper Planning Prevents Poor Performance

The purpose of a programme is to provide a management tool that sets the following key aims:

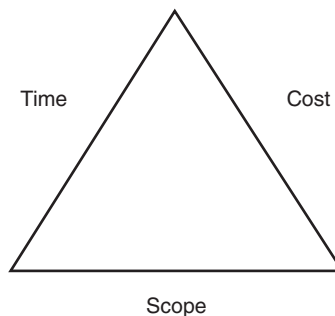
- To establish the goals and key elements necessary for completion of the project to meet the target cost and contractual completion date.
- To determine the duration and feasibility of the construction period relative to the scope of works, cost and resources available.
- To facilitate good management of the project by regularly being able to update the programme to reflect progress achieved, and thus highlighting differences between planned and actual performance.
- React to situations and adjust the plan:
 - For earlier (or quicker) completion of tasks.
 - For problems and delays that have occurred.

These aims are achieved by one of the following means:

- Using planning techniques to describe the key elements of a project, set them out in a clear manner, and ensure that the programme is understood by the site management. This plan should indicate the intended sequence, timing and dependency of one activity upon another and their individual role in the overall scheme.
- The preparation of budgets and cost controls based upon the programme and then monitoring those elements as work proceeds.
- To identify and predict the effect of changes to a project (either in the form of a revised completion date or alterations to the budgeted costs), and to assess the risks involved in making those changes.
- To set out any key dates for provision of design information or approvals.
- Record and report delays to operations and their impact on planned completion. Do this by monitoring production and identifying problems that may cause the project to overrun unless corrective action is taken.

6.1.1.4 Main Elements of a Programme

The key elements of a project plan can be considered as:



This triangle represents the relationship of scope to time and cost. If the scope of works is increased, it will affect the time for completion and cost of a project. If a reduction in the specified scope or work content occurs, a similar reduction in time and cost may follow. This is the essence of programmes, and why they are used. However, many projects never have a programme. For example, 'jobbing builders' are unlikely to plan their work using a programme. They generally make a physical inspection of the site/work required and 'guesstimate', from their own experience, the time and materials content of the work to be done. However, when dealing with medium-large-sized projects, which involve the management of many different trades and specialist sub-contractors that all need to be controlled and managed, a detailed plan of work is required. Starting from the premise that the need to plan and schedule the works in a logical order to enable efficient construction, with as much continuity of work as possible and minimising the number of return visits to areas, proper detailed programming is a fundamental element of any modern construction project.

6.1.1.5 Choice of Programming Technique

Having determined that a programme is required, the next hurdle to overcome is what form or type of programme to prepare. There are numerous planning techniques in use in construction, and each has its merits. However, the choice of what format the programme will take may have more to do with company policy, contract conditions or personal preference/experience than merely choosing the 'best' system suited to the project at hand.

6.1.2 Types of Programming Techniques Available

I will now review the various techniques and types of programmes available, and their usage. There are many forms of construction planning techniques available to depict the order and procedure of the works. The sequence and method of construction adopted may not be solely of the contractor's choice; much of the construction sequence and logic is dictated by the design, site layout and access constraints of the building/structure/scheme itself.

When preparing a programme for a contract, personal knowledge of the technique or the design of the scheme often dictates the type of programme used. The planning system adopted may be computer-based or hand-drawn (as all programme charts once were). However, for our purposes, we shall assume that the majority of programmes required in the twenty-first century will be generated by some form of computer software. The main advantage of computer-generated bar charts or networks is the high speed of updating that is possible without the time-consuming process of redrawing the programme from scratch. However, the problem with computer generated programmes is the temptation to delve into more and more detail as information becomes available, making the programme larger, more cumbersome and unintelligible to all but the planner who created the programme. Once too much detail is entered, the essence of the programme is lost as a management tool, since it cannot be grasped without careful summarisation of the information.

6.1.2.1 Hand-Drawn Bar Charts

At one time, virtually every construction programme consisted of a hand-drawn bar chart. Some construction contracts are still programmed by hand. With this approach,

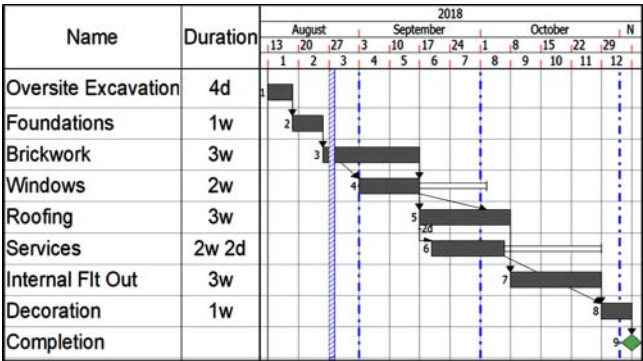


Figure 6.1 A simple bar chart.

there was no need, or often no attempt, to show any constructional links or logic. Often, a simple bar chart is chosen, because that is the preferred technique within a particular company, or because the planning engineer is not familiar with alternative types of programmes. This is the most common form of programme system in use. A bar chart is a graphical depiction of a programme or schedule in which bars representing activities are distributed across a timescale according to their scheduled dates. The length of each bar is also scaled according to the timescale, as indicated in Figure 6.1 a simple bar chart showing logic links.

6.1.2.2 Logic-Linked Bar Chart

These were originally introduced as hand-drawn bar charts showing some of the logic or relationships between activities by means of a simple line drawn between them (sometimes coloured to indicate a common resource). Such charts were the forerunners to the graphical, computer-driven charts produced today, where the logic links can be turned on to the relationships between activities.

6.1.3 Updating/Monitoring Hand-Drawn Programmes

Further, there was no way of updating the programme other than re-drawing the whole chart. Re-drawing was rarely undertaken, unless it was felt that the project was so delayed or advanced as to render the monitoring of progress against the original chart useless. Progress monitoring on hand-drawn bar charts was traditionally achieved by marking the programme showing work completed in some graphical manner.

6.1.3.1 Pins and String

- At the progress update or data date, a line is drawn down the chart at the end of each month. The actual progress on each activity then involves sticking mapping pins in each bar to represent the progress achieved (e.g. the amount of that bar completed).
- A piece of string is tied to the chart from a pin representing the ‘update’ date in the dateline at the top of the chart and linking it to each of the progress pins to show work ahead or behind schedule. This could also be produced using ink lines drawn on the chart.

- A variant of this system was to draw a second line down the chart and along each bar to indicate where progress was as compared to the date-line datum rather than use the pins and string.

6.1.3.2 Admirals Ribbons

The chart is coloured to represent work completed in each period, using a key colour on the top dateline of the chart to represent the month or week being monitored and using this same colour to hatch in the proportion of work completed on each bar line. This became known as 'Admirals Ribbons' because of its appearance (i.e. the similarity to military campaign ribbons).

6.1.3.3 Progress Tabulation

A table or schedule is prepared to show the percentage completed against each activity on the programme. Each week or month, the planner or site manager would assess progress on each activity on the chart and report progress either (i) as a percentage complete, or (ii) as a number of days or weeks ahead/behind schedule table.

6.1.3.4 Planned Project Management: Progress Monitoring

One straightforward method of assessing progress achieved against that planned is to perform an activity counting exercise. This system was once called 'Planned Project Management'¹, and basically consists of counting the activity days per week as shown on the planned programme and comparing this number to the activity count in days per week calculated from the as-built (or updated/progressed) programme, including items for delays suffered and additional works executed. Having derived the number of activities per week required to be done by the programme, the as-built (or updated) schedule can then be assessed in the same manner and the actual number of activities achieved per week calculated. This method of activity sampling and counting is sometimes called 'CTS' ('Count the Squares'), and, while this may seem a very basic method, the 'S' curves generated are a very good measure of the progress achieved against the planned. It also shows the input in terms of activities done per week. This can identify that the Contractor had provided the resources necessary to meet the planned activity count per week, only to have the progress impacted by the additional works and delay events, resulting in slippage against the planned deadlines.

6.1.3.5 Computer-Based Programmes and Progress Updates

Where the programme is computer based, it still needs to be updated to show progress achieved at each reporting point. While this can be entered directly into the software package, it is still worth creating a schedule (using Microsoft Excel or similar) that records the percentage completed or the remaining duration of each activity. This is sometimes a contractual requirement for submission to the Employer each month as part of the Contractor's Report. Once the schedule is prepared and reviewed, the progress noted can be entered into the planning software and the slippage against the baseline programme together with any impact on the completion date or dates

¹ Planned Progress Monitoring was a system adopted and published by the Professional Practice Group of the Directorate of Quantity Surveying Services of the UK Government Department: Property Services Agency in 1979.

observed. This will allow remedial action to be taken to see whether a delay can be recovered or whether an extension of time is required if the delay is caused by a change or other Employer delay event.

6.1.4 Critical Path Analysis

Critical path is a term used when referring to a project programme, which has been defined as:

... the sequence of activities through a Project Network from start to finish, the sum of whose duration determine the overall project duration – *Mirant Asia Pacific Construction Hong Kong Ltd v (1) Over Arup and Partners International (2) Ove Arup and Partners Hong Kong Ltd* [2007] EWHC 918 (TCC).

Systems that displayed or allowed a calculation to be made of the critical path were then introduced. These systems fell into two main categories:

- *Critical path network*: Arrow diagrams using circles to depict start and finish duration information and connecting arrows to show activities and their logical links.
- *Precedence network diagram*: Activity boxes containing the key duration and activity information with only the logic links shown between them – for example, arrows, which also indicate lead and lag requirements

These systems evolved as simple hand-drawn logic diagrams as shown in Figure 6.2 with the critical path being calculated longhand by a mathematical forward and backward pass through the network to determine float and criticality. They were not the clearest of planning systems and depended on draughtsmanship for clarity. The larger the network and increased number of links began to confuse the reader as the diagram became unwieldy. As a result, when the network and logic links diagram grew in size

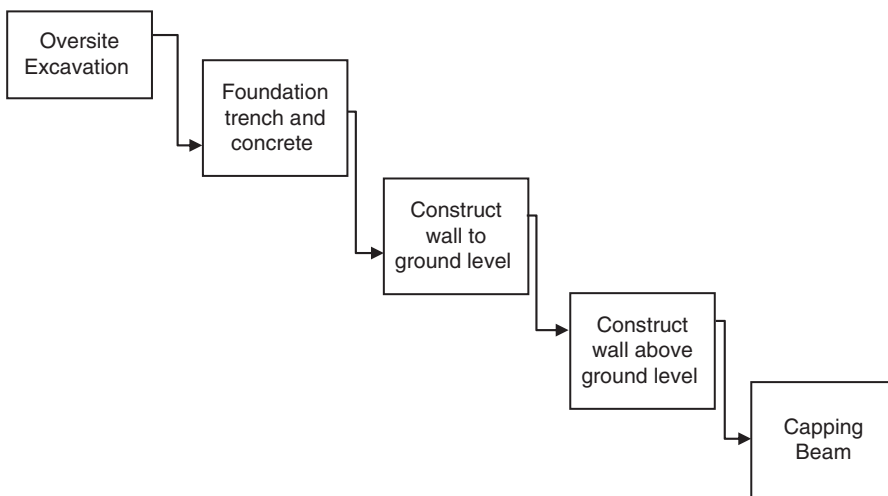


Figure 6.2 Simple Network Diagram

and complexity, the diagrams were often transformed into a bar chart. This was to aid understanding of the sequence of construction, since, the more complex and interlinked the activities and network diagram became, the more difficult it was for site supervisors to comprehend and pass on the work plan to the resources.

The disadvantage of hand-drawn graphical bar charts was the time it took to update them. Consequently, they were only updated as the last resort, as the whole network diagram and the resulting bar chart depiction of it had to be completely redrawn. The disadvantage of computer versions is the almost limitless number of varying updates that can be printed at the touch of a button. Too many options and complicated diagrams obfuscate rather than clarify information, and the clarity of the final chart is reliant upon the skill of the planning engineer.

6.1.5 Computer-Based Systems

Critical path analysis systems really became useful when a computer was used to do the calculations. With the aid of computer packages, both precedence and arrow network systems were used to create simple bar charts as a representation of the logic diagram in its simplest form. The most common forms in use today are based on the precedence network system. These logical, mathematical systems are ideal for computer production of the programme and have the ability to quickly produce updated charts reflecting the progress achieved. One of the first of these computer-aided systems was developed in the United States for the planning and development of the Polaris project. It was called 'PERT' (Programme Evaluation and Review Technique). This precedence planning system has subsequently lent its name to all forms of precedence network diagrams. Unfortunately, until the 1980s, not many construction companies, other than very large organisations, had computers, and certainly not on site. Construction planners found that displaying a critical path network diagram was ideal for showing the order and logic of a programme, but they do not easily show this plotted against time. To indicate the time allowed and the next activity, a bar chart is the simplest diagram to prepare for two reasons:

- First, the bar chart is easy to understand, and most site managers and supervisors are used to this type of presentation.
- Second, the bar chart is easy to monitor (e.g. back to basics – mount the chart on the wall and use 'pins and string' to record progress).

With the advent of the personal computer, it became possible for planners to enter the precedence network or Critical Path network onto the machine. The computer then calculated the critical and non-critical activities and plotted the result as a bar chart. Early plots were not very graphical, consisting of 'X' characters to depict bars plotted against a timeline at the top of the diagram. These and similar systems are still used today in a similar format as when the first evolved, although the software is now much more sophisticated and user-friendly, and the resultant graphical bar chart print greatly improved. The main advantage of using a computer-based programme is the ability to update the chart with the progress achieved and changes due to variations or other events and predict a revised completion date, given the situation at any one time. To do this, the programme is updated to show progress achieved by entering the assessment

of work completed and then rescheduling the programme. Progress is entered in one of three ways:

- As a percentage complete.
- By entering the number of days worked.
- Changing the remaining duration of each activity to reflect the work still remaining (which may also update the overall duration of the relevant task).

The computer reschedules (re-calculates) the project based on the original logic and the progress achieved on site at the given date, and then displays the projected completion date and critical path. One matter that has to be reviewed is the impact of recorded progress and potential delays or additional work on the original programme logic links. Some systems warn the planner if the progress entered would render the original logic invalid, requiring a review of the logic. Whether the system is sophisticated enough to provide such warnings or not, the programme has to be inspected and the logic checked before the revised programme can be considered realistic.

The critical path is largely a mathematical function based on the construction or resource logic entered into the programme by the planner. Of course, it is possible to 'tweak' the critical path to suit some 'commercial' assessment of a particular contract, but this is usually done after the programme has first been established and the 'real' completion dates and critical paths calculated. Further, to the experienced eye, this 'tweaking' would soon become evident as some activities would be far too short and others too long as compared to the general site progress. Alternatively, the planner may have chosen scheduling options within the software such that any activity with less than 2 weeks of float (or more) was to be shown as critical. To avoid arguments, many clients now insist that the programme details and calculation parameters be submitted with the programme. That is, they stipulate that the logic, duration, fixed or milestone dates inserted, scheduling options chosen, etc., must be extracted and tabulated for all to see (in some cases, they require an electronic version of the programme and matching software with which to view it).

6.1.6 Time Location Chart

The time chainage/time location chart originates from a project management system known as line of balance or elemental trend analysis, which is used on projects that are repetitive and require strict trade sequencing, that is, factory production lines, housing estate construction, etc. The chart highlights the importance of activity completion, production rates and relationships between selective activities. This system was developed in the construction industry for linear projects such as roads, railways, tunnels and pipelines.

A time location chart depicts the work as a plan of the contract on one axis and the time scale on the other. It is mostly used for roadworks, railways or pipeline contracts, as these are linear-activity-related programmes. Some planners always put time horizontally and distance or plan outline vertically; others draw the chart the other way round. It is largely a matter of scale and readability. By setting an outline plan of the works on one axis and time on the other, the duration of each activity and direction of workflow is then drawn. This is, basically, a line between the two points, sometimes drawn as a particular shape and colour coded to indicate the category of work. The

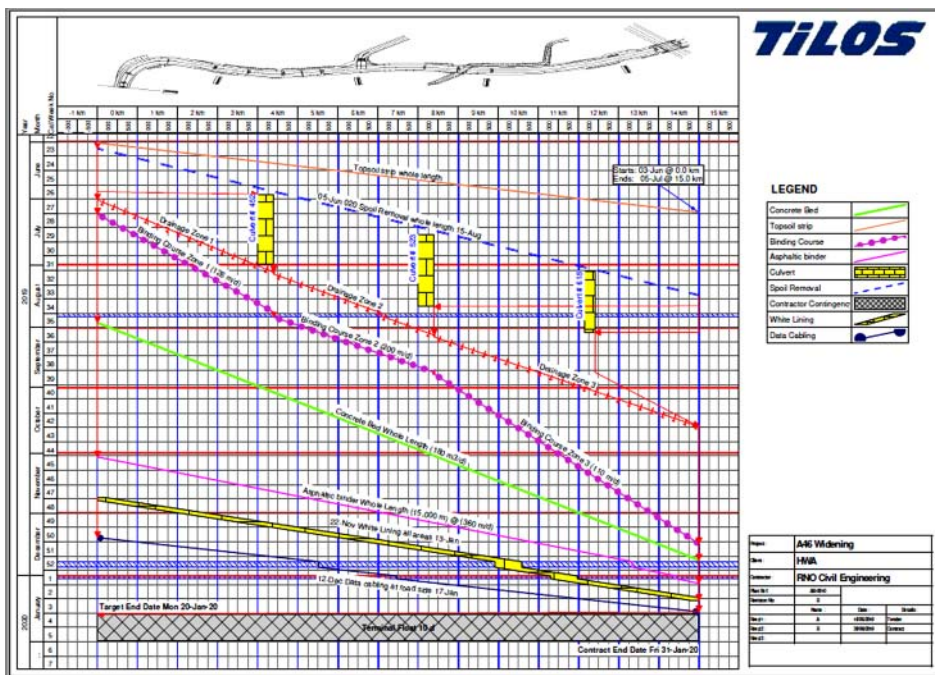


Figure 6.3 Example of a time location chart

chart depicts not only when work will be done but also the order and direction of work. Other restrictions can be depicted as shaded blocks, and milestone dates can be outlined as a rectangle encompassing the relevant activities necessary to achieve the goal. To make the chart more artistic, some planners prefer to show some activities as lines and others as blocks or triangles. The advantage of the time location programme is that it shows the logic sequence and timing of the various activities graphically. The direction of workflow and any physical restraints can also be indicated, which is often of primary importance on linear projects. The disadvantage of these charts is that they are nearly always hand drawn and cannot be updated quickly. However, there is now computer software available (see Figure 6.3) that can plot time location charts resembling the hand-drawn versions, with the added advantage that they can be quickly updated. A time location chart tracks the work activities (by chainage or distance), showing the work activities pictured against a distance scale on one axis with time plotted on the other.

6.1.7 Line of Balance

Line of balance is very similar to time location, in that it produces a chart with time on one axis and work categories on the other – for example, house types or numbers, flat numbers or floor numbers. It is sometimes debated which came first, ‘line of balance’ or ‘time location’, but, for all practical purposes, they are similar techniques. The difference is not the style or presentation of the technique but the type of project and uses to which it is put. The system is commonly used where key resources are at

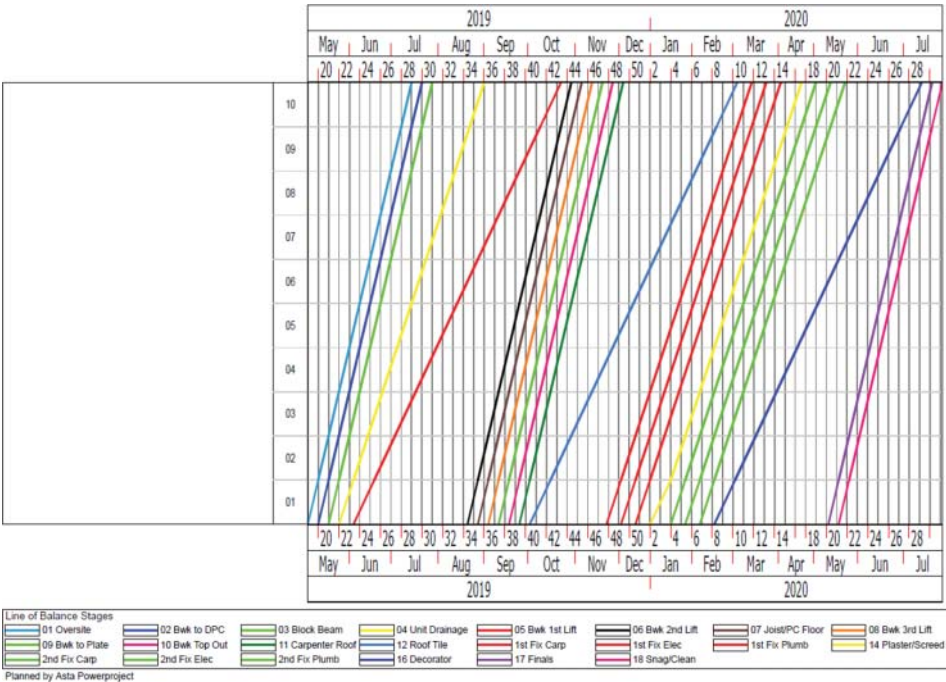


Figure 6.4 Example of a line of balance chart

a premium and maintaining the order or sequence of work between elements is key to the achievement of the programme. For example, a housing or hotel contract, especially refurbishment work, which is usually dictated by access or possession dates, requires hand-over sequences and key trades. Efficient construction of these contracts relies on the time lag or relationship between the slower and faster trades (e.g. between the wet and dry trades). This has to be finely balanced because, if the sequence between the key trades is lost, the contract will suffer disruption and delay. The same computer software developed for time location graphs can similarly produce a line of balance chart. For council house refurbishment or housing contracts, a line of balance technique tracks the key resources and the house numbers/locations on one axis against time charted on the other axis. This type of chart is visually similar to a time location chart (see Figure 6.4 below).

6.1.8 Short-Term Planning

6.1.8.1 Daily/Weekly Target Schedule

In its simplest form, this would consist of a list of work to be done looking no further than a week ahead, with a numbered list of work items to be completed each day or for the forthcoming week. This is often used for short-term detail to enhance the overall project schedule. Sometimes, these short-term programmes are prepared as simplified bar charts

6.1.8.2 Daily Graphical Output Chart

One alternative to a typed list is a daily or weekly production graph that shows the output planned for each week and which can be monitored by marking the graph with

units completed, sometimes with the addition of graphics such as ‘smileys’ to show the impact that performance has on tender expectations. These charts show, on a simple daily graph, the production attained versus the target set. This type of chart can be drawn for a day or for a whole week’s work, or for an individual operation. These are especially suited to repetitive operations such as a structure with numerous identical concrete pours or for drilling or piling operations where the number of piles per day or linear meterage can be set as one axis. Where these charts are used, they are a superb record of performance anticipated versus actual achievement. If the reasons for non-achievement are added to the chart, they are invaluable as a means of demonstrating production losses sustained and the reasons they occurred.

6.1.8.3 Pictograms

Another system used is the pictogram approach, where simple two- or three-dimensional sketches of the work to be done are prepared and marked up or coloured in to show the date for completion, progress achieved and/or work areas remaining. These are produced from reduced copies of the contract drawings marked to show progress and planned intent in pictorial form. The work planned for that day/week can simply be coloured in on the drawings, and the work actually achieved can similarly be coloured to indicate built progress. These are not strictly programmes but a visual representation of the planned operations within a limited timescale in a simple format that can be quickly disseminated to the workforce and monitored. This is especially useful on multi-storey buildings where floor plans can be marked to show the concrete pour sequence and anticipated durations, or showing the fit-out trade sequences each week.

6.1.8.4 What is a Programme?

A *programme* is a list of activities to be done, the time required for that work and the order in which the work is to be done. The duration of activities and items on the programme are often based on performance calculations or ‘norms’, together with experience to derive activity duration. The method of construction and sequence are determined by a combination of the design of the project, the chosen sequence or planned order of construction, the usage and numbers of cranes and other key plant items (prime movers), together with logistics – that is, access and egress to the works for material deliveries and resources.

6.1.8.5 What is the Programme’s Contractual Status?

Planning and programmes for construction sites have become commonplace, and it is normal to find that a programme (and perhaps even the format of the programme) is specified in the contract documents – for example:

- Incorporated within the Preamble to the Bill of Quantities (typical under the JCT forms of contract).
- Required by a term, or terms, of the contract (e.g. under the Institution of Civil Engineer’s form of contract at Clause 14; FIDIC Clause 8; and the New Engineering Contract (NEC) form of Contract at clause 31).

Some contracts stipulate the status and use of the programmes, and others only require a programme to be prepared and submitted for approval. Even when a programme has been approved, it may not enhance its status under the terms of a particular

contract, but it will form the basis of how and when the works will be constructed and when they will be completed.

How many of the Client/Employer's team (Architects or Engineers) really understand planning and programming techniques and the importance of meeting key dates or maintaining a logical progressive construction sequence? All too often, a programme is requested and prepared by the contractor and presented to the Client's Contract Administrator, who then says '... great, smashing, just what I needed', and then pins it to the wall and never looks at the document again! Many contractors' Planning Engineers would argue that too many of their own Site Agents do the same! However, neither statement is completely true or fair, but it does underline the common misunderstanding of programming and planning, and its failures.

However, a warning here about the status of the programme in terms of its 'weight' when under later review in assessing claims and in Adjudication or Arbitration proceedings. Although the preparation of a programme may be a contractual requirement, the content, style and use of the chart are rarely described in the contract document. The programme is always the Contractor's responsibility, and the style and technique used to present the programme may also be of his/her choice, but whether it is followed and what its status is under the contract is not as clear as often believed. The requirement to produce a programme does not make that programme a contract document unless the tender instructions called for a detailed programme to be prepared and submitted as part of the tender, and this document is then referred to and 'bound-in' to the contract. However, the programme is invariably used as the basis for delay claims and monitoring progress. For example, under the FIDIC forms of contract, the Employer's personnel are entitled to rely on the programme when planning their activities (FIDIC Clause 8.3). The NEC form of contract is more specific and stipulates when and if the programme should be updated (Clause 31), and its use when assessing compensation events that result in a change to the completion date (Clauses 62 and 63).

Generally, a programme is a speculative document indicating nothing more than the intended (planned) order, sequence, timing and duration of operations, with little detail of the intricacies of the project. This type of programme invariably needs to be expanded and monitored for day-to-day management of the project. It is also relevant to note here that the amount of detail required depends on the type of work and the subject being monitored, since much can change between preparing the outline programme and the eventual 'as built' result. The level of detail that is shown on a programme may also be only a fraction of the effort that was put into preparing the chart. This would include a detailed examination of the drawings, quantities and specified or other contractual restrictions. Site layout, and how the work fits together in the most logical sequence, will have been considered in order to understand the project and determine the practicalities of construction. Some of this work will be purely a visual exercise undertaken by the management team; estimators, engineers, surveyors and planners will have input into the elements contained in the programme. Other elements of the programme will result from a more detailed assessment of the amount of work to be undertaken and the realistic resource levels required to do the work. These decisions are often changed and adjusted as the programme unfolds and the overall picture is appreciated. The programme will have been reviewed several times before the final document is published. Many Engineers expect a set of calculations that exactly represent the final version, whereas there may have been one set of calculations, which were then

discussed, and decisions made to adjust the chart taken at team meetings, and the 'arithmetic' would have been quickly finalised from the original concept.

Therefore, when disputes arise due to delays and a detailed examination of the planned intent versus the actual progress is undertaken, the basis of the programme may be called into question. However, too much emphasis is placed upon the content of bars on a programme, or sufficiency of resources. The facts of any delaying event need to be discovered first, and then the impact of this information on the actual progress at the time of the event has to be determined. It is not the impact of an event on a theoretical programme that is relevant; it is the actual delay suffered. In these situations, both sides are trying to defend a position that was probably never considered at the time of tender and certainly never anticipated by the original programme. The most important point is that, when disputes arise (during or after construction) concerning the impact of changes and delays, the basis of the programme and how it was prepared must be thoroughly understood – I will explain more about this concept later, in the section on delay analysis.

6.1.9 Preparing and Monitoring the Programme

Having decided to prepare a programme and chosen the type of chart to be used, the next step is to prepare the programme.

6.1.9.1 Content

The programme will consist of the estimated duration of the relevant activities together with the planned timing and sequence of work. Methods of construction, access and type of work tend to dictate the remainder of the programme logic, including the particular idiosyncrasies of the design. The durations are usually calculated from summary figures of quantities abstracted from the Bill of Quantities. Resource outputs and levels are estimated based on an inspection of the work and suitable gang sizes for the job at hand.

Planning a project also needs to take into consideration other key elements:

- Site access/egress and related constraints.
- Cabins, storage areas, location of off-loading bays, etc.
- Long lead-in periods and procurement of materials, plant and equipment to be installed – especially those elements where the engineer or architect expects to check and approve workshop drawings and fittings calculations.
- Horizontal and vertical transport of materials:
 - Tower or mobile cranes (type and location), together with access arrangements for the erection of craneage where required and crane utilisation schedules.
 - Forklifts trucks, tractors and trailers required.
- Resource levels and local labour availability
- Methods and sequence constraints could include:
 - The specified procedures for specialist materials.
 - The height at which concrete can be poured (e.g. the need for tremie tubes).
- Site clearance, demolition and treatment of the site prior to starting works (might involve dealing with contaminated material, etc.).
- Enabling works necessary to gain access to the site for plant and equipment (e.g. hard standings, car parks, haul roads, piling platforms, etc.).

- Scaffolding, shoring, sheet piling/cofferdams and other temporary works required.
- Planned visits for specialist contractors who require adequate notice for mobilisation.

As discussed under types of programme, planning and monitoring a project often involves more than one single overall chart for the contract. It is common to prepare short-term target programmes for individual elements together with materials call off schedules and lists of other deliverables that are needed, for example design approvals. Special attention is given to key deliveries/lead in periods for fabricated materials or specialist installations (e.g. lifts, overhead cranes, etc.), plus planned visits for specialist subcontractors (e.g. piling, terrazzo flooring, HVAC, mechanical and electrical installations, lifts, etc.).

One thing that is of no value is an unrealistically tight programme prepared with little thought to delivery periods and no calculations to check the validity of durations or integrity of the programme.

In summary, therefore, each activity that is entered on a programme must be based upon the planner's view of the work:

- How to tackle the operation (method and equipment constraints).
- The resources available and the likely outputs of those resources (may be affected by local situations and shortages).
- The anticipated start dates for specialist items and a realistic allowance for 'lead in' periods.
- Physical restraints and impositions (access from main roads, and traffic congestion or traffic management requirements).

The following is an example: It is of little use planning a 3000 m³ excavation to take 3 days if the access and traffic movement constraints imposed by the project make this impossible to achieve. If an excavation suffers from having limited access/egress for transport vehicles, this would limit the contractor to using four on/off road dump trucks carrying 8 m³ (when measured net 'in the solid') in each load, and perhaps (due to traffic constraints or distance to the tip) only capable of completing two trips per hour each on an average. If the contract also contained constraints about working times, perhaps only permitting road vehicle access for 8 hours a day, this would reduce the capacity for work output as follows:

This would leave a typical production rate of only 4 trucks × 2 loads @ 8 m³ per load = 64 m³ per hour achievable – at full stretch. In other words, 3000 m³/64 m³ = 47 hours work/8 hours per day = 6 days, and not the 3000 m³/100 m³ per hour at 10 hours per day = 3 days as the programme showed.

In other words, a sensible programme cannot just be based on a duration plucked from thin air any more than it can be based purely on a theoretical optimum output for a piece of plant. A meaningful programme must use realistic outputs and take due cognisance of any other physical restrictions on that output. Sometimes the estimator's notes for a project are used as the basis for the outputs, but often this is not possible since the works are heavily sub-let to specialist subcontractors, so the planner has to use common sense and experience to insert a duration that is realistic. This may be based purely on similar works on previous contracts or from discussions with prospective subcontractors. For this example, the excavation was the foundation of a new office block in the middle of a city. The output of the excavator may not be the prime mover in terms

of duration. The driving event may be traffic restrictions that operate to stop site traffic entering and leaving the site during peak rush hour traffic conditions. Returning to the preceding example: suppose the contract stipulates that transporting materials can only be undertaken between the hours of 05:30 and 07:00, 10:30 and 15:00, and after 19:00, up to a limit of 22:00 hours. If the governing local authority has insisted on the number of movements being limited to five per hour, the output of the excavator is entirely irrelevant to determining the duration of the excavation. The output/duration will be dictated by the number and capacity of trucks permitted per hour and the working hours permitted.

6.1.10 Degree of Detail in Programmes

6.1.10.1 The Outline or Tender Programme

Generally, a tender programme, in 'broad brush' terms, details the approximate duration, sequence and timing of the works, and is used for the coordination of the estimate and the preliminary items. Rate and outputs used for a tender programme tend to be empirical, but are sufficient to provide an overview and allow the potential risks and timing difficulties to be assessed. Many major contractors have their own database of anticipated outputs for various types of work – pouring floor spans or casting columns, basement excavations, etc. – built up from historical production records. Others may rely on well-known 'estimating price books/databases' to derive initial durations for operations.

6.1.10.2 The Master or Baseline Programme

Once a contract has been awarded, the Contractor usually prepares a detailed working programme or Master Programme for submission to the client. This programme usually (but not always) follows the tender plan, but is in much more detail. It is during this process that any obvious errors in the original programme, logic, sequence or timing are discovered and overcome.

6.1.10.3 Sectional Completion Programmes or Special 'Restricted Possession' Programmes

For example:

- Railway operations during line shutdowns.
- Connections to 'live' water mains during shutdowns.
- Airport maintenance during runway closures.
- Maintenance projects for water plants or power stations that are usually carried out during a shutdown or 'outage'.
- Staggered completion of works phased to suit the Employer's access (e.g. refurbishment works, retail development, etc.).

6.1.10.4 Construction or Working Programmes

During construction, there are times when more detail than can be shown on the overall contract chart is needed to aid management and control of the works. This is usually achieved by:

- Detailed sub-programmes.

- Daily target sheets (also see pictograms given earlier).
- Weekly programmes.
- Monthly programmes.
- Three-monthly rolling programmes.
- Completion programmes.

6.1.10.5 Compromise

Charts must be in sufficient detail to allow accurate monitoring and control, yet simple enough to be understood in the overall concept of the works. A good compromise is to have sub-charts for detailed planning of certain elements that relate back to a summary bar on the main programme. To support and explain the printed programme, a project notebook should be prepared.

6.1.11 Project Notebook

As part of the planning process in conjunction with creating the programme, a project notebook (or, alternatively, a programme method statement) should be prepared. The planner should succinctly describe the work breakdown structure, key elements of the project and the intended sequence of working, with reasons why it was chosen. These are mostly practical considerations, such as beginning a major building with the excavation and construction of the deepest foundation or the most inaccessible foundation to avoid obstructing access and metaphorically painting oneself into a corner. Even where some time has been allocated for a specialist subcontractor's work, it is still necessary to identify this work and explain the presumptions supporting the duration and timing of that work – for example, piling or diaphragm walling construction that requires the mobilisation of specialist equipment with realistic duration for that work as negotiated with the specialist subcontractor. If this method statement is clearly written, explaining the planned intent, key objectives and how they were envisaged to be achieved, it will also explain the perceived 'critical path' inherent in the programme. It will form the foundation of the programme, making it easier to understand for all recipients, whether they be the Contractor's site managers or the Client's representatives. The key to understanding is clarity of objectives and a simplified summary that shows the main elements, how they interact and the 'calculated' critical path.

Remember – KISS.

6.1.12 Float in Programmes

Before going into delay analysis and the forensic reconstruction of projects, the thorny topic of float needs to be discussed and understood.

6.1.13 What is Float?

6.1.13.1 Consider the Following as a Simple Definition

Float is the difference between the duration of the various activities and the time available for the completion of that work. The absence of float on a programme

activity indicates that the particular activity is critical to achieving the completion date.

A definition by the courts was provided in *Mirant Asia-Pacific Construction Hong Kong Ltd. v (1) Ove Arup and Partners International Ltd. (2) Ove Arup and Partners Hong Kong Ltd.* [2007] EHC 918 (TCC) at paragraph 573.9 per Toulmin J.

Float, in the programming sense, means the length of time between when an activity is due to start and when it must start to avoid being on the critical path. Float can also be used to refer to the additional time needed/allowed to complete an activity over and above the shortest time that is reasonably required.

The difficulty with float is that too many people assume that the float shown on a programme is there to be used up at no additional cost. Absorption or use of float periods within activities always means that the work either took longer than planned or started and finished later than planned, and this invariably leads to additional cost in one form or another. However, the direct cost of work being prolonged beyond the calculated duration is different from entitlement to an extension of time situation. All programmes need to contain some degree of float; otherwise, the inherent 'risk of failure' is much higher. If the work is set out in such a way that the activities have little or no float, the resulting programme will show that nearly all the work is critical to completion. This situation would lead to crisis management and leaves no room for any errors or adjustments to the duration, resources or logistics involved.

A programme needs to show the logical sequence of work and allocate the correct level of resources to that work to meet the planned durations. If nearly all activities are set out to be critical, and there is no slack on the programme, how are any foreseeable events – for example, adjustments needed for changes to site or factory holidays, underestimated work duration, or plant and equipment servicing and breakdowns that occur..

6.1.14 Types of Float

Float is an amount or measure of slack time that is built into a programme, or which arises during construction due to actual performance. There are essentially two types of float: programmed or 'built-in' float and generated float.

6.1.14.1 Programmed (or Built-in) Float

This is part of the planning, and is derived from the inbuilt activity durations and logic links inserted into a programme and the mathematical calculation or 'scheduling' of the activities to derive a critical path. It is a calculated time value and based on the difference between the planned duration of activities as compared to the prescribed contract period. Float is the net mathematical difference between the longest or critical path to completion and the other non-critical activities that make up the remainder of the programme. This can take three forms: activity float, end float and added duration.

6.1.14.2 Activity Float

This is the calculated difference between connecting operations and is derived from the programmed logic and the activity duration inserted into the programme. Of course, the activity durations themselves may contain some float, or risk allowance (weather/frost/shutdown periods and risk, perhaps), depending on the type of operations involved, the time of year in which they are to be executed and the construction method adopted by the planning engineer.

6.1.14.3 End Float

This is generated when the overall (or sectional) planned completion occurs before the contractual or prescribed date. This 'float' is often shown as a dotted line between planned completion and the contractual completion date.

6.1.14.4 Added Duration

This is not strictly programme float. It is an assessment that the net duration calculated needs some addition for added perceived risks and difficulties. This type of float should more correctly be referred to as 'contractor's risk', and is comprised of a number of days added to an activity's net duration to allow for the 'risks' inherent in that particular operation.

Here are some examples:

- Winter working on weather- or temperature-susceptible operations, for example, wearing course and white lining on roads, epoxy flooring, brickwork, or concreting during periods when severe frost commonly occurs.
- Risks inherent in tidal work on sea defences during times when historically there are gales combined with particularly high tides in a given area.

6.1.14.5 Gained or Generated Float

This arises when the actual pace of construction is quicker than originally programmed, for example, an element of work that was planned to take 20 weeks but which actually takes 15 weeks. Therefore, it can be seen that 5 weeks float was gained during the construction period. This type of float can arise from three causes:

- The original time allowance/duration was generous.
- Additional or varied resources were employed, which resulted in a faster rate of production than originally calculated.
- Contract work was omitted, and the relevant programme activities deleted, perhaps inducing float in other activities and/or in the overall period.

6.1.15 Float: Its Effects and Who Owns It

6.1.15.1 Financial Implications of Float

Having thus considered what float is, we have set the baseline from which its implications can be assessed. Float is not something that directly contains any cost allowance from the point of view of the tender – it cannot, since it is a function of the programme and the contracted completion periods. The only time float will have affected the tender price is when the Contractor plans to complete the works before the contractual completion date, thus creating some buffer for contingencies, or 'end float'. Where this overall

construction period was used for calculating the preliminaries or job site overheads and establishment (sometimes called 'oncosts'), this will have had an impact on the tender price. This should only occur where the works may be weather dependent toward the end of the project (e.g. where the contractual date is December and the Contractor plans to complete in October before the bad weather takes hold), thus allowing additional time for finishing works in the predicted climatic conditions as a risk item – for example, epoxy coatings or other weather or temperature constraints that could be considered as a high-risk element. Remember that individual activity durations are calculated net (quantity of work divided by output per day/hour), and the float shown on the programme is purely a mathematical result of a forward and backward pass through the network (if the programme was network based). The programme logic and activity durations, therefore, allowed certain activities to have earlier or later start/finish times without them affecting contract completion, but no cost allowance would have been included for such slippage.

6.1.15.2 Ownership

Float is a product of the chosen methods, logic, sequence and activity durations. It is important to remember that the Contractor constructed its programme and any float allowance for likely risks that it has to bear under the terms of the contract. The Client cannot unilaterally use the float period indicated on a programme for the purposes of absorbing a delay of its making without considering the financial implications. This would alter the inherent balance of risks and might render the Contractor liable for a later delay for which the Contractor was liable and for which risk it had added the float (e.g. inclement weather, breakdowns, snagging items, etc.). However, who 'owns' the float and whether it should be retained by the Contractor may be stipulated in the Contract, so it is essential to review these terms before taking a stance on the ownership of any float within the programme. For example, under the NEC form of contract, the contractor clearly owns the float according to the wording of Clause 31.2.

Float was discussed in *Royal Brompton Hospital NHS Trust v Hammond and Others* [2002] 88 Con LR 1 at paragraph 246:

The architect should, in such circumstances, inform the Contractor that, if there-after events occur for which an extension of time cannot be granted, and if, as a result, the Contractor would be liable for liquidated damages, then an appropriate extension of time, not exceeding the float, would be given. In that way, the purposes of the clause can be met: the date for completion is always known; the position on liquidated damages is clear; yet the Contractor is not deprived permanently of 'its' float.

End float or the period from planned completion to the contractual date for completion was discussed in *Glenlion Construction Ltd v The Guinness Trust* (1987) 39 BLR 89, wherein the court decided that the ownership or reinstatement of a period of 'end float' had no basis under the JCT form of contract. However, as noted earlier, this is different under the NEC form of contract.

For example, a contractor inserted 3 weeks float in the structural frame construction to allow for wind delays and other climatic conditions affecting production or tower crane usage. If a variation occurs that delays the frame by 2 weeks, this may not be a problem. However, if the crane breaks down and takes 2 weeks to repair, the Contractor

would then suffer a 1 week overrun, partly caused by the use of float by the variation. If this were the only delay on the project, and the Employer tried to deduct damages for the 1-week delay to completion, any impartial observer would see this as very unfair and not in accordance with the intent of the contract.

Absorption of float by the parties has to be inspected and considered in a more pragmatic way than just arguing that the project owns any float and the first party to get there and use it is entitled to do so. Absorption of the float can also affect the balance and timing of resource utilisation. Many planners construct a programme using net durations, and then revisit the result to inspect periods of peaks and troughs, and adjust durations or links to even out these peaks and troughs. Often, at or near completion, projects suffer from numerous delays and snags that hinder the final handover, for which the Contractor is blamed. However, it must be examined overall, and sight is often lost of earlier delays caused by instructions and other changes that impacted the Contractor's performance when the final commissioning takes longer than planned. Therefore, in the 'as-built' situation, any delay to an activity will incur some level of additional cost irrespective of the 'float' shown on the original programme. Resources will have taken longer to construct the element of the works, and some loss of continuity between subsequent operations may have been lost.

For example, assume that there is a delay to one retaining wall to be constructed. The wall construction is delayed, but project completion may not be affected. However, there will be additional costs associated with the delayed wall construction in the form of resources (labour, plant and supervision) and temporary works (formwork, propping, etc.) being deployed for extended periods irrespective of any overall impact of the delayed work. The costs of delay, therefore, have to be considered at the point of origin rather than just globally in the form of additional site overheads. Additional hire of plant and equipment incurred is claimable against the additional work or delaying event that caused the prolongation of the activity. The logic behind making this the essence of the claim derives from the usual variation order clauses that require the additional work and its effects to be valued against the variation order. The practicalities of how and when this is done are a separate matter. Obviously, if the variation also causes a delay in overall completion, the cost of on-site and off-site overheads, etc., will also need to be calculated.

6.1.15.3 Problems With Programmes

Modern computer-based planning techniques should enable better control of projects due to the speed with which progress information can be updated. These programmes can be quickly updated with the actual progress achieved and then re-scheduled to show the predicted effect on the completion date or sectional completion dates of a project based on the recorded information. However, despite all the advantages of computer-based programmes, they also have one major disadvantage. Briefly, they provide the tool and opportunity to go into more and more detail until the originally planned intent is lost in a mire of information overload. Once this happens, the planned intent becomes lost or obfuscated by the extent of detail produced, and the programme serves no practical purpose for managing the project. There is no benefit to constructing an elegantly simple outline of the project and identifying its key objectives only to expand the programme to such an extent that this outline is lost or misunderstood. Having a programme with perhaps 2000 activities showing the key events and sequence

of work, clearly identifying the critical path and its dependencies, is better than having 50 000 activities all linked (or sometimes without all the required links), which when printed runs to hundreds of pages that few people can understand or comprehend. In theory, the master programme should be capable of being pinned on the office wall and understood. It can be updated with progress electronically or manually (marking data dates and sticking pins in the bars to view what activities are ahead or behind programme). This way, the programme becomes a management tool, which quickly enables decisions to be made where activities are ahead or behind schedule. Having to thumb through hundreds of pages of printed charts in a file is no way to manage progress or make decisions. The emphasis should be on clarity, so that the sequence, duration and timing of the major events are observed, and the critical path is obvious to all who use the document. An overly complex programme that only the planner can follow, or which can only be followed using the software version, is of little value as a management and monitoring tool. Just because the software allows almost limitless numbers of activities to be created does not mean that the programme is better if the degree of detail is expanded to the ultimate level. In fact, updating it becomes a job creation scheme by itself due to the number of activities and the time it takes to monitor each one. Worse still, an overly complex programme with thousands of activities is indecipherable by the site supervisors and foremen, who are then unable to follow its precepts. As a result, the project falls into crisis management or is run on the hoof, based on the whims or experience of the construction team, and the programme is ignored. The real problem is that modern software allows the planner to develop the activities in detail, which may be useful to support the overall duration of key activities, but always clouds the key issues. Part of the problem is the poor definition of the work breakdown structure before entering the programme activities. The various levels of detail should be rolled up such that the summary bars are capable of being understood and mean something. Having summary bars that stretch for months is just as useless as having summary bars that only cover a couple of days.

7

Delay Analysis

7.1 What Is a Delay?

The first issue to comprehend for any claim is to understand what constitutes a delay. While this may sound obvious, I have encountered people on site who do not understand the difference between delay and disruption. I had an occasion where a supervisor believed he was not in delay on one section of the works because he had moved the resources elsewhere to keep them occupied. Moving resources to avoid standing time does not remove the delay; it merely mitigates the production loss suffered. This is especially true where a contract contains sectional completion requirements, and, if a section is late, damages would be applied. It does not matter if resources are being used to progress work on another section; the delay has still occurred.

A typical search in a dictionary for a definition of *delay* will provide the following:

As a verb

- *It means to put off to a later time; defer, postpone*
- *To slow up, hinder or cause to be late; detain or restrain*

As a noun

- *the act or an instance of delaying or being delayed*
- *the interval between one event and another; lull; interlude*

In terms of a construction claim for delay, I prefer to consider the definition of *delay* as:

If while executing work or preparing for the next operation, an event occurs that stops that operation beginning, causes that operation to take longer, or stops work from continuing, then that task has suffered a delay.

There are two main forms of delay: critical delay, which causes a delay to the date for completion; and non-critical delay or activity delay, which causes additional costs but does not change the completion date. If any claimable event causes delay to the completion date of the whole or a section of the works, then that delay will entitle the Contractor to an extension of time.

As noted earlier, if, to mitigate or avoid standing time costs, the Contractor re-deploys its resources to another operation, this does not alter the fact that the planned activity was delayed. Whether such an event then results in a delay to the completion date is subject to analysis. Further, by relocating resources to other perhaps unplanned work, the regular and planned progress, timing and sequence of work has changed. Moving resources around a site is always costly, it may still involve some standing or unproductive time while the alternative work area is prepared – for example, setting out, provision of relevant drawings or delivery of material. It is therefore essential to keep records of such redeployment, together with a note of any standing time or additional plant or materials obtained to allow the unscheduled alternate work to progress.

7.2 Principles

Once all the records, notices, photographs and other supporting data is obtained, it will be necessary to consider the effect of the claim event(s) on the progress of the works. This is usually done using the programme as a guide to what was intended, identifying what changed and then determining whether there is an entitlement to an extension of time for completion. The programme can only be considered as a guide to what was planned, in terms of whether a delay impacted on the completion date; this must rely on an examination of the factual evidence. For an extension of time to be granted, a change or other event must cause delay to completion, which means it must fall on the ‘critical path’. However, it is unwise to solely rely on the original, computer-generated programme showing a particular critical path, as this may have changed during construction. The original programme may have been superseded by events, and the works may be in delay already for other reasons, causing the critical path to change – for example, due to late delivery of materials or equipment, alterations made by the site team to the timing or sequence of work, or because work progressed slower than planned, perhaps due to lack of resources.

The assessment of a delay must show how the event caused delay to the works. It is necessary to show what happened, and when, where and how it affected the work in progress. Activities impacted by a change or other delaying event may or may not have been clearly identified in the original programme. Similarly, the delay may cause previously non-critical work to become critical, thus changing the planned critical path. First and foremost, it is essential to gather the facts and review any records kept of the change or event in question. It is essential to understand how the event delayed the works in progress when it occurred; to do this, the people involved need to be interviewed. This ensures that the delay analysis is based on first-hand knowledge of the timing and impact of the event on the works. The information gained from interviewing the personnel should be supported by an examination of the records, diaries, time sheets, allocation sheets, photographs, etc. These records should confirm what was going on when the event occurred and how it would impact the work. Using factual records, in conjunction with interviews of the personnel involved, helps avoid issues caused by the inaccurate recollection of events by witnesses, which can be unreliable and may also be affected by the amount of time that has elapsed between the matter arising and the interviews.

The programme can then be examined to find the relevant activities that were affected by the delay. However, the problem with many construction programmes is the amount

of detail they contain. No programme will show every item of work identified on the drawings or described in the Bill of Quantities, and nor should it. When a programme is developed into too much detail, the essential planned intent is often lost or masked by the sheer number of tasks shown. Generally, the programme will be a summary of the work required, divided into sufficiently detailed sub-activities to explain the location, setting out the order, timing and duration of works. If the activities and sub-activities are sufficiently detailed, such that the delay in question can be easily inserted into the programme, it will be necessary to re-schedule it to show the theoretical impact of the delay. This theoretical effect must be supported by and compared with the contemporary records to ensure that the analysis closely resembles what happened; otherwise, it will be dismissed as incorrect. Where more detail is needed to insert the delay event into the programme, a small extract from the relevant section of the programme can be expanded to explain where and how the item fits in the plan. These extracts are sometimes referred to as a 'fragnet', which is jargon for a fragment of the network. What is essential is to check the delay modelled in this manner against the records to ensure that the theoretical delay model does not produce an unrealistic result. The problem with all programmes is that the details, logic, sequence and duration of activities is a theoretical exercise produced prior to any work beginning on site. When the delay analysis is carried out long after the event, it is necessary to check the contemporaneous programme updates and progress reports prepared at the relevant time to judge what had happened to the original programme prior to the change or event occurring. In summary, any analysis must be methodical and follow the factual record of the project's construction progress; otherwise, it will degenerate into a purely theoretical exercise completely divorced from reality that can be shown as incorrect when the site progress records are compared to the results of such an analysis.

As noted earlier, once the work starts, the actual duration and timing of works recorded are rarely the same as the original schedule. Some tasks may advance faster than expected, and others may take longer. Sometimes these changes are merely corrections of estimates in the programme, or they may be due to outside events influencing construction progress. For example, there may be fewer or perhaps more resources deployed than planned; the work may have suffered the impact of severe adverse weather; or the effects of variations and other claimable events may all have had some effect on the reported progress. Further, the site team may have altered the planned sequence, timing and duration of works or changed the temporary works and altered the plant and equipment from that planned. This may have been to maintain progress or because they decided there was an alternative method or sequence required that had not been considered in the original programme. Updating a programme with the reported progress achieved will supersede the planned expectations and alter the timing of work based on the recorded progress for each activity within each working area. When rescheduled, the programme should indicate the effect of actual progress on the planned work and on the overall programme. Such an update should be carried out before the insertion of the change event into the network. When reviewing the monthly progress reports, it is essential to review the recorded sequence; if work has progressed in a different manner to the original programme, this should be noted and the reasons for the change identified. If this means that the planned logic links and duration of activities need to be changed to reflect the actual work being undertaken, this should be done prior to any delay analysis to ensure that the programme follows

what changed from the planned intent and correctly reports the critical path at the time of the delay.

Forensic delay analysis is a skilled task; it requires practical experience, not only in the analysis techniques or software used, but also from working on construction sites and having witnessed construction techniques and the problems encountered on numerous projects. Such experience is essential so that the analyst can, from his/her own knowledge, understand how a change or other event can disrupt or delay the works. It involves reviewing the original programme and comparing this model with the as-built records for the project. Recent judgements handed down in the English courts have, rather than using a purely theoretical analysis, tended to rely more heavily on the records and contemporary documents that prove what happened based on site records and/or witness statements. Therefore, any delay analysis should undertake a realistic appraisal of the events and what caused the claimed delays, and not merely an insertion of numerous alleged events into the original programme without any adjustment of the programme to match what was happening on site at that time. This was the most common method of delay analysis adopted, and it was called ‘impacted as-planned’ analysis. While this technique still has its place, the approach to delay analysis now requires more emphasis on what actually happened and how that would affect the completion of the works, rather than relying on a purely theoretical result based on the original as-planned critical path.

7.3 Validating the Programme

When attempting to model a delay, it is essential to validate the original programme to ensure that, not only did it contain sufficient activities to describe the work to be done, but also was fully logic linked and not artificially driven by fixed constraint dates or false logic links. Validating a programme for forensic analysis is completely different from checking a programme for project control during construction. A check must be made on the content and validity of durations and sequence to ensure that the programme was viable; the acid test is to determine if the manner of construction shown on the programme complied with all the requirements of the contract. For example, the application of numerous constraint dates on a programme overrides the logic links and skews the critical path calculation. Similarly, where there are long lead or lag durations placing activities in a false position or timescale, these need to be checked and, if necessary, removed or replaced with realistic logic links. If a schedule has numerous activities that have no incoming or outgoing logic links, these will not react when reported progress is entered, and again may affect the analysis of the critical path depicted. It is unwise to blindly adopt the original programme schedule without first checking its validity and making corrections where necessary by removing constraints and inserting logic links so that the activities react in a dynamic manner when progress is entered, and the programme rescheduled. However, the review of the programme and correction of logic should not be subject to changes to improve the content or make the durations and sequence more reasonable; the purpose is to provide a baseline that complies with the contractual requirements and will react in a dynamic manner when delay events and variations are inserted. Preparing a delay analysis programme is not simply the insertion of delays and changes into the programme; all the changes made to the programme

to correct logic errors to remove constraints or insert delays must be set out in a narrative or in a tabular form explaining the alterations made and reasons for changing the logic or removing or even inserting constraint dates where appropriate, so that the process is transparent and capable of being understood and checked by a third party. It is also essential to prepare a schedule recording where the reported progress at each chosen interval was obtained, together with details of how the variations or delay events were inserted. This is essential to ensure transparency and record what exactly has been done to model the delays claimed. If such changes are made, and the logic links added have resulted in a delay to the planned completion date, these alterations must be documented at each stage of the analysis; otherwise, when questions are raised later (as they most certainly will be), the reasoning and method of insertion will have been long forgotten, and time will be wasted researching the actions taken when the analysis was produced.

Once this has been done for all events being investigated, either in a periodic, windows or time slice analysis in weekly or monthly increments, or in a larger period that collects together several changes or months, the programme can be re-scheduled to determine the impact of the event or number of events on the completion date (if any). If the programme and number of events being examined are complex, it is better to produce several programmes to avoid inserting dozens of events and not checking whether the result is correct until afterwards. It is recommended that events be inserted chronologically based on when they were instructed or occurred. Where an instruction has been issued but the work not yet done, it should still be inserted, so that the remaining programme reflects the work now required for construction. For example, insert the events that occurred within a period (monthly or quarterly), then reschedule the programme and record the impact on completion. Alternatively, it may be more practical to deal with the delays based on the location or within a particular section of work. What is essential is to compare any delay event modelled in this way to the as-built records to ensure that the delay programme mirrors what happened as closely as possible. Where a delay analysis produces a programme that is dramatically different from what was recorded on site, it is probably due to incorrect logic or a change in the sequence of work as compared to the planned intent.

Another factor to be considered is the alterations or updates made to the programme during construction. Such alterations may have been made to correct errors, insert additional works or implement other changes necessary to reflect the works undertaken as the construction proceeded. If these changes are fundamental and the programme no longer resembles the original baseline schedule, any analysis prepared solely reliant on the original schedule will not match the actual progress or sequence of events on site, nor will it report the correct critical path. Where the construction programme is updated in such a manner, the delay analysis must pause to show where the programme and contractual entitlement stood prior to such major alterations being made, and summarise the situation that existed before the revisions were implemented. It may be that the reason for such dramatic change to the original schedule was to accommodate acceleration measures or implement a large variation that changed the works scope such that the programme had to be redrawn. Whatever the reason for the changes to the programme, the revised schedule must be investigated to ensure that there are no fixed constraint-driven activities, and that all activities have incoming and outgoing logic

links in the same detailed manner as the investigation performed on the original baseline programme before moving forward in the analysis.

7.4 Techniques

There are two very good practice guides to techniques and procedures involved in forensic schedule analysis. The first is published by the US-based Association for the Advancement of Cost Engineering International (AACEI), titled Recommended Practice No 29R-03 (a detailed protocol setting out the procedures to be followed when preparing a forensic delay analysis); the second was first published in November 2001 by the UK-based Society of Construction Law. This was their first protocol relating to disruption and delay analysis, and pertaining to the investigation of programmes and delay assessments necessary to provide a theoretical model that contractors and employers could adopt to manage changes and delays in a systematic and logical manner. The reality is somewhat different – while the protocol addressed the best practice of updating the programme regularly and identifying and attempting to agree within each review period the changes and delay events that occurred, the protocol was not often adopted. The Society of Construction Law issued an updated protocol in February 2017, which addressed some of the criticisms received and reflected changes in the law and approach of the courts when dealing with delays and extension of time. While this Protocol is not a legal doctrine, it does set out some best practice recommendations for creating and updating programmes, record keeping and delay analysis, and anyone following its precepts should take comfort in knowing that it was prepared based on the collective experience of the drafting team.

The 2017 SCL Protocol states:

- 11.2 Irrespective of which method of delay analysis is deployed, there is an overriding objective of ensuring that the conclusions derived from that analysis are sound from a common sense perspective. This is particularly relevant where there is a significant risk that the remaining duration projections, logic links, calendars and constraints within the baseline programme (preferably the Accepted/Updated Programme) might produce anomalous results.
- 11.3 The choice of method of delay analysis to be deployed should be determined by reference to the following criteria:
 - (a) The relevant conditions of contract.
 - (b) The nature of the causative events.
 - (c) The nature of the project.
 - (d) To ensure a proportionate approach, the value of the project or dispute.
 - (e) The time available.
 - (f) The nature, extent and quality of the records available.
 - (g) The nature, extent and quality of the programme information available.
 - (h) The forum in which the assessment is being made.
- 11.5 The following table provides a summary of the methods described below.

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
<i>Impacted As-Planned Analysis</i>	<i>Cause & Effect</i>	<i>Prospectively</i>	<i>Prospectively</i>	• Logic-linked baseline programme. • A selection of delay events to be modelled.
<i>Time Impact Analysis</i>	<i>Cause & Effect</i>	<i>Contemporaneously</i>	<i>Prospectively</i>	• Logic-linked baseline programme. • Update programmes or progress information with which to update the baseline programme. • A selection of delay events to be modelled.
<i>Time Slice Windows Analysis</i>	<i>Effect & Cause</i>	<i>Contemporaneously</i>	<i>Retrospectively</i>	• Logic linked baseline programme. • Update programmes or progress information with which to update the baseline programme.
<i>As-Planned versus As-Built Windows Analysis</i>	<i>Effect & Cause</i>	<i>Contemporaneously</i>	<i>Retrospectively</i>	• Baseline programme. • As-built data.
<i>Retrospective Longest Path Analysis</i>	<i>Effect & Cause</i>	<i>Retrospectively</i>	<i>Retrospectively</i>	• Baseline Programme. • As-built programme.
<i>Collapsed As-Built Analysis</i>	<i>Cause & Effect</i>	<i>Retrospectively</i>	<i>Retrospectively</i>	• Logic linked as-built programme. • A selection of delay events to be modelled.

11.6 Some of these methods require a baseline programme. If the parties have followed the guidance to Core Principle 1 in Part B, that will be the Accepted/Updated Programmes. If the parties have not followed the guidance to Core Principle 1 in Part B and one of those methods is adopted in carrying out the delay analysis, this could lead to greater scope for disagreement on the assessment of delay.

- (a) The impacted as-planned analysis method involves introducing delay event sub-networks into a logic-linked baseline programme and its recalculation using CPM programming software in order to determine the prospective impact these events have on the predicted contract completion dates shown within the baseline programme. Before embarking upon the analysis, the analyst needs to confirm that the sequences and durations for the works shown in the programme are reasonable, realistic and achievable and properly logically linked within the software, to deal with the risk that the baseline programme contains fundamental flaws which cannot be overcome. In general, this is thought to be the simplest and least expensive form of delay analysis, but has material limitations, principally because it does not consider actual progress and changes to the original planned intent. The product of this method of analysis is a conclusion as to the likely effect of the modelled delay events on the baseline programme. In limited circumstances, this analysis may be deemed sufficient for assessing EOT entitlement. Such circumstances include where the impacted as-planned method is dictated by the terms of the contract and/or where the delay events being considered occurs right at the outset of the works.
- (b) The time impact analysis involves introducing delay event sub-networks into a logic-linked baseline programme and recalculation of this updated programme using CPM programming software in order to determine the prospective impact the delay event would have on the then-predicted completion dates. The baseline programme for each analysis can be either a contemporaneous programme or a contemporaneously updated baseline programme (i.e. an Updated Programme), the difference being the revised contemporaneous programme may have logic changes/activity/resource changes from the original baseline programme. In either case, the analyst needs to verify that the baseline programme's historical components reflect the actual progress of the works and its future sequences and durations for the works are reasonable, realistic and achievable and properly logically linked within the software. Mitigation and acceleration already incorporated into the updated baseline programme need to be considered as these can conceal or distort the projected impact of the delay events. The number of delay events being modelled has a significant impact on the complexity and cost of deploying this method. The product of this method of analysis is a conclusion as to the likely delay of the modelled delay events on the programme/critical path that is most reflective of the contemporaneous position when the delay events arose. This method usually does not capture the eventual

actual delay caused by the delay events as subsequent project progress is not considered. This method is also described in the guidance to Core Principle 4 in the context of a contemporaneous assessment of an EOT application.

- (c) The time slice analysis method is the first of two ‘windows’ analysis methods. This method requires the analyst to verify (or develop) a reliable series of contemporaneously updated baseline programmes or revised contemporaneous programmes reflecting an accurate status of the works at various snapshots (being the time slices) throughout the course of the works. Through this process, the progress of the works is divided into time slices. The time slices are typically carried out at monthly intervals. The series of time slice programmes reveals the contemporaneous or actual critical path in each time slice period as the works progressed and the critical delay status at the end of each time slice, thus allowing the analyst to conclude the extent of actual critical delay incurred within each window. Thereafter, the analyst investigates the project records to determine what events might have caused the identified critical delay in each time slice period. For each time slice programme, the analyst needs to verify that the historical components reflect the actual progress of the works and that its future sequences and durations for the works are reasonable, realistic and achievable and properly logically linked within the software.
- (d) The as-planned versus as-built windows analysis method is the second of the ‘windows’ analysis methods. As distinct from a time slice analysis, it is less reliant on programming software and usually applied when there is concern over the validity or reasonableness of the baseline programme and/or contemporaneously updated programmes and/or where there are too few contemporaneously updated programmes. In this method, the duration of the works is broken down into windows. Those windows are framed by revised contemporaneous programmes, contemporaneously updated programmes, milestones or significant events. The analyst determines the contemporaneous or actual critical path in each window by a common-sense and practical analysis of the available facts. As this task does not substantially rely on programming software, it is important that the analyst sets out the rationale and reasoning by which criticality has been determined. The incidence and extent of critical delay in each window is then determined by comparing key dates along the contemporaneous or actual critical path against corresponding planned dates in the baseline programme. Thereafter, the analyst investigates the project records to determine what delay events might have caused the identified critical delay. The critical delay incurred and the mitigation or acceleration achieved in each window is accumulated to identify critical delay over the duration of the works.
- (e) The retrospective longest path analysis method involves the determination of the retrospective as-built critical path (which should not be confused with the contemporaneous or actual critical path identified in the windows methods above). In this method, the analyst must first verify or develop a detailed as-built programme. Once completed, the analyst then traces the longest continuous path backwards from the

actual completion date to determine the as-built critical path. The incidence and extent of critical delay is then determined by comparing key dates along the as-built critical path against corresponding planned dates in the baseline programme. Thereafter, the analyst investigates the project records to determine what events might have caused the identified critical delay. A limitation to this method is its more limited capacity to recognise and allow for switches in the critical path during the course of the works.

- (f) The collapsed as-built (or but-for) analysis method involves the extraction of delay events from the as-built programme to provide a hypothesis of what might have happened had the delay events not occurred. This method does not require a baseline programme. This method requires a detailed logic-linked as-built programme. It is rare that such a programme would exist on the project, and therefore the analyst is usually required to introduce logic to a verified as-built programme. This can be a time consuming and complex endeavour. Once completed, the sub-networks for the delay events within the as-built programme are identified and they are 'collapsed' or extracted in order to determine the net impact of the delay events. This method is sometimes done in windows, using interim or contemporaneous programmes which contain detailed and comprehensive as-built data. A limitation to this method is that it measures only incremental delay to the critical path, because the completion date will not collapse further than the closest near-critical path.

- 11.7 Other methods which may be reasonably deployed in particular circumstances having considered the criteria in paragraph 11.3 above, include: project wide retrospective as-planned versus as-built analysis (i.e. not in windows), time chainage analysis, line of balance analysis, resource curve analysis and earned value analysis.

Contractors use different planning techniques and software to suit the type of project or their company's preferred software system. For example, planning techniques may include any of the following: bar charts, line of balance diagrams and/or time location diagrams. For smaller projects, some contractors prepare programmes by hand, which is still a valid method of programming work in terms of setting out the planned intent and sequence of working, and many forms of contract do not stipulate the use computer-based project management/planning software. The point to remember is that the planning method or software used is not important; what matters is the preparation of a logical plan for construction that shows the order and timing of the work. Further, it is vital to regularly monitor and update the programme to reflect recorded progress and the impact of delays suffered. As already stated, changes and events occur during construction that may affect the logic, timing or sequence of work, and which will often alter the planned duration of work and the calculated critical path. Therefore, when preparing an updated programme or delay assessment, merely inserting reported progress on the original programme activities does not necessarily reflect what is happening. If there have been numerous additional works instructed or several delay events suffered, all causing delay or if the planned intent has been revised, the original programme will not show what is happening or the effects of the events on the completion date. The updated programme should contain the insertion of new items to incorporate variations or delays

suffered as it is essential that the updated chart reflects what is happening on site at each update – even if the alleged delay events are not agreed, they will have happened, and the programme should contain all work and relevant events that lead to or affect completion. Both the Contractor and the Employer need to know where the project is in terms of programme and progress, so that potential and actual delays can be monitored and, where possible, corrective action agreed. At each stage of the project, a methodical inspection of the programme and any claimed events, together with the relevant site records and progress reports, should produce an outline of how the works were constructed and when the delays occurred. However, the true effect of a delay on the completion date may be masked at various intervals by the actions taken by personnel on site or misreported progress.

The critical path becomes the essence of many delay issues and is probably the biggest source of argument between contesting parties. The original planned critical path is a figment of planning; it is derived from a mathematical calculation of all the activities their durations and logic links, and represents the longest path through the construction tasks that drive the completion date. It is derived from a mathematical calculation known as a ‘forward and backward pass’ through the underlying network programme to calculate the revised start and finish dates for activities and then determine which activities have ‘float’ and those that have ‘zero float’ (critical). While the original critical path may have been correct, it could easily have been manipulated by the insertion of milestone dates that fix start and finish dates, and/or due to some element of flawed logic within the programme. It is worth noting here that the software used may also allow the planner to manipulate how the critical path is calculated, rather than using a simple mathematical calculation as the determination of what is shown as critical. This means that what is represented as critical can be changed to include not just mathematically critical events (those with zero float) but those with less than a specified period of float. For example, an activity with less than 5-, 10- or even 20-day float may be considered by many as a critical activity. In construction operations, it is often sensible to show items that only have a limited amount of float, as well as those with none, by depicting them both as critical items, so that the programme slippage on nearly critical activities will also trigger the risk of delay to completion.

Problems occur when there is no detailed programme or the base programme was insufficiently detailed and not fully linked, such that the programme presented for comparison was drawn at a very high level, with little detail shown. In such cases, it may be that the delay analysis can only be carried out by inspection of the as-built records to create a more detailed as-built programme. If an as-built programme was not kept by the site team during construction, reviewing the events and preparing an as-built programme or factual matrix long after the works are completed is time consuming and expensive. It is heavily reliant on records and reports prepared at the time, and may be influenced by disputed events.

Once construction starts, the planned intent is key. This is not necessarily the individual activities or the logic links that were used in the programme; it is the overall planned sequence and timing of the work. Some Contractors issue an overview or method statement detailing the planned intent and identifying the key areas and important milestones or targets necessary to achieve completion. This method statement should also indicate the dates by which key information release or approvals are needed to allow for procurement and delivery of materials and equipment. The preceding is good practice and helps avoid later arguments that the intended sequence was not clear or that the critical dates for approvals and information release were unknown. Some types

of construction are clearly logic based due to the sequential nature of their design. For example, reinforced concrete and structural steelwork frames to buildings will follow the pattern prescribed by the design, sequence of construction and temporary works. However, subsequent activities, such as internal fit-out operations, mechanical and electrical services, decoration, etc., are not solely driven by logic. These works follow behind the construction of ceilings, walls and floors, and may be dependent on resources deployed and the sequence of material deliveries. They tend to be more flexible in terms of which ceiling, wall, floor or other items are installed first. The same is true in civil engineering works, but to a lesser degree. For example, on a large motorway project, the construction of each individual structure or stretch of road will follow a logical sequence, but the overall sequence for the project may be more flexible and can be revised if problems occur in one location. The key to road construction is usually the earthworks operations, which will dictate where and when work starts, the sequence of cuttings and embankment construction, and when these sections are released for subsequent activities (e.g. construction of the drainage, culverts, structures, etc.).

7.4.1 Concurrent Delay

The concept of concurrent delay relates to events where two or more causes of delay are considered to have affected the completion date. Concurrency can take more than one form; two events may both be considered to have caused the delay, but one may have started before the other, and the second event may have gone on later or lasted longer. True concurrency occurs where two causes of delay occur at the same time and have an identical impact on completion – one event being the responsibility of the Contractor, and the other the responsibility of the Employer. It has been suggested that, where there is concurrency, the Contractor should still get its extension of time. In a recent case,¹ the contract had been modified to exclude concurrent delay events from consideration for an extension of time. However, the real answer relies on a factual analysis to determine whether the events were truly concurrent and whether one or both impacted on the completion date. If one event is perceived to be the dominant or overriding delay, and the other only partly concurrent, the result is somewhat clouded. In the Scottish case of *City Inns Ltd. v Shepherd Construction Ltd.* [2007] CSOH 190, Lord Drummond Young decided that, where there was some concurrency, the extension of time should be based on an apportionment.

... Where there is true concurrency between a relevant event and a contractor default, in the sense that both existing simultaneously, regardless of which started first, it may be appropriate to apportion responsibility for the delay between the two causes; obviously, however, the basis for such apportionment must be fair and reasonable. Precisely what is fair and reasonable is likely to depend on the exact circumstances of the particular case.

To be entitled to an extension of time for completion, the Contractor must show that an event actually caused delay to completion. Similarly, where the Employer is seeking to rely on a concurrent delay to avoid an extension of time due to some alleged failing by the Contractor, the Employer is under the same burden of proof to show that the alleged concurrent delay was, in fact, critical, or has some impact on the completion date.

1 *North Midland Building v Cyden Homes* [2018] EWCA Civ 1744.

7.5 Methods

In addition to the Society of Construction Law Protocol or the AACEI Recommended Practice, there are numerous textbooks and papers that describe the main methods of delay analysis. However, the overriding principle for any exercise is to obtain the records of what happened, where and when, etc. The details of what happened, and when, should not be contentious but based on recorded facts. Any delay analysis will be subjective and based on opinion, as well as application of the facts to a baseline programme, an updated programme or the as-built programme. Irrespective of which method of delay analysis is undertaken, it must be rooted in the facts; otherwise, it would be a purely theoretical calculation. When carrying out a delay analysis, it is recommended that:

1. For each event examined, a report is prepared, setting out what the item concerned and how it affected the works. The analysis should set out a schedule report detailing the period examined and the delays inserted, and how this was achieved. On a large project with hundreds of events, this can become unwieldy. If this is the case, the best approach is to follow a system using a numbered page for each item, based on a simple template that records the details of each delay event identified and how it has been inserted into the programme. The format of such a summary sheet is not fixed and should be adapted for each project to reflect the programme approach being undertaken and match the software used in the analysis. The following example (Figure 7.1) is only a guide; for some events, the analysis may run to several pages.



Delay Analysis Sheet

CONTRACT: TITLE:		D.A.S. No:	
Work Section:		Activity No:	
Programme Reference No:			
Analysis of Delay & Disruption			
Imposed Start/End date: ()	Additional Duration: ()	Revisions to Programme Logic: ()	Mitigating Measures Taken: ()
Source of Delay: (State correspondence, drawings, etc. in detail)			
Analysis of Delay & Disruption: (Include the reasons why, what, where, when, who and how & follow on with further evidence, correspondence & mitigation. If there is an involved network to explain the delay attach as a separate page)			
Cross Reference to other DAS sheets			
Basis of Claims: (Refer to attached schedule)			



Figure 7.1 An example of a delay analysis sheet.

2. A schedule in tabular form is prepared, listing all the events identified and which activities they affected, with a summary of the facts uncovered surrounding the alleged delay event. This is best set out in chronological order, and the results of impacting the item onto the chosen baseline programme are recorded for each event. This process should be systematic, recording at each step the facts known and how they have been inserted into the programme, together with details of any changes to the logic links and activities. At each stage, the item references should be clearly shown, together with the activity numbers, so that the insertion of additional items can be verified, and the impact on the completion date, if any, should be recorded for each step of the analysis. The purpose of presenting a tabular schedule, listing all the delay events identified and how they have been inserted on the programme, is to provide transparency, so that the recipient can follow the approach taken, and this aids discussion and agreement on the method used and the impact claimed (see Table 7.1).

Table 7.1 is only a bare-bones example showing the type of detailed schedule needed and the method for setting out the delays identified, which would continue chronologically throughout the project until the last programme or period analysed was reached. The exact content and detail of the delays and analysis of the various programmes or periods investigated will vary from job to job.

The main issue in terms of the method of delay analysis undertaken will be driven by:

- The records and information available.
- The type of programme produced, and whether it is available in digital form or merely as paper prints or PDF.
- Any method statements produced in support of the general intent behind the programmes used (see the comments about preparing a project notebook in the chapter on planning).

Table 7.1 Example delay schedule

Ref no.	Programme used	Events or delays identified	Liability	Schedule finish date	Cumulative delay identified (calendar days)
00	Baseline contract master programme	None	None	01/08/2016	0.0
01	Updated programme with progress at week no. 'X' or dated 'Y'	None entered just progress as reported for each task	Contractor liable due to slower progress than planned	08/8/2016	7.0
02	Update as 01 above with variations added; see activities 1234 and 1235 inserted on the network	Variation order no. 1 and delay event (ground conditions) ref. DAS sheet no. XYZ	Employer delay caused by changes instructed and ground conditions differing from the contract information	22/8/2016	21.0

Nearly all the various forms of delay analysis have come under criticism in UK and US courts. There are several reasons for this, the main issues being:

- The credibility of the expert performing the analysis.
- The extent of records and as-built information used to support the analysis.
- The complexity of the analysis technique adopted.

A complicated programme analysis combined with lots of technical jargon and computer schedules will tend to bewilder rather than convince a tribunal. Clarity and simplicity are the essential tools to employ, so that, however complex the project and the programme analysis, it can be reduced to terms that a non-technical person can understand and, most importantly, it is supported by the facts and evidence relied upon. A purely theoretical analysis that drifts away from reality will be criticised for not representing the facts, and the analysis will be discarded as flawed.

Any major project will contain numerous activities that should be completed in a certain sequence before the works are completed. However, the original sequence, timing and logic of how the project was to be constructed are more subjective. The Contractor prepares the original programme based on its anticipated production rates and choice of construction methods. It will be based on experience not only in the type of work but also its location, as the geographic position of a site can affect the likely production rates achieved. Similarly, the project's location may also affect the recruitment of skilled labour, materials delivery (logistics) and the provision of suitable plant and equipment. The Contractor will thus determine the duration and timing of the works based on the resources and equipment at its disposal. The original programme should be the starting point for any analysis, but any programme is subject to alteration to react to events and progress on site. Most forms of construction contracts require the programme to be submitted within a short period after acceptance of the Contractor's tender. This is sometimes because of the imposed time constraint for submission of a programme very soon after the award of the contract. Thereafter, the conditions of the contract may require the programme to be updated to reflect actual progress at set intervals during construction. It is therefore common to find that any programme produced has errors and omissions, sometimes because of the size of the programme and sometimes because the works were unclear. If these errors are small, they may have no effect, especially if any omissions or errors are related to items not considered critical. The updating of the original programme causes complications in any delay analysis since the originally planned intent is presumed to be based on the Contractor's tender. Amendments to the programme will occur due to a mixture of events, for example:

- Variations and instructions issued.
- Late release of information and drawings.
- Suspension of work in certain areas.
- Delayed access to work areas.
- Ground conditions encountered or other unforeseen events.
- Poor progress on site caused by lack of production or lower resource levels.
- Late delivery of materials and equipment.
- Errors in the original programme logic and sequence that had to be corrected.

The preceding list is not exhaustive and serves to demonstrate many possible reasons why the original programme needs to be reviewed and updated during construction.

Often the need to update the programme is a combination of all these rather than just one event. Where a programme is regularly revised or completely updated, this will complicate the analysis of delays as the original programme will have been superseded and the new replacement programme becomes the benchmark by which subsequent progress and delays are monitored.

Before computer-based planning software was available, all programmes were hand drawn, irrespective of the planning process used (bar chart, time location charts or CPM/precedence network diagrams). Managers or engineers who were experienced in the type of construction undertook planning, and the logic was based on their previous experience, and not based on links added to a computer model. Programmes were often much simpler in terms of the number of activities shown on the programme because the size of the programme was limited to the paper size it was drawn on. Where more detail was needed, separate sub-programmes were drawn, perhaps for each structure or section, to explain the summary bars shown on the master programme. The advent of computer-based programming techniques has resulted in programmes exploding into many thousands of items which often cloud the issue and make understanding the programme more difficult for both the construction team and the delay analyst after the event.

Any analysis undertaken must be based on the evidence available and the result will depend on the skill and experience of the analyst interpreting the information provided. The problem with modern computer-based programmes is that too much emphasis is often placed on the logic links, calendars, activity durations and timing of the original baseline programme rather than the facts of what happened and why the planned sequence, timing and duration of works was changed. However, it is common to find that any computerised delay model will not exactly reflect what happened because of the level of detail involved or because of other subtle changes that take place on the site which cannot be replicated easily in a theoretical exercise. For example, the introduction of increased overtime or night shift and weekend working, together with any other acceleration measures introduced in an attempt to meet various deadlines, will cloud the results if the analysis is solely based on the originally planned resource levels and shifts/working patterns.

What happened and why the timing or sequence changed can only be assessed from the factual evidence. This means that the site records must be detailed enough but may require some explanation from a factual witness who was involved in the construction and kept the records being used to support the case. Where there are numerous changes and other reasons for delay (some of them due to the Contractor's own issues), the Contractor may have redeployed resources and/or mobilised additional resources or additional shift work to maintain progress and mitigate standing time. Such actions change the planned logic pattern, and the sequence and duration of the work changes.

7.5.1 The Use of As-Built Programmes

Where an as-built programme has been prepared, it will show the recorded duration and timing of the various activities and is nothing more than a record of when the work was carried out. An as-built programme will not explain why work was carried out in the sequence or timing depicted, neither will it explain why the duration differs from that planned; it is only a factual record. The activities shown started and finished when they

did, and there can be no adjustment to these times. It should be investigated whether any delay or prolongation of activity duration as compared to the original plan occurred. Further, whether these events were critical to overall completion is, of course, another matter for debate. When using an as-built programme, the benefit of 20/20 hindsight must be considered. When decisions were made on site that changed logic, sequence of working, and if alternate resources were mobilised or resources relocated the reasons for these decisions must be noted. Such management decisions made during the project would have been made in the heat of the action. Such actions and decisions may have been perfectly valid at the time and only later seen to be erroneous because of supervening events.

All delays impact upon the completion of the activity they affect and result in some measure of increased cost even though they may not be critical to contract completion. Generally, delay to a given activity is usually easy to determine. Delay to a section or the overall contract is more difficult to analyse. This difficulty arises from the following factors:

- The presence of float in the programme may mask or distort the effect of a delay.
- After a delay, a contractor often takes some form of mitigating action that might have the effect of reducing or masking the delay.
- A contractor will strive throughout the project to maintain progress and, where possible, improve upon the tender or perceived performance outputs contained in the programme.
- Delays arising from matters for which one party or the other is responsible that may overlap one with another, confusing the result without further investigation.
- Activities in work sections are, to some extent, independent of one another, but they may well be interlinked at certain stages or may have been planned to utilise common resources, which will also confuse the picture (e.g. plant or formwork). In extreme circumstances, the critical effect of a delay may have been removed or avoided, simply by the deployment of additional resources, but there would still be a cost implication to mobilising additional resources.

As-built programmes need to be in as much detail as possible, showing:

- Start and finish dates of activities.
- If work was fragmented.
- Why work was started earlier or later than planned.
- Resources used and, if possible, where they went next.
- Additional works ordered, and by whom.
- Staff and labour histograms and bar charts are also necessary to show the level of labour and supervision deployed as the works progressed.

All this sounds like a lot of work, and it is if it is not produced contemporaneously. Anyone who has had to construct an as-built programme long after the event would agree that to produce one in sufficient detail is a nightmare. The best type of as-built programme is produced by using a blank chart that is then completed weekly or daily showing the history of all the necessary activities. When an as-built programme is compiled daily/weekly, it should only take a few minutes as compared to the time taken on diaries and other reports, and will produce the essential records in a visual form. A quick

note of resources used can be made in code (e.g. 2C = two carpenters, 4S = four steel fixers, 2/1 BL = a two and one bricklayer gang, etc.).

Computerised as-built programmes can be produced, provided that the software can also depict fragmented work patterns and does not just show the initial start date and eventual finish date of activities, which result in long bars indicating extended durations that would be incorrect.

The following text presents advantages and disadvantages that must be considered when delay analysis is prepared using an as-built programme.

The advantages of only using an as-built programme for analysis are as follows:

- It is factual.
- It can be verified from records, diaries, etc.
- It should not be in dispute as a true record of what happened and when.
- It is not subject to the vagaries of computer software and logic links; even if the original programme contained errors, the as-built programme must record when activities were carried out.

The disadvantages of *only* using an as-built programme for analysis are as follows:

- It only shows what happened and when, and to varying extents where the work was done.
- Unless it is carefully annotated, it does not show why, who or what caused the activity to be built when it was.
- It does not show how the work was done (if that is also important).
- It does not depict the critical path in the same manner as a re-scheduled programme; however, if the programme is detailed enough, the as-built critical path can be determined by inspection and based on investigations, records and interviews with the site staff in terms of what was considered or reported as critical at various times during construction.

An as-built programme must be considered as one of the tools used for the analysis of delays to a construction project. It is invaluable, but not the only tool available. If an as-built programme was drawn up as the works proceeded, with logic, resources and reasons added as annotations, it would be ideal, but this rarely, if ever, happens. However, even if such a detailed as-built chart were available, it would still need a narrative to explain what happened. An as-built programme does not tell the whole story; it can show when activities started or finished, but not what, where, why, when, how and who caused events to unfold as they did. It is not a complete analysis as it does not analyse the critical path through the project, nor does it explain why and when it changed. This information may be obtained from the site records (e.g. meetings, reports, etc.). On any project, activities become delayed for various reasons, and these need to be researched.

7.5.2 Collapsed As-Built Analysis

This delay analysis technique uses an as-built programme and attempts to deduct from it the actual duration of work periods for accepted variations and delay items. The flaw in this technique is that it does not reflect the realities of the site situation that may have driven decisions and relocation of the workforce due to problems that arose. Nor does a collapsed as-built programme demonstrate the impact of mitigating measures and other

events that occurred. To be useful, the collapsed as-built method should have detailed supporting information to explain what happened, when, where and why. Without supporting details of the actual logic behind decisions that were taken, any such analysis is just as false as a theoretically constructed programme that attempts to 'walk forward' through a project.

The following are reasons for revisions to the programme:

- The Contractor changing its arrangements, perhaps for purely commercial reasons, or when an error in the original programme logic is discovered.
- Client variations.
- The release of design information.
- Disruption and interrupted working.
- Actual resource levels and their movement about the site.
- If the effects of weather impose other changes – for example, drought, heavy rain and frost.
- Changes may also occur due to the knock-on effects of earlier delays and completion constraints insisted upon (e.g. acceleration agreements reached).

7.5.2.1 Example Planned v Collapsed As-Built

The preceding three charts indicate that the project was originally planned to be completed on 30 July 2019 (Figure 7.2), but due to delay events, some by the Contractor and some by the Employer, the project was completed late, on 14 August 2019 (Figure 7.3). The collapsed as-built chart (Figure 7.4) indicates that, if only the Employer delay events are deleted and the chart re-scheduled, the completion date might have been 12 August 2019, suggesting that the Contractor is only entitled to a 2-day extension of time for the

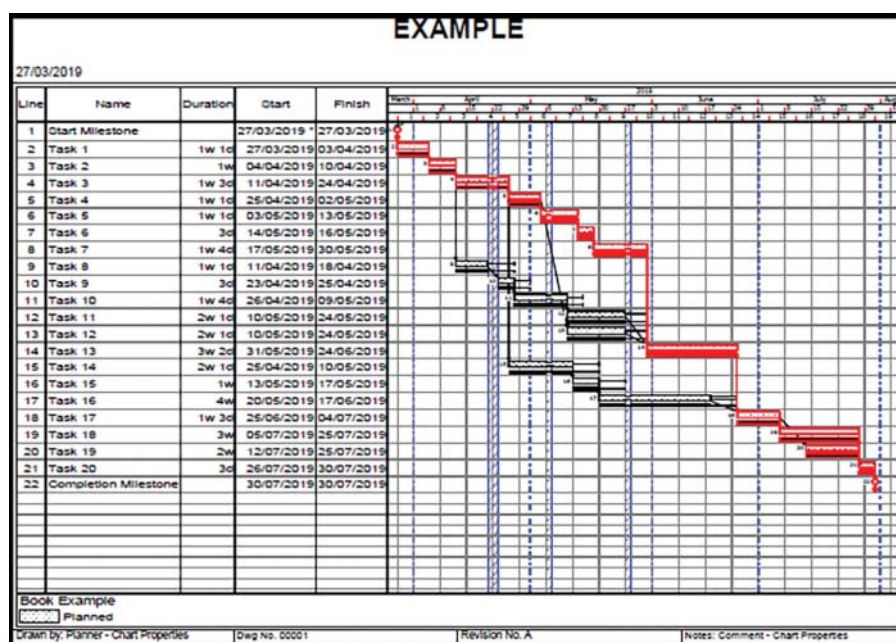


Figure 7.2 Example original planned intent.

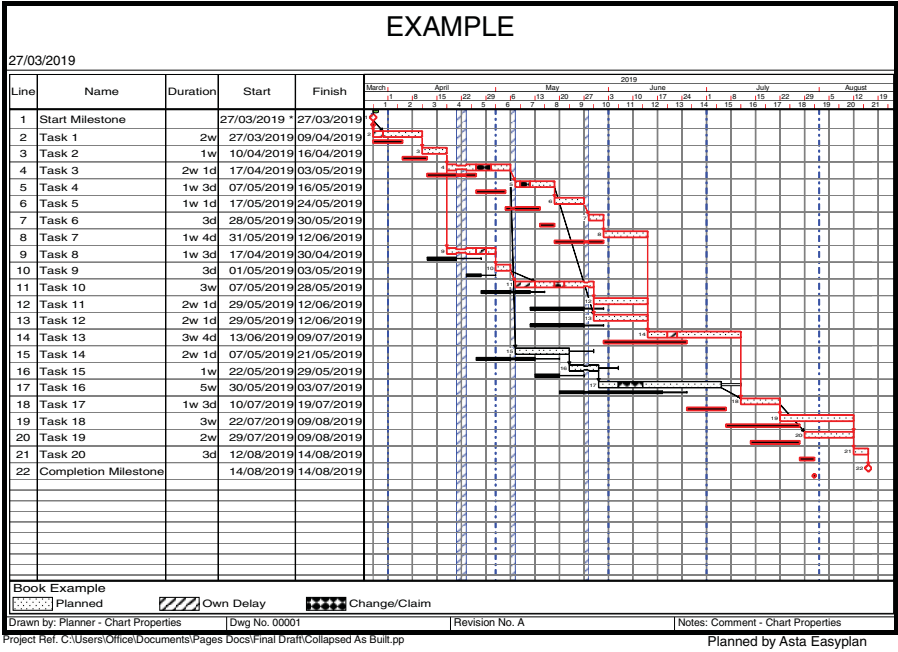


Figure 7.3 Example as-built.

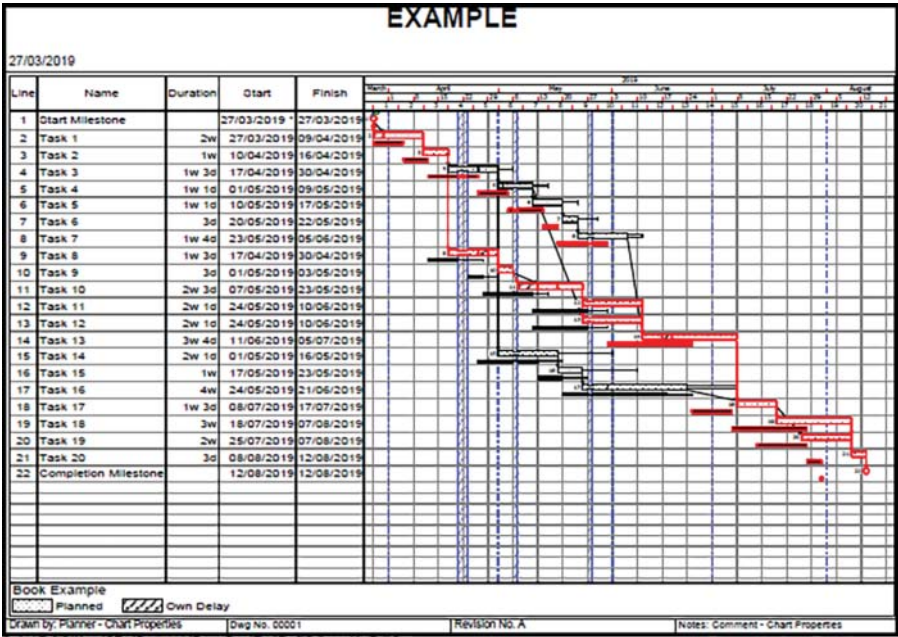


Figure 7.4 Example planned v collapsed as-built.

changes and variations, but that the remainder was its own fault. However, it may be that there is more to this story, and the delays may be a combination of its own problems together with the knock-on or disruptive effect of the changes.

An example would be if a Contractor had to postpone a specialist Subcontractor's visit due to earlier delays. Then, once the delay had passed, it could not get the Subcontractor back at short notice as Subcontractor had filled that schedule slot with other work. Sadly, and all too often, some Clients advisers either, through lack of knowledge, or because it suits them, refuse to accept such facts as their responsibility, and a dispute arises. It must always be remembered that resources cannot be turned on and off like a tap – whether they are specialists, tradesmen or labourers, all require continuity of work. Specialist resources are much more difficult to mobilise, and periods of notice are necessary; additional or alternative plants can be hired in, but this takes time and incurs mobilisation costs. In addition, the plant may attract a premium as compared to waiting for the original plant source (hired or owned) to become available. Similarly, if a Contractor gets ahead of schedule, it may be unreasonable for it to expect the Architect or Engineer to revise his/her arrangements for the provision of information to meet the advanced deadline – unless of course the information was due or promised earlier. In each case, the analysis of whether a delay occurred must review if a reasonable period of notice was given, or if the information was long overdue anyway. However, most delays that occur due to late or conflicting information have nothing to do with the Contractor's progress; they are usually caused by incomplete details or lack of thoroughness in the design at the outset. Often delays occur that are considered important, but which are later swept up in other events and no longer critical with hindsight. However, such matters are all part of the story and must be included. The period required for materials procurement is often forgotten, and the effect of delayed information may not be appreciated at the time as causing a delay. Later, when materials are delivered late, the fault may lie with both information supplied, and/or late ordering by the Contractor. The delay assessment then becomes a matter of determining the facts to assess who was primarily at fault.

7.5.3 Computerised Delay Analysis Techniques

Any computerised delay model is only useful if the resulting analysis bears a close relationship to the 'as-built' programme. Any computer model or method of delay analysis is invalid if it strays too far away from what really happened. Failure to 'replicate reality' and an argument or claim based solely on theory will nearly always result in failure of the claim. A claim must show the relationship between cause and effect, and the several causes of delay or activity prolongation must be identified with reference to the terms of the contract and the notices given in correspondence. Claim submissions must represent what happened and who was to blame. Reliance on what was the planned intent and alleged critical path is unlikely to reflect what eventually happened. The real critical path fluctuates as events unfold, and the only reliable way to demonstrate what happened and what was a delay is to first analyse all delays on a factual basis. That is, the source of the delay (instructions, drawings, etc.) must be reviewed and the facts ascertained, so that what happened and when is clearly recorded. This exercise must be undertaken

regardless of the delay analysis technique used. The result of this factual analysis can then be inserted into or shown on the programme used. In summary, any computerised analysis is a tool that can quickly be updated to show the effects of changes to the original scheme. However, these systems and the varying results that they produce are merely tools and no substitute for common sense and experience when assessing the cause and effect of delays and liability. Merely to produce a revised programme by plugging delays into the original contract programme chart without careful consideration can result in a nonsense result being produced when the reschedule button is pressed. Further, in the Sottish case of *City Inn Ltd. v Shepherd Construction Ltd.* [2007] CSOH 190, Lord Drummond Young commented on the use of computer-based methods, stating:

...The major difficulty, it seems to me, is that, in the type of program used to carry out a critical path analysis, any significant error in the information that is fed into the program is liable to invalidate the entire analysis. Moreover, for reasons explained by the defendant's expert, I conclude that it is easy to make such errors. That seems to invalidate the use of an as-built critical path analysis to discover, after the event, where the critical path lay, at least in a case where full electronic records are not available from the contractor.

...I think it's necessary to revert to the methods that were in use before computer software came to be used extensively in the programming of complex construction contracts. That is essentially what (the defendant's expert) did in his evidence. Those older methods are still plainly valid; and, if computer-based techniques cannot be used accurately, there is no alternative to using these older, non-computer-based techniques.

Lord Drummond Young's decision, therefore, followed the defendant's expert analysis, which was based upon 'factual evidence and sound practical experience and common sense'.

7.5.4 The Additive Approach/Impacted As-Planned

This technique requires the original programme to be set and then 'baselined'. Once this has been achieved, the analysis is produced by moving forward through the project and then adding or deducting events: variations, delays, new activities, etc., to the original activities. This creates a theoretical programme showing what happened to the programme when delays and additional work is added to the original scheme. This technique is supposed to arrive at the as-built duration from the original programme having demonstrated the reasons for the delay, but it is more likely to produce an overstated result, as it would not account for changes to the sequence and timing of work.

However, if the planned intent is in enough detail and can easily be expanded, then, as additional work or delay activities are added, and logic revised to reflect the as-built situation, a more realistic analysis can be made moving forward through a project. This is best completed in segments or suitable time periods, and by adding late information, variations and other delays as the works proceed, to derive a 'theoretical' as-built within each period. If the logic is correct, or is altered to reflect what happened in terms

of revisions to the sequence and timing of work on the site, then the theoretical programme should closely reflect the as-built. Of course, it will not be identical, as there are always varying periods of float in many activities on a programme unless such activities were on the critical path. However, an as-built programme will contain no record of float between tasks, and all activities are fixed at the time and date they started and finished, including weekends or overtime working, altered logic and resources, etc. These matters depict all the elements of an 'as-built' programme. However, if the theoretical programme closely resembles the as-built and is accurate enough to be acceptable, then the details added must be the correct reasons for the delay. If the analysis is progressed moving forward through the programme in suitable periods (weekly, monthly or quarterly, as needed), and the details and 'logic' are reviewed at the same time, what results should, as far as theory permits, replicate the as-built programme. If the analysis moves too far away from the as-built scenario, the 'logic or duration' must have altered on site. The reasons for the changes must be identified and the programme altered to reflect these events. Once the chart is re-scheduled, the programme should again reflect reality. At no time should the person producing this analysis fall into the trap of only following the alleged critical path in the original programme. The theoretical analysis should be supported by 'as-built' programmes with contemporary records and written commentaries. The written commentary should explain all the changes made, and why – for example, changes to resources, supervision, temporary works, traffic control measures, general timing or sequence, logic, etc.

7.5.5 Stage As-Built Addition Method/Time-Slice/Windows Analysis

The 'stage as-built addition'/'time-slice'/'windows analysis' method of analysis is a fairly recent addition to the toolbox of those involved in identifying and evaluating delay to construction projects. It is not the panacea for all ills, and, while extremely useful, as with all computer-based methods of analysis, it needs using with care, and is no substitute for obtaining the facts and using experienced judgement to assess delays.

Considerable experience in the planning and programming of construction projects, plus an awareness of the vagaries of differing project management software and their effects on the programme, are essential. Care must be taken to ensure that the analysis is thorough, and not driven by the software but by the records of what happened and why. The danger with all computerised project management systems is that the simple programme may not be detailed enough to react to changes and additions to demonstrate how the works were affected. Further, there is a tendency with many computer users to presume that the first answer provided by a reschedule is correct. The true aim of any analysis, whether manually drawn or computerised, is to establish what events occurred and what effects they would have had on the planned intent. It is all too easy to produce a detailed analysis that is driven by the software rather than the facts.

As a further warning about computer software systems before embarking on any analysis, it is essential to know how the programme re-schedules the works and treats started activities and remaining duration items. Many of the excellent systems necessarily ignore the precedent logic once an item of work is reported as started or a remaining duration is entered; others can be made to act in two different ways. Progress can be set to override logic, so that the links are effectively broken; or, alternatively, it can be set so that the planned logic overrides progress entered, so that the planned

sequence is maintained. Also, most systems can be set to dictate what is considered critical in terms of activity float – this can be set anywhere from 0 to 10 or up to 20 days or more, which creates false critical items. Therefore, care is needed to ensure the progress update truly reflects the work carried out. There is a tendency for people to record work starting when setting out has been started, but then real work may not take place for several weeks afterwards. Unless a realistic, consistent and careful approach to progress input is maintained, erroneous results occur once a project is rescheduled, and misleading results are reported.

In the time-slice method, progress in a contract is reviewed at the end of each time-slice, and the delays to date are analysed as to their effect and ownership. Future entitlements due to variation instructions should be considered. Ideally, the Engineer/Architect and the Contractor should carry out the process jointly as the contract progresses, enabling each to make decisions about variations, resources and revisions to the future programme logic prior to re-calculating the programme to completion.

Delays can be assessed in the computer in two ways:

- The progress of each relevant activity at a point in time, the time-slice, can be entered, and the programme re-scheduled from that point in time.
- Delays that have occurred during the time-slice can be included in the programme and logically linked to the other activities, and then the whole programme can be re-scheduled.

To carry out a time-slice analysis retrospectively, and particularly if it is not being carried out jointly, it is essential that the alleged delays arising in each time-slice be entered on the programme, and that the whole of the programme be re-scheduled from the beginning. This way, the ultimate critical path or paths will be shown up throughout the whole of the programme (which will practically be a logic-linked as-built programme). This must include inserting changes that have been instructed, but which have not yet started, so that the forecast impact on completion will include all known events at the end of each relevant window period examined.

This will then show:

- What really was important to the completion of the works.
- Whether variation instructions were given timeously, and what their effects were.
- Whether the mitigating measures taken were reasonable.
- That a link between cause and effect exists in all cases of alleged delay to completion.
- That, where there are concurrent delays, the dominant delay has been properly identified.
- That all the logical links in the final programme are valid and reasonable, and represent any changes made on site.

Further, if a 'retrospective analysis' is carried out, and the programme to completion is re-scheduled from each time-slice, a false picture can emerge by failing to reveal the true final critical path through the whole of the project, unless it contains all events known at each time slice or period examined.

7.5.6 The Deductive Approach

This approach takes the 'as-built' programme and adjusts it by deducting the accepted or known delays. This is supposed to arrive back at the earliest date by which the works

would have been complete, but, for the delay suffered, the remaining period is deemed the Contractor's liability. Proponents of this system point to the use of the factual as-built programme and other contemporary records to support their findings and validate their use of this system. However, this system is just as flawed as any other, since, without further adjustment, it fails to take any cognisance of the disruptive effect of delays or the 'knock-on' effects on resources that can occur. Unless these matters are also considered, the result is heavily biased in the Employer's favour, and therefore incorrect. The actual delays suffered, their timing, magnitude and disruptive effects must be considered. This is especially true where the delay is claimed to be due to numerous minor changes rather than one major variation. Some delays can be minor, but a constant delay cycle of late information, instructions and extra works, however minor, can prove a serious drain on resources and management. This costly effect is lost if no examination is undertaken to check the logic changes that occurred, and the reasons for other events being delayed noted. Often delays occur in one area of a site, and the effect is also felt elsewhere due to the delayed release of resources or the access constraints imposed. Provided all the various constraints, resource delays and other events that influence progress are noted, this system should, in theory, return the same answer as any of the others mentioned earlier.

7.5.7 Choice of Method

Which system is adopted is largely a matter of personal choice, or sometimes dictated by commercial realities or the Client's preference for a particular system. The best approach is to unfold the story of the contract from the beginning, so that the effect of each change is analysed in the period in which it occurred, and then move forward through the project to recreate, as far as any theoretical analysis can, what happened. The site records should do this anyway, but correspondence should be considered objectively, as the letters written at the time may not have been a true reflection of opinion but a deliberate attempt to avoid a claim or cover up an embarrassing error. The problem is that the correspondence may later become what the party thinks happened, or would like to believe was what happened, rather than the truth. It would be unwise to construct an analysis based on correspondence alone, as each party to a dispute would have tended to allege 'facts' that supported its case and ignored or 'glossed over' those events that detracted from it. A thorough analysis and interview of the 'witnesses' must be carried out to determine all the facts and form a judgement from that investigation.

7.6 Conversion of Programmes to Alternate Software

When a programme is later analysed in detail as part of a dispute procedure, it is common to find that some experts, when preparing a delay claim for a tribunal, will convert the original programme into a different software system of their own preference rather than using the original system to carry out the analysis. This can cause many problems due to the different ways in which software programmes treat various calendars and how the critical path is calculated. Some software suites assume that all work begins at 8 a.m. and finishes by, say, 6 p.m., so that, where a delay moves an activity, the completion date for that task may be the day before or the day after it was shown using the

previous software. Similarly, logic link calendars may be adopted in one programme in a particular manner and not used at all in another software system. It is much more difficult to compare programmes when there are numerous calendars for different conditions – for example, 7-day working, 24-hour working, night work, weekend working and tidal work. Unless these are handled correctly and checked in detail, the resulting analysis will contain errors. This problem was highlighted in recent cases. For example, in the case of *Skanska Construction UK Ltd. v Egger (Barony) Ltd.* [2004] EWHC 1748 (TCC), Judge Wilcox determined that an expert's conversion of an original programme prepared using Asta Power Project software into Primavera resulted in mistakes within the analysis undertaken (which ran to many hundreds of pages). This particular analysis was also criticised for being overly complex with over 200 charts which were affected by the errors stemming from the method of analysis and conversion of the original programme into Primavera, and the judgement was made using the analysis that had been undertaken using the Asta Power Project software used during construction.

7.7 Critical Path

The critical path or longest path to completion is a figment of planning. It is entirely dependent upon the links between activities and the summation of the activity durations. Further, the critical path can easily be manipulated to show certain sections of the works as more critical than others. This may be achieved by the insertion of certain constraint dates or long lead or lag durations on certain links to force the critical path to follow a particular route. In addition, most computer software allows the user to define what is meant by 'critical' and the number of days float on an activity, which can be used to define the activity as 'critical'. In pure theory, the critical path should be the longest route to completion through activities that have zero float. Changing the software parameters to take anything with less than 5 or 10-days float as critical may be considered perfectly reasonable, as many activities with less than a working week's float may indeed be perceived as critical on site, and any slippage at all will impact on subsequent operations. The point is that any delay assessment must begin with the native software or digital versions of the baseline programme and delay programme presented, so that the analyst can determine what links and alterations are acceptable and which are manipulative.

Another complication of programmes is when resources are inserted into the activities and used to connect activities to balance resource usage. Any resource links between activities can manipulate the critical path by linking together otherwise unrelated sections of the work merely to utilise resources effectively. Such resource links may be valid or may be deliberate to force certain works onto the critical path. Some resources are clearly limited, and their movement around a site between various locations and operations is necessary. For example:

- Piling rigs or very large cranes for certain lifts that have been identified (e.g. large pre-cast concrete beams or steelwork members), concrete paving trains, floating cranes or other very expensive equipment that must be booked and mobilised at certain times because of limited availability.

- Specialist formwork, especially steel shutters for columns, are very expensive, and the planner will attempt to ensure the maximum number of uses in a logical sequence between the various columns wherever they are on the site.

However, apart from specialist resources as described in the preceding paragraph, other logic links such as labour resource links which may have been perfectly valid in the initial programme, and linked to show that they would follow the planned and orderly workflow around the site, may change once construction starts. It is common to find that activities are constructed at different times or take longer for external reasons, in which case these resource links are probably no longer valid. Resource links that were inserted solely for the efficient movement of labour around the site are not as restrictive as specialist plant and equipment. The resource links in the base programme are sometimes changed at the whim of supervisors, merely to keep gangs usefully employed without recourse to the planned sequence of works. Therefore, the impact of delays and external events affecting progress will cause the resource links to change, and these links need to be inspected with the as-built records to reconsider their validity. The constant movement of labour around the site will also cause disruption and production losses, and, while the removal of the labour work-flow links may reduce the impact of a delay, it may add to the total costs because of the inherent time lost relocating and setting up work in alternate areas. The as-built programme may reveal that the whole labour usage and work-flow has become increasingly fragmented, and the difference between the resource utilisation planned and the final as-built usage will assist in assessing the disruption suffered.

Site labour records should show what the labour was doing and where they were working, but it is common to find that such records do not mention being relocated due to events, and it may be impossible from the bare records to identify the degree of remobilisation that occurred. To assess such matters, a database may be needed to show the activities worked on and to compare this with the planned sequence of events. When delay events are inserted into a resource-linked programme, the effect of a delay in one area may show a similar delay in another location seemingly unrelated to the activity but merely linked by a chosen resource path between work items.

Excessive detail, combined with complex logic links and other constraints within a programme, will confuse or obfuscate the critical path and the impact of the changes to the project. With some effort, the main activities on most projects can be distilled to a few key milestones or activities that must be achieved in order that other works can progress and lead to the completion of the project.

7.8 Extensions of Time

All forms of construction contracts include an extension-of-time clause. Such clauses are there to protect the Employer from arguments invoking the prevention principle or, more commonly, to declare that the time for completion is 'at large' if varied or additional work, or other matters for which the Employer is responsible, have caused delays and prevented completion of the works by the prescribed date. This approach argues that

the Contractor is released from its obligation to complete the work by a fixed date (or dates), and instead is only obliged to complete it 'within a reasonable time'. This does not mean the Contractor can take as long as it likes; the period must be reasonable for the remaining work. If a dispute arises, this would be assessed by the relevant tribunal, which would probably rely on expert evidence as to what a reasonable time was to complete the works from the date the issue arose.

Changes and delay events are features of construction, and, over time, the mechanism to deal with such matters evolved into the extension-of-time and variation clauses that exist in all forms of contract. The general principle is that the Architect/Engineer/Contract Administrator will grant an extension of time and set a revised completion date for the effects of any changes or delays for which the Employer is liable under the terms of the Contract, thus resetting the completion date and permitting liquidated damages to run from the new 'extended' date in the event of further delay to completion that is not the fault of the Employer. A common argument raised by Contractors is that a very late extension of time, awarded long after the events that gave rise to the delay, or even after delayed completion of the work, is of no value or effect, and, therefore, time is at large due to the inaction of the Employer or its representatives.

The type of delay event must also be considered. If the alleged delay was caused by additional work instructed, or by a stoppage caused by the Employer or its Agents, adverse weather, etc., the period of delay to the affected tasks can be determined from accurate site records of how long the delay lasted. However, if the delay is caused by a change in the quantity of work, this must also be considered. Where there is an increase in quantity, the impact of this change can be assessed in several ways, but the end result must be a reasonable period of time for the additional work arising from the increase. Basically, the methods for assessing the impact of increased quantities are:

1. From the site records of how long the affected work actually took, and then assessing the adjustment to the planned period for the delay caused by the quantity increase.
2. By reference to the originally planned period of the work, and adjusting that period pro rata for the revised quantity.
3. Where there is no identifiable item on the programme due to the composite nature of an activity, and therefore no discernible output or production rate from the programme, it would then need to be assessed based on 'norms' for the type and quantity of work undertaken – for example, by using recognised price books or texts that detail outputs for similar work. The problem in using such 'norms' is that they must relate to similar work carried out under similar conditions for these notional outputs or 'norms' to represent a reasonable assessment. Outputs are varied by working conditions, site location, the quality of locally available resources, prevailing weather, height above ground, depth below ground, the season, etc.
4. It is not always reasonable to assess the change using the as-built duration, as the contractor may have not had enough resources on site, and all work was taking much longer than planned. For example, if the original duration for an item was 12 days and the quantity increased to double that stated in the contract, it may not be fair to take the actual period and compare it to the planned period for that work. If the actual time taken was 30 days, it would suggest that the delay was 15 days due to the production being achieved on site. However, it can also be argued that the delay

should only be considered based on the originally planned duration of 12 days, and an additional period of 12 days allowed for the doubling of the quantities involved, leaving the responsibility for the remaining period of 6 days (30 minus 24 days) down to the contractor's poor performance on site. Referring to the words of the contract may assist in this assessment and resolve any arguments, as most extension-of-time clauses usually require a 'fair and reasonable' assessment to be made.

8

Direct Costs of Changes/Variations

8.1 Definition

Direct costs are those arising directly from the change or event that has resulted in the additional costs.

Most Contractors are capable of pricing the additional work instructed based on contract prices, industry norms, labour records, etc. Often what is not considered is the attendant costs that go with any work that causes some delay to an activity. These are not consequential costs – the impact of extra work or some other event on production and progress is a direct effect. This means that the direct costs of a change or delay event are all those factors that are affected – all labour, plant and supervision involved, and not just the resources performing the work. Production resources are obviously the labour, plant and equipment carrying out work or being disrupted or delayed by an event, but the supporting resources will be affected if the event delays completion of the task, the work section or the entire project. Where an event delays project completion, details should be recorded of the management, supervisors and engineers, together with any site-based offices, support staff, cleaners, yard labour/distribution labour, plant, etc., that are all affected by a project overrun, and these costs flow directly from the events or changes that caused the delay. If an event only affects a section of a project, that section may also have dedicated resources, supervision and equipment that are retained in the location for longer than anticipated.

When the cause of delay to the project is a massive change in quantities as compared to those set out in the original Bills of Quantities, the increase or decrease may or may not affect the rates and prices for the unit costs of performing the work, but it will naturally have an effect on the duration of the work. Large increases in quantities will result in the work taking much longer than expected, and this additional duration may, in turn, delay the completion date. It is important to review any activities that are at or near the critical path (i.e. work with very little or zero float on the programme). Should such near critical work be delayed, it can change the critical path and result in a delay to completion. A significant change in the quantities of work (either increases or decreases) may also affect the fundamental elements of the rates and prices. For example, on a major road project, an underestimation in the Bill of Quantity (BOQ) for unsuitable material to be excavated for disposal off-site might result in the available spoil tip being filled long before the work is completed, and a new tip would have to be located. The additional tip might be some distance from the project, resulting in additional unit costs, and may (depending on the haulage distances and transport plant used) require a

different transport plant – for example, road transport rather than dump trucks, which will be restricted in terms of capacity and working hours on public roads. The distance from the site to the new tip may result in each load taking much longer, requiring either additional transport or causing a delay to the work. In such circumstances, the unexpected change in quantity has resulted in a fundamental difference between what was originally priced and the time and cost incurred in carrying out the additional volume of work.

Some contracts dictate that a change in quantity must be greater than a certain percentage of the original figure or of a proportion of the contract price before a new rate or price would be fixed. For example, a motorway contract with a total of 2 000 000 m³ of excavation suffering an increase of 200 000 m³ of unsuitable excavation may seem to be a small change (10%), but a tip to accommodate the extra 200 000 m³ would be sizable. In any event, the claim can be made on two heads: the unexpected increase in volume of unsuitable material due to poor ground conditions as compared to that indicated in the contract ground investigation, and the increased quantity from that described in the BOQ, the combined effect of which is to render the original rates and prices inappropriate for valuing the change. The price for the varied quantities would have to include locating a suitable tip, obtaining permission, payment of royalties or fees, erecting fences or barricades around the area, and its access and egress points, in addition to the cost of plant needed for depositing, spreading, compacting and maintaining the material. There may also be some costs of final landscaping and reinstatement of the surface once deposition of material has finished. If the new tip is at some distance from the original location, there would be a change to the haulage cost, and perhaps an increase in transport plant. The point of this example is to show that each change has to be investigated on its merits and the correct price for the varied work calculated accordingly.

8.2 Prolongation Cost/Extended Site Expenditure

The costs claimed for delay are termed ‘prolongation costs’, and these all arise directly out of delays to the completion and include all items of time-related expenditure. Such costs would include, but not be limited to, staff and supervision, offices, mess facilities, workshops, storage areas, cranes, transport, batching plants, land rental, fees, insurances, bonds, site security, etc. In addition, there would be time-related labour and plant to value – for example, service gangs or general support labour (people that do not perform any measured work but service those that do, such as material distribution or maintaining and fuelling plants), pumps, lighting towers and task lighting equipment, tower cranes, generators, site materials transport (tractors and trailers, forklifts dumpers, etc., and their drivers), etc. A further claim is often made for off-site overheads such as regional offices or head offices that have been affected by the delay to the project.

In some instances, items that were originally priced as work-related can become time-related due to the delays on the project – for example, concrete gangs, which are mobilised from the first pour and will stay until the very last pour, even if the volume of concrete remains unchanged during the project. Also, if a crane is mobilised for a particular series of lifts, and the work that requires the crane is delayed by variations or other events, then the cost of the crane must form part of the time-related expense

arising from the delay. The method of presenting these time-related costs is usually a schedule with names of staff, labour, plant and equipment claimed set against time in a matrix that shows the week in which they began and finished on the project. Claims for the costs of time-related labour and plant require a written explanation to state why these costs were or have become time-related and are no longer directly related to the amount of work performed.

8.3 Overheads

All companies have to finance the costs of providing their head office and/or regional offices to manage and control the business. The money for this expenditure comes from the margin contribution provided by the various projects undertaken each year. When a project that contributed a large portion of overhead recovery is delayed, the late completion is usually combined with lower cash flow, resulting in an under-recovery of overheads contribution from that project during the period of delay. This is not a claim for loss of profit; it is a claim for under-recovery of operating costs caused by the delayed project.

The problem with claims for head office costs involves proving that the reduced contributions during the delay period actually impacted on the head office running costs. If, for example, the Contractor had other projects that were ahead of schedule and making a profit, the impact of the delayed site may not be so severe. Traditionally, this type of claim was put forward as a formula-based calculation showing the proportion of head office costs represented by the project over its duration to calculate the anticipated overhead recovery per week. The Society of Construction Law publishes a free download showing the various formula and the differing calculations involved.

9

Disruption

Disruption can be extremely difficult to prove, depending on the quality of the site records kept, but it is something that everyone has suffered at one time or another. For example, late trains, buses, traffic jams, etc., can cause a 'knock-on' effect on the rest of one's journey and the remainder of the day.

9.1 Definition

A typical dictionary definition of *disruption* would include any or all of the following: disruption of one's plans, disturbance, disordering, disarrangement, interruption in normal work patterns, interference, upset, confusion, disorganization, turmoil, disarray; suspension, discontinuation, stoppage; obstruction, impeding, hampering, spoiling, ruining, wrecking, undermining; holding up, delaying, delay, retardation.

I prefer a simpler definition. *Disruption* is the hindrance, stoppage or interruption of the regular and planned progress of work, resulting in production loss and increased costs.

9.2 Delay and Disruption

Delay and disruption are not the same things. Delay may affect the date for completion, whereas disruption results in production loss and increased costs, but may not result in a delay to completion unless the activities affected are on the planned critical path or the affected tasks become critical. If a delay causes the completion date to slip, this may result in an extension of time for completion. Such matters are stipulated in specific clauses in all major forms of construction contracts and generally relate to matters for which the Employer is liable under the terms of the contract, or for other neutral risks that are clearly specified (e.g. adverse weather or force majeure).

The major source of disruption may not be just a few large variations, it is just as likely to come from a combination of numerous small changes, revised drawings, varied work or late information and other delays. The timing of such numerous changes and other events can cause disruption due to their impact on the regular and planned progress of the works; late information or the issuance of new and varied drawings can all cause fragmented and disrupted work patterns. Only when disruptive events are on,

or in some way affect, the critical path will they also result in a delay to completion. Disruption claims always concern claims for additional payment for production losses caused by the timing and impact of changes and delays suffered that in combination have reduced outputs and prolonged the duration of tasks. Delays caused by lack of design information or dimensions can cause serious delays and alter the sequence of work. Even when answers are provided, they may not significantly alter the original scope of work, but they will have taken time to obtain the missing information which will have impeded progress. Where there is a continual need for further or corrected information, this causes a break in the sequence and timing of work, and the resulting effect on production will be considerable. The time spent having to research drawings, looking for missing details or dimensions, can result in work having to stop or diverts resources away from the planned tasks while these details are obtained.

In addition, if there are numerous events causing delay and disruption on a project, the cumulative effect of several causes can result in a general loss of production, affecting activities not directly impacted by those events, but which nevertheless suffer prolongation or loss of productivity. In such cases, the cumulative impact of these events on the general progress of work may also cause a delay in completion of the project. There are many factors that lead to disruption; it can be considered as the impact of one event upon another or a series of events that cumulatively reduce overall production and lead to the extended duration of work activities and additional costs. Severely disrupted projects tend to show a tail off in terms of production, and all activities begin to suffer from a general slowing down or reduction of output. Where this causes activities to become fragmented or disjointed as compared to the originally planned sequence, then wholesale disruption can occur. This also affects the morale of the staff and workforce, leading to a general lack of progress, and operations begin to slow down as the workers become disillusioned about the prospect of making good money. It becomes apparent when observations record progress slowing down everywhere, with delays being incurred in all areas, and not in just the critical path activities. In such cases, where projects suffer an increasing number of changes and delays – due to dozens or even hundreds of requests for further information; release of revised and new drawings or sketches to explain details or add work; and instructions (oral and written) and formal variation orders (VOs) requiring additional or varied work performed – the overall progress and production suffers.

Disruption claims usually include the loss of sequence and extended duration of all activities caused by a combination of waiting time in relation to the release of information or answers to requests for further information, together with the impact of instructions issued requiring additional and varied work. Where there are many instances of technical queries or further information requests, and these take time to resolve, the intended flow of work and sequence are often lost. The Contractor will re-deploy its resources to other activities to mitigate standing time. These resources may later return to the original work once instructions or answers are received. Or, if they are no longer free, then alternative resources are deployed. Each time resources are moved to and from new or alternative work, some production time is lost during the relocation period, and again while materials, information and equipment are organised to service the new work area. If the alternate work is entirely different from the planned work, there may also be a learning curve effect while the drawings are read and understood, and work begins. If such relocations become a common event due to numerous delays, the production losses

and learning curve delays combine to create further losses on the new/replacement activities, and an overall disruption to work occurs.

9.3 Global Claims

The remaining matter to consider in terms of time and disruption claims is the ‘global’ approach, which combines all the prolongation elements described in the preceding text with disruption to production resources, and seeks to evaluate all these factors almost on a residual cost basis – the general view being that the work was so badly disrupted that none of the rates or prices truly reflect the works as executed.

9.3.1 Cumulative Impact/Ripple Effect

These are essentially global disruption claims, and they have some recognition in the US courts, where a cumulative impact claim is a valid proposition. In the UK, the ‘global claim’ approach was first established in the case of *Crosby v Portland UDC*. However, merely because a court recognises the principle of a ‘global disruption’ or ‘cumulative impact’ claim, this does not mean that the Contractor can merely assert such an occurrence to get paid. As usual, while the principle is considered sound, it relies on facts and records to prove that such an occurrence happened. Courts in both the UK and US are not easily convinced that an award or payment should be made, and require documentary evidence to demonstrate the allegation.

In the UK, acceptance of a global claim requires proof of all the various changes and delays complained of and allocation of the alleged costs to each of the discrete heads of claim, in sufficient detail, before a rolled-up or global award will be made for the remainder. A global or cumulative impact claim seeks to argue that, in addition to the direct effects of all the variations or other delaying events cited, the effect of these matters, each acting one upon the other, has caused disruption and production losses on all surrounding ‘unchanged’ activities. The clearest description of a global claim and the court’s opinion on its validity remains that cited in *Crosby v Portland*, but there is a host of other cases which have shown that the court will require considerable proof based on detailed factual records to show that this actually occurred before it will accept that this is a valid approach for reimbursement. This means that, to succeed in such a claim, it is necessary, wherever practically possible, to separate the various events and elements of a claim into its constituent parts and to analyse the impact of each of the changes and delays on production and activity duration. Where these events are numerous and continual, the process must still focus on showing that the interaction of these events one on another has impeded progress, reduced production and kept valuable resources in the disrupted work area when they should have been moved on to the next operation.

Where the extent of late information, changes and delays become extreme and the planned sequence and timing of work is lost, crisis management takes hold. The supervisors end up ‘fire-fighting’ to keep the labour busy, with such actions combining to make the site appear mismanaged and disorganised. In the extreme case, this means that the planned sequence is completely lost, causing interrupted and disjointed work patterns, and production levels are not achieved anywhere on the site. Resources are constantly shuffled from one task to the next to mitigate standing time. The result is

a dramatically increased unit cost of work beyond the allowances made in the original contract price. Where accurate records are kept, the fragmentation of work patterns, site moves, resource relocation and the extended duration of activities will be supported by production information from the field, and the claim will be much easier to prove. In addition to the direct effects, disruption tends to cause production losses on other operations not directly altered by the claimable events, but which also suffer a loss of production due to the impact of continual delay or relocation of resources, and the loss of planned sequence and the impact this has on progress and morale.

On a site that suffers continual change, delays and time lost waiting for information or further instructions, the planned sequence becomes interrupted, and resources are shunted from task to task to avoid standing time costs. What happens is that the project deteriorates into a chaotic sequence of work driven by outside events. The resources lose continuity of work, and production suffers due to the constant moving to and from tasks (not always in the same location). The teams become demoralised from the drop in their performance levels owing to these changes and the restricted areas available where work can proceed unhindered. Production losses will continue to spiral out of control until the regular and planned sequence is recovered (if at all). This results in all operations suffering, and not just those directly affected by the delay events. This downward trend can affect direct resources and subcontractors alike, and, in extreme cases, the labour will become disgruntled and start to leave the site. Subcontractors will start to complain and seek extra payment or demand that their work be converted from measured work/priced work into a time and materials or 'dayworks' basis to reduce their exposure to such losses. This leaves the Main Contractor having to absorb such additional costs until they can be recovered by means of a successful claim.

The main issue for construction sites is that of complexity. A project that suffers delays caused by numerous events, late information, dozens (if not hundreds) of revised drawings, unforeseen ground conditions, late replies to technical queries or requests for further information, which all combine to delay and disrupt the regular and planned progress of the works, will be in chaos. If the number of instructions and changes increases to the point where every activity suffers varying periods of delay and additional works, the sum of which do not fundamentally change the overall contract but conspire to delay and disrupt its construction, the effect is one of 'the death of a thousand cuts', wherein nothing planned occurs as intended without some change or delay affecting it. Whether these changes are minor or large, the overriding impact is that the planned sequence, timing and duration of work is lost, and progress becomes fragmented, causing production to deteriorate. This affects the morale of the workforce as its ability to produce completed work and earnings are continually reduced. The site becomes disorganised as work is performed out of sequence, requiring several return visits to areas to complete work due to delayed information or late changes. The result in terms of progress and performance is exponential as production and planning descend into chaos and disorder, and management is constantly 'fire-fighting' to resolve matters and divert resources to other operations to mitigate standing time and achieve some progress.

A detailed as-built programme prepared for a project disrupted in this manner will show the various activities, scattered with small bursts of activity followed by periods of delay while problems are resolved. Constantly having to move resources around to progress some work and then returning to the originally planned activity once the

problem materials or information is provided causes delay that can be exacerbated as the diverted workforce complete their unplanned activity before returning to what was originally intended. This invariably results in additional resources being deployed to cope with the level of changes and out-of-sequence work. In effect, numerous smaller changes and delays can detract from production more than a few large variations, which can more easily be resourced and managed. If there is a constant flow of minor changes and late information delaying production, resources become depleted as they constantly get moved from one operation to another, and morale and confidence in the management deteriorates. Moving resources from one operation to another and back again causes logistical problems and delays while the alternate work is organised: materials, drawings and setting out must be prepared before the alternative work can commence. Each time the resources move, a new 'learning curve' occurs, further reducing production, which is added to the disruptive effect of moving men and equipment or materials around the site. This is sometimes referred to as the 'ripple effect', which is really another name for a cumulative impact claim. This occurs when the cycle of delay, transfer/relocation and return, and then further delay, etc., begins to repeat, causing the production on site to degenerate, resulting in all hopes of achieving the target programme and operational efficiency being lost. Operations decline into a series of disrupted and disjointed activities in fragmented locations.

Where a project has suffered numerous changes and delays for which the Employer is liable under the contract, it is often dealt with by the Contractor submitting a global claim to sweep up all the production losses and other expense incurred, rather than providing a detailed submission for each head of claim. While the courts now seem to be less strict on the validity of submitting global claims, there are still considerable hurdles that the claimant must clear before the global submission is accepted. The Society of Construction Law (SCL) Delay and Disruption Protocol, at core principle 19, tends to discourage the submission of a global claim without substantiating cause and effect. Until some notable recent cases, the courts would often strike out a global claim for lack of particularisation of cause and effect. The 2002 edition of the SCL Delay and Disruption Protocol discourages the making of composite or global claims by Contractors. Paragraph 1.14.1 and 1.14.2 of the Guidance Notes to the Protocol states:

1.14.1 The not uncommon practice of contractors making composite or global claims without substantiating cause and effect is discouraged by the Protocol and rarely accepted by the courts.

1.14.2 If the Contractor has made and maintained accurate and complete records, the Contractor should be able to establish the causal link between the Employer Risk event and the resultant loss and/or expense suffered, without the need to make a global claim. The failure to maintain such records does not justify the Contractor in making a global claim.

The Protocol contains detailed guidance as to the keeping of records. The 2017 update of the SCL Protocol now states:

If there exists a contractual obligation upon the contractor to maintain particular types of records, perhaps in a defined format with a certain degree of detail, then, if a failure to do so results in the pursuit of a global claim, it is not difficult to see

that this would be another factor for a tribunal to consider when determining the merits of a global claim. However, in the post-John Doyle era, it seems unlikely that an assertion by an employer that a contractor has failed, in breach of contract, to maintain certain records would form the basis of a successful strike out application. The quality of records maintained is plainly a question of degree, and detailed consideration would be required of (a) the records in existence and (b) the reasons for the non-availability of other records.

... An employer might be well advised to insist, by way of express contractual provisions, that a contractor maintains the records recommended by the Protocol. This may limit the necessity and opportunity for making a global claim, but it is unlikely it is suggested, to eliminate it entirely.

The first time the English courts allowed a global claim to succeed on a construction project was in the decision of *J. Crosby and Sons v Portland Urban District Council* [1967] 32BLR 121 Q.B.D. This was an appeal against an arbitrator's award. The arbitrator had awarded sums on a composite or rolled-up basis. The award was upheld by the court with the following comment on the rolled-up award:

... The result, in terms of delay and disorganisation, of each of the matters referred to above was a continuing one. As each matter occurred, its consequences were added to the cumulative consequences of the matters which had preceded it. The delay and disorganisation which ultimately resulted was cumulative and attributable to the combined effect of all these matters. It is therefore impracticable, if not impossible, to assess the additional expense caused by delay and disorganisation due to any one of these matters in isolation from the other matters...

In his judgement on the preceding approach when the issue came before him on appeal in the High Court (Queen's Bench Division), Justice Donaldson (as he then was) said:

... The claimants disavow any intention of founding a claim upon clause 52(iv) or upon clause 66 of the contract [then the *Institution of Civil Engineers form of Contract* 4th]. They say that where you have a series of events which can be categorised as denial of possession of part of the site, suspensions of work, as variations, the result is, or may be, that the Contractor incurs the extra expense by way of overhead expenses and loss of productivity; these extra costs are all recoverable directly under clause 40 or clause 42, or indirectly under clauses 51 and 52. They say 'indirectly' because any revised rate or price and the scheduled daywork rates must include a large cost element even if they go further than this and also cover profit. Since, however, the extent of the extra cost incurred depends upon an extremely complex interaction between the consequences of the various denials, suspensions and variations, it may well be difficult or even impossible to make an accurate apportionment of the total extra cost between the several causative events. An artificial apportionment could of course have been made; but why, they ask, should the Arbitrator make such an apportionment which has no basis in reality? I can see no answer to this question, extra costs are a factor

common to all these clauses, and so long as the Arbitrator does not make any award which contains a profit element; this being permissible under clauses 51 and 52 but not under 41 and 42, and provided that he ensures there is no duplication I can see no reason why he should not recognise the realities of the situation and make individual awards in respect of those parts of the individual items of the claim which can be dealt with in isolation and a supplementary award in respect of the remainder as a composite whole.

This view was reinforced by Justice Vinelott in the case of *London Borough of Merton v Stanley Hugh Leach* [1985], 32 BLR 51, which considered the approach in Crosby. Indeed, the judge approved the decision and went on to clarify the rules concerning the ability to make a rolled-up award. The essential point to remember is the criteria to be met before a global or rolled-up claim would be allowed to succeed:

... a rolled-up award can only be made in a case where the loss or expense attributable to each head of claim cannot in reality be separated, and secondly that a rolled-up award can only be made where, apart from that practical impossibility, the conditions which have to be satisfied before an award can be made have been satisfied in relation to each head of claim.

This has been referred to in subsequent cases, and various rules were established relating to the permissibility of a global or rolled-up claim.

As discussed under 'Crosby', there are certain limitations to this approach, and certain guidelines were laid down in the subsequent case of *Merton v Stanley Hugh Leach*.

In the case of *McAlpine Humberoak v McDermott International* [1992] 52 BLR 1, this case related to a global claim that was challenged and on appeal, following the initial decision (*McAlpine Humberoak v McDermott International Inc.* [1992] AC [6 March]), the Court of Appeal rejected the original claim and decided that McAlpine Humberoak failed on an examination of the facts. Having determined that the first judgement was wrong, the Court of Appeal decided that it would re-examine the basis of the claim and determined that the whole exercise lacked credibility. Entitlement or notional claims remain a valuable if theoretical way of demonstrating the complex interaction and effects of variations, etc., on a large contract – provided always that the result is not based on wild assumptions and bears some resemblance to what actually happened. In respect of 'time at large' claims, the case is not the authority for the position on contracts that contain a liquidated damages clause. The proposition was argued by McAlpine, but they lost because their contract had no liquidated damages. McDermott's remedy for late completion was strict proof of loss incurred. To examine this point further, let us consider the case in a little more detail. The important things to understand about this case with respect to making claims are as follows:

1. The issue here was not the principle that any global claim must fail, and that was not the court's finding.
2. The real reason behind the appeal was that the judge in the original trial (who had spent months sifting through the claim, aided by two technical assessors) eventually determined that the original contract had been frustrated.
3. Having thus torn up the contract, he was free to pay McAlpine on a cost-plus basis for all subsequent events.

4. Therefore, the initial referral to the Court of Appeal was on the basis that the judge of the first trial had made a serious error of law in this finding. However, the court went on to decide that leave to appeal was available also on the correct interpretation of the factual evidence (i.e. the delay and costs details).
5. On the first issue, the Court of Appeal found that the judge had indeed made an error of law. Therefore, the initial basis of the first judgement had been overturned, and McAlpine was now exposed to the court's ruling on a proper basis for the evaluation of their claim.
6. The court decided that they preferred the assessment of McDermott to that of McAlpine. McDermott had employed an expert to produce their version of the events, as had McAlpine; the essential difference was the approach.
7. McDermott's expert had produced a blow-by-blow account of the contract that examined each variation/drawing issue, etc., and its impact on the works from the signing of the contract to 'completion'.
8. McAlpine's expert had produced an 'entitlement' programme, which was not aligned to reality and grossly over-assessed their claim. It assumed that, if one man was working on a VO for 1 day, then the whole contract was held up for that day. The court's finding was influenced by the unreality of this type of submission; the illustration of this – in McDermott's counsels' words, *the reductio ad absurdum*¹ – was a claim for 1 day's prolongation of the works for an inspection which only took 1 hour and for which the agreed daywork account came to £39!
9. The astonishing point here is that the court, which had already overturned the basic finding of frustration on a purely legal interpretation, then completely reversed the finding of fact based on the trial transcripts and despite the opinion evidence of the assessor and without the benefit of seeing and hearing the various witnesses.

The lessons to be learned from this case are as follows:

- Always check an entitlement or notional programme-based claim against what happened, and refine it accordingly.
- Ensure that site records and correspondence properly note any event that resulted in a delay (however apparently trifling the event); for example, an unreasonable refusal to inspect a foundation prior to a concrete pour may result in that pour being cancelled, causing a 1-day delay to the programme, whereas the inspection may have only taken 2 hours.
- The remaining matter to consider in terms of time and disruption claims is the 'global' approach, which combines all the prolongation elements described in the preceding text with disruption to production resources and seeks to evaluate all these factors almost on a residual cost basis – the general view being that the work was so badly disrupted that none of the rates or prices truly reflect the works as executed.

Another case that served to outline the extent and expense that a claimant must go to when presented a global claim was *AMEC Process and Energy Ltd. v Stork Engineers and Contractors BV* [2002] EWHC B1 (TCC) (15 March 2002).

This was a global claim that succeeded at trial, but there were separate trials regarding the costs claimed. The trial about costs is a good example of the complexities and problems associated with preparing such a complex global claim. In his judgement, his Honour Judge Thornton QC set out his opinion regarding the problems with global

1 The disproof of a proposition by showing the absurdity of its inevitable conclusion.

claim. In his judgement he set out the issues that had arisen since the earlier decisions in *Crosby v Portland* and *Wharf Properties Ltd. v Eric Cumine Associates*. The judgement was the finalisation of three trials on the facts and principles of the case and claims for reimbursement of all expert and legal costs incurred presenting the claims. The judgement outlined the problems associated with presenting a global disruption claim as follows:

3.4.2. The Problems Confronting the Claims Team

25. The team were acutely aware of the problems of claim presentation arising from the Wharf Properties case and other cases concerned with disruption claims of a global nature. The team saw the problems as being these:

1. Disruption, particularly when it had been so extensive and caused by so many different causes, is difficult to establish, and a causal link between individual causes and losses almost impossible to show.
2. Global claims, that is, claims which are based on establishing that the totality of disruption losses was caused by the totality of causative events, may in principle be claimed, but are likely to fail unless each supporting fact is established in full.
3. There is no agreed or clear-cut method or methods of identifying and quantifying disruption, and many of the available methods are widely held to be incapable of satisfying empirical, contractual or evidential standards of proof.
4. Whatever method of proof is adopted, the pleadings should set out a party's case as to causative events, causation, loss and methods of proof with sufficient clarity so as to enable the opposing party to know what case it is facing, to prepare its own case and to provide a manageable agenda for the trial. In particular, a claiming party should set out what case, if any, it is advancing as to how any global or rolled-up claim should be reduced or valued in the event of it achieving only partial success in the proof of the primary facts that it is relying on.
5. Where the project, as this one, was a large one with many thousands of documents and with many documents in electronic form, the marshalling of the data and its analysis would depend, in part, on the use of appropriate software. Choosing the appropriate programs, adapting the programs and loading the software with the primary data would be difficult, skilled, time-consuming and expensive operations, and much care and thought would be needed in these exercises.
6. The preparation of the evidence to support the claims would involve a huge task of assembly and presentation so that it emerges in a reliable and meaningful form. There was, in reality, no obvious dividing line between the pleadings and particulars setting out the claims, the primary evidence needed to establish the claims, the methods of analysis needed to marshal and analyse the evidence and the expert quantity surveying evidence needed to reach conclusions as to the causes and consequences of disruption that had occurred.
7. At every stage of preparation, AMEC would have to tread an almost impossible dividing line between failing to particularise its case sufficiently and providing so much detail that no clear-cut agenda for trial had emerged.

8. Given Stork's attitude to AMEC's claims that had been displayed throughout the lengthy process of applications, discussions, negotiations and settlement talks, it was reasonable to anticipate that Stork would seek to harry AMEC procedurally at every step along the road to trial, and therefore the procedural steps had to be prepared with unusual care and detail.
9. Stork would contest each part of each step along the road to recovery. This contested approach would include Stork disputing the following: the existence of the primary facts relied on; the allegations of causation and loss; the contractual basis of claim; the authenticity of the records relied on; the existence of the suggested procedural preconditions to payment; and the suggested methods of establishing the claims by resort to sample modules and lump sum or global methods of proof. Stork would also seek to show that AMEC had mismanaged the project in almost all of the steps that it had taken.

While the preceding hearing was concerned with the claims for payment and recovery of legal and expert witness costs incurred, it clearly sets out the hurdles that a claimant must clear to succeed in a global disruption claim in the English courts. The basic premise is that all variation clauses contain rules which enable revised rates and prices to be claimed if the works have:

- a) Changed in quality, quantity or character.
- b) The sequence, timing and method of working has been varied.
- c) The individual duration of work tasks has been extended due to the changes and delay events.
- d) That the preceding has had an impact on the integrity of the original rates and prices (which includes preliminaries and temporary works).

9.3.2 *John Doyle v Laing*

In the more recent case of *John Doyle Construction Ltd. vs Laing Management (Scotland) Ltd.* [2004] BLR 295, the approach to dealing with global claims was reviewed at length. John Doyle was engaged as a Works Contractor by management contractors (Laing) to carry out certain works for the construction of a new headquarters for Scottish Widows. The contract was an amended form of Scottish Works Contract (1988). John Doyle sought an extension of time of 22 weeks, made a substantial claim for loss and expense, and a claim upon the final account. The loss and expense claim was calculated utilising a comparison between pre-contract estimates and actual costs (ACs) – that is, a global claim. Laing accepted that, in principle, it was permissible to advance such a claim if it were impossible to trace the causal nexus between each individual event and each item of loss, although the burden of showing this was upon John Doyle. Laing maintained, however, that such an approach was only permissible if the following were true:

1. John Doyle was not itself responsible for any increased costs.
2. Laing was responsible for all the causal factors that contributed to the increased costs; and since, on the facts, it could be readily demonstrated that an element of the delay was not the fault of Laing, one of the essential factors for a global claim to succeed was absent. Accordingly, Laing contended that John Doyle's claim should not be allowed to proceed to trial.

On appeal, the Inner House Court of Session (Lords MacLean, Johnston and Drummond Young) dismissed Laing's appeal. In doing so, the Inner House's judgement contained an important reassessment of the current law on global claims (although not strictly binding on the courts in England and Wales); this judgement stated as follows:

[5] The Lord Ordinary began his discussion by pointing out that the case was not concerned with whether a global claim for loss and expense may relevantly be advanced by a contractor under a construction contract. The debate had proceeded on the common ground that such a claim could in principle be made and referred to earlier cases: *London Borough of Merton v Stanley Hugh Leach Ltd.* (1985) 32 BLR 51; *Wharf Properties Ltd. v Eric Cumine Associates* (1991) 52 BLR 8; *John Holland Construction & Engineering Pty Ltd. v Kvaerner RJ Brown Pty Ltd.* (1996) 82 BLR 81. The pursuers had averred that, despite their best efforts, it was not possible to identify causal links between each cause of delay and disruption and the cost consequences thereof. On that basis, the defenders accepted that the pursuers were in principle entitled to advance a global claim. The Lord Ordinary nevertheless reserved his opinion as to whether an averment of that nature was essential to the relevancy of a global claim, what is required to prove such an averment and what the consequences of failure to prove it might be.

[35] Ordinarily, in order to make a relevant claim for contractual loss and expense under a construction contract (or a common law claim for damages) 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. In some circumstances, relatively commonly in the context of construction contracts, a whole series of events occur which individually would form the basis of a claim for loss and expense. These events may inter-react with each other in very complex ways, so that it becomes very difficult, if not impossible, to identify what loss and expense each event has caused. The emergence of such a difficulty does not, however, absolve the pursuer from the need to aver and prove the causal connections between the events and the loss and expense. However, if all the events are events for which the defender is legally responsible, it is unnecessary to insist on proof of which loss has been caused by each event. In such circumstances, it will suffice for the pursuer to aver and prove that he has suffered a global loss to the causation of which each of the events for which the defender is responsible has contributed. Thus far, provided the pursuer is able to give adequate specification of the events, of the basis of the defender's responsibility for each of them, of the fact of the defender's involvement in causing his global loss, and of the method of computation of that loss, there is no difficulty in principle in permitting a claim to be advanced in that way.

[36] The logic of a global claim demands, however, that all the events which contribute to causing the global loss be events for which the defender is liable. 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. A global claim, as such, must therefore fail if any material contribution to the causation of the global loss is made by a factor or factors for which the defender bears no legal liability. ... The point has on occasion been expressed in terms of a requirement that the pursuer should

not himself have been responsible for any factor contributing materially to the global loss, but it is in my view clearly more accurate to say that there must be no material causative factor for which the defender is not liable.

[37] Advancing a claim for loss and expense in global form is therefore a risky enterprise. Failure to prove that a particular event for which the defender was liable played a part in causing the global loss will not have any adverse effect on the claim, provided the remaining events for which the defender was liable are proved to have caused the global loss. On the other hand, proof that an event played a material part in causing the global loss, combined with failure to prove that event was one for which the defender was responsible, will undermine the logic of the global claim. Moreover, the defender may set out to prove that, in addition to the factors for which he is liable founded on by the pursuer, a material contribution to the causation of the global loss has been made by another factor or other factors for which he has no liability. If he succeeds in proving that, again the global claim will be undermined.

[38] The rigour of that analysis is in my view mitigated by two considerations. The first of these is that while, in the circumstances outlined, the global claim as such will fail, it does not follow that no claim will succeed. The fact that the pursuer has been driven (or chosen) to advance a global claim because of the difficulty of relating each causative event to an individual sum of loss or expense does not mean that after evidence has been led it will remain impossible to attribute individual sums of loss or expense to individual causative events. The point is illustrated in certain of the American cases. The global claim may fail, but there may be in the evidence a sufficient basis to find causal connections between individual losses and individual events, or to make a rational apportionment of part of the global loss to the causative events for which the defender has been held responsible.

[39] The second factor mitigating the rigour of the logic of global claims is that causation must be treated as a common sense matter. ... That is particularly important, in my view, where averments are made attributing, for example, the same period of delay to more than one cause.

Conclusion

[32] For the foregoing reasons, we are of opinion that the Lord Ordinary's decision was correct. We will accordingly refuse the reclaiming motion [12]. Perhaps the most detailed description of total cost claims is found in *John Holland Construction & Engineering Pty Ltd. v Kvaerner RJ Brown Pty Ltd.*, supra, a decision of the Supreme Court of Victoria. In that case, Byrne J. stated (at 82 BLR 85-87): "The claim as pleaded ... is a global claim, that is, the claimant does not seek to attribute any specific loss to a specific breach of contract, but is content to allege a composite loss as a result of all of the breaches alleged, or presumably as a result of such breaches as are ultimately proved. Such claim has been held to be permissible in the case where it is impractical to disentangle that part of the loss which is attributable to each head of claim, and this situation has not been brought about by delay or other conduct of the claimant..."

Further, this global claim is in fact a total cost claim. In its simplest manifestation, a contractor, as the maker of such claim, alleges against a proprietor a number of breaches of contract and quantifies its global loss as the actual cost of the work less the expected cost. The logic of such a claim is this: the contractor

might reasonably have expected to perform the work for a particular sum, usually the contract price; the proprietor committed breaches of contract; the actual reasonable cost of the work was a sum greater than the expected cost.

The logical consequence implicit in this is that the proprietor's breaches caused that extra cost or cost overrun.

This implication is valid only so long as, and to the extent that, the three propositions are proved and a further unstated one is accepted: the proprietor's breaches represent the only causally significant factor responsible for the difference between the expected cost and the actual cost. In such a case, the causal nexus is inferred rather than demonstrated. ... The understated assumption underlying the inference may be further analysed.

What is involved here is two things: first, the breaches of contract caused some extra cost; secondly, the contractor's cost overrun is this extra cost. The first aspect will often cause little difficulty, but it should not, for this reason, be ignored. ... It is the second aspect of the understated assumption, however, which is likely to cause the more obvious problem because it involves an allegation that the breaches of contract were the material cause of all of the contractor's cost overrun. This involves an assertion that, given that the breaches of contract caused some extra cost, they must have caused the whole of the extra cost because no other relevant cause was responsible for any part of it.

Byrne J. went on to consider the claim made by the plaintiffs in the case before him, and pointed out that, because it was a total cost claim, it was necessary to eliminate any causes of inadequacy in the tender price other than matters for which the employer was responsible. It is also necessary to eliminate any causes of the overrun on the construction cost other than matters for which the employer was responsible.

If, however, the contractor is able to demonstrate that all of the events on which he relies are in law the responsibility of the employer, it is not necessary for him to demonstrate causal links between individual events and particular heads of loss. In such a case, because all of the causative events are matters for which the employer is responsible, any loss and expense that is caused by those events and no others must necessarily be the responsibility of the employer. That is in essence the nature of a global claim.

A common example occurs when a contractor contends that delay and disruption have resulted from a combination of the late provision of drawings and information and design changes instructed on the employer's behalf; in such a case, all of the matters relied on are the legal responsibility of the employer. Where, however, it appears that a significant cause of the delay and disruption has been a matter for which the employer is not responsible, a claim presented in this manner must necessarily fail.

If, for example, the loss and expense has been caused in part by bad weather, for which neither party is responsible, or by inefficient working on the part of the contractor, which is his responsibility, such a claim must fail.

In each case, of course, if the claim is to fail, the matter for which the employer is not responsible in law must play a significant part in the causation of the loss and

expense. In some cases, it may be possible to separate out the effects of matters for which the employer is not responsible.

9.3.3 Conclusion

It is clear from the preceding extracts that the law in relation to global claims has evolved following numerous cases, each of which has tried to find an equitable solution allowing for the practical difficulties of the claimant in presenting such a case and the right of the defendant to know and understand the case being brought against it. Global claims should still be considered as the exception rather than the rule due to the difficulties and risks of pursuing a claim through the courts. A party pursuing such a claim must recognise the complexities and risks involved in making a claim and what may happen at trial. Further, as with all claims for additional payment, the ultimate requirement is always one of proof. The legal maxim of 'he who asserts must prove' still applies, and any disruption calculation requires detailed labour and plant allocation records for every man, machine and work gang. Such records are necessary to show where the labour and plant were each day and what they were doing, or where they moved to or if they were standing awaiting decisions. Set against this, there must be reliable measurements of the production achieved, so that the input hours can be shown as a ratio of output quantities in order to determine the difference between what was achievable prior to the alleged causes and what happened due to those causes. Attempting to launch a global claim when the records are poor and lack the detail needed to show cause and effect, or at the very least what the actual production achieved was as compared to a calculated 'norm' from the contract data, is unlikely to succeed.

9.4 Methods

The most common methods used to calculate the loss of production (often expressed as a ratio or percentage) are discussed in the following text.

9.4.1 Measured Mile

To counter the usual argument that the main causes of production loss were the Contractor's own inefficiencies, a calculation based on detailed site records must be made to show what was possible in locations where the works were performed without incident. This then provides the foundation for the assessment of what 'normal' production was possible or at least nearly achieved when there were no effects of changes or delays. By assessing what was achievable on the project during a period when there were no delaying events will demonstrate what the Contractor was able to produce when it was not being impacted by changes and delays. This approach avoids arguments about whether the tendered rates and prices or planned durations were realistic. By performing the calculation based on the actual job site, the derived baseline does not rely on the original output calculations in the tender rates and prices or the planned production rates used in the programme; it relies on a factual interpretation of what happened on the work site.

This comparison technique is known as the ‘measured mile’²; it relies on a calculation of the recorded outputs achievable in unaffected areas as compared with the production in disrupted areas. To perform this calculation, a baseline is created of similar work to that disrupted, and compared to the actual production achieved in the affected location. In other words, you cannot compare plumbing or services production with carpentry or concrete production. Also, the work area chosen should be similar in character and size to avoid skewing results by trying to compare small, isolated areas with large, open areas of work. This requires a calculation of the undisrupted output achievable on the site based on the recorded hours for labour and plant together with a measurement of the work achieved by those resources in that location.

In theory, this method measures what the Contractor can achieve without interference by matters for which the Employer is liable and then compares this to production where the disruptive events occurred. This baseline and the site records for the disrupted areas must both be adjusted to remove recovery achieved for varied works, accepted delay events and authorised changes, etc., already reimbursed through the variation account to ensure there is no duplication. It is also necessary to inspect the records and remove any time lost due to the Contractor’s own errors – for example, if there was a plant breakdown for several hours. In my opinion, the baseline output calculated must use a sufficiently large sample to avoid the argument that it was ‘cherry-picked’ for an easy area of high production that could not be sustained in normal working conditions. Once a baseline output for a task has been determined, this can be compared to the same work in areas affected by variations and other delay events, and the production losses calculated. However, where the measured mile technique fails is on a project where delay and disruption occur from the outset and affects nearly every section of the project, either directly or indirectly, making it difficult to locate an area of unaffected work. In such circumstances, the calculations will have to revert to a realistic ‘norm’ for production gleaned from the Contractor’s tender, recognised ‘construction price books’ or other ‘industry norms’ that provide guidance on anticipated outputs for tasks on a typical project of the same character and content. Alternatively, some construction companies may have historical records of the production they have achieved on similar projects in similar locations that can be used to establish a baseline production to compare with actual outputs on the project being investigated.

9.5 Other Methods

The key to establishing the impact of all forms of delay events and variation instructions is to keep good records, so that the production achieved can be accurately measured against the man-hours input to identify the production loss suffered. There are also several performance graphs and other theoretical calculations that have been published relating to production losses and the impact of change on construction activities. Most of these only refer to the effect of changes (variations) on the work patterns; however, on many contracts, the extent or number of changes instructed is only one element, and the impact of other events such as the late release of information, withholding of access, late acceptance of method statements, provision of revised drawings, etc., all have to be

2 Zink, D.A. (1986). The measured mile: proving construction inefficiency costs. *Cost Eng.* 28 (4): 19–21.

considered, as these can be very disruptive in terms of the ability to plan, resource and manage work.

9.5.1 Earned Value (EV) Analysis

Where disruption occurs from the outset and happens throughout the project, it may not be possible to produce a fair measured mile calculation, as there will be nowhere where production was achieved as planned or anywhere close to the planned output. In such cases, it may be necessary to produce an EV analysis calculation based on the planned man-hours per unit earned and the actual hours per unit recorded on site. This must be broken down into enough detail for all areas of the project, so that each section can have a differing baseline output to compare to the relevant extract from the programme.

The criticism of EV analysis is that it presumes that the planned man-hours per unit output is achievable, and care must therefore be taken to assess the reasonableness of the planned production rate. As with the measured mile, this can be done using industry norms or data from previous projects to ensure the outputs were reasonable. However, the more global the comparison of the targets and production achieved becomes, the more an EV analysis will be criticised as unrealistic. The EV calculation can be used to assess the cost differential due to production as well as increased cost in areas or at times when enhanced hourly rate payments were made to achieve goals or accelerate production (e.g. weekend or extended daytime working hours or night working premiums paid above the normal hourly wage rate). In common with the measured mile approach, EV analysis works best when locations and tasks are discrete, and the data of actual production, man-hours used and cost information for each location or area is sufficiently detailed.

An EV analysis is more reliable when the project is broken down into a detailed structure – usually referred to as the work breakdown structure (WBS). The expanded WBS is used as the basis for planning the project and provides a structure, setting out the key elements to be carried out and the time allotted for them. It divides the work into a series of connected tasks under suitable headings detailing the scope of work covered by the tasks in each section, thus breaking down the work scope into logical elements for planning, progress measuring, budgeting, cost control and management. For each task or section of the WBS, there should be a budgeted cost and production details that can be identified from the programme or schedule; this may be in monetary values, or man-hours or gang-hours per unit. The site records of production and costs should be maintained in the same format, so that each part of the WBS has a defined budget in terms of man-hours or cost and a record of the actual performance achieved. EV analysis measures progress against this baseline by calculating three key values for each key or summary activity in the WBS:

1. The planned value (PV) in terms of either money, work gang hours or man-hours per activity.
2. The AC, which must correspond to whatever was budgeted for the PV and the EV, so that a like-for-like comparison can be made (e.g. the same constituents for labour, plant, equipment and indirect costs that were set in the baseline budget for the WBS element) – this can be in monetary terms or labour hours. However, if premium

payments were being made due to extended work hours, this will need to be identified and the value adjusted to avoid an incorrect result.

3. The EV or the value of the work actually completed based on the budget (in money or man-hours – reported progress $\times$ the labour/cost per item planned = value earned in money or hours based on the planned activity and resources).

The preceding is used to measure the cost variance $(CV) = EV - AC$. The schedule variance $(SV) = EV - PV$. These two values can be used to provide an efficiency indicator CPI (cost performance indicator) to reflect the cost and schedule performance of the project: the CPI is calculated as $CPI = EV/AC$.

However, as explained in the preceding text, the EV analysis is reliant on having sufficient details of the actual performance against the planned in the form of detailed costs and labour/plant/gang hours expended for the relevant WBS section to compare with the planned baseline and assess the production values. As with a measured mile approach, before the calculation can be used for comparison, it is necessary to inspect all the records and site areas to adjust the recorded times for recovery already received through VOs, time and material payments, etc., and to adjust the records for known errors of the Contractor's own making – for example, remedial works or plant breakdowns and any adverse weather delays suffered. This will ensure that a like-for-like comparison is made of the expended hours versus the planned hours for the activities being monitored.

9.5.2 Mathematical Approaches

As noted earlier, the main difficulty with the application of the measured mile technique is in finding a location or task that has not been affected and of enough size that is representative of the work undertaken to derive a realistic baseline production factor. On a severely disrupted project that suffered delays from the outset, this can be a challenge, as it may be nigh on impossible to find an area that was unaffected by instructions or delays. However, as an alternative to using the measured mile or EV analysis techniques, there are mathematical models that have been developed which can be used where the site records are not sufficiently detailed, or where it is difficult to separate an unaffected section of the works to derive a baseline production input and measured output against individual tasks (e.g. man-hours per square metre). While it is beyond the scope of this book to delve into complex mathematics to prove or demonstrate the validity of such calculations, these statistical techniques are useful, and it is necessary to have some knowledge of them. However, the courts have often been sceptical and have treated the results of mathematical models with suspicion, preferring a detailed analysis of facts based on site records. The main issue is one of gathering enough site data to fit the model, and the work must be of a similar nature for the graphs to be meaningful – for example, you cannot use a mechanical contract to compare with a road-paving project. An Internet search for measured mile, statistical clustering, system dynamics, etc., will provide a long list of such articles and tutorials. In short, there is no substitute for detailed records of labour deployed and activities undertaken when trying to prove production loss due to the cumulative impact of change on construction operations. That said, while these learned studies are not direct evidence of disruption on a particular project, the findings are persuasive. They demonstrate a linkage between the

percentage or volume of change instructed and the production losses suffered during any construction project.

One of the first attempts to display such investigations in a graphic manner was undertaken by Charles A. Leonard³, who, as part of his doctoral thesis, devised graphs for mechanical and civil/structural projects based on a sampling obtained for several sites showing the impact of changes on construction productivity. These graphs showed that there was a relationship between production loss and the incidence of instructed changes. His research covered two types of projects: civil/architectural and mechanical/electrical; they are reproduced in Figures 9.1 and 9.2.

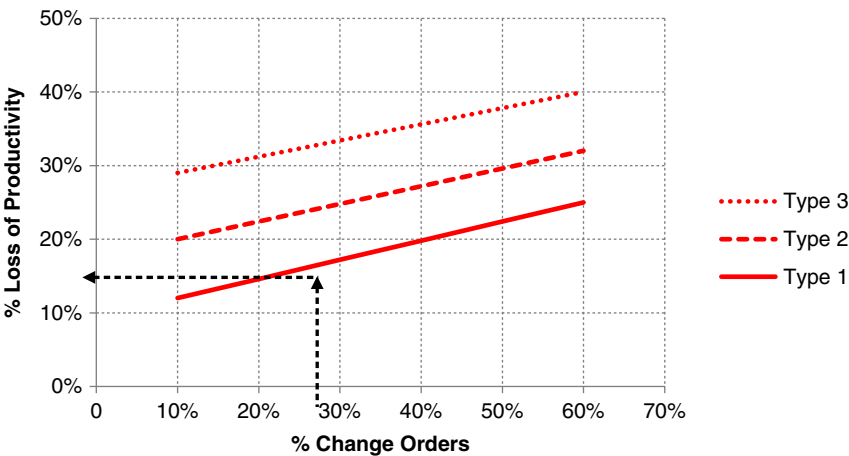


Figure 9.1 Leonard curve – civil and architectural projects.

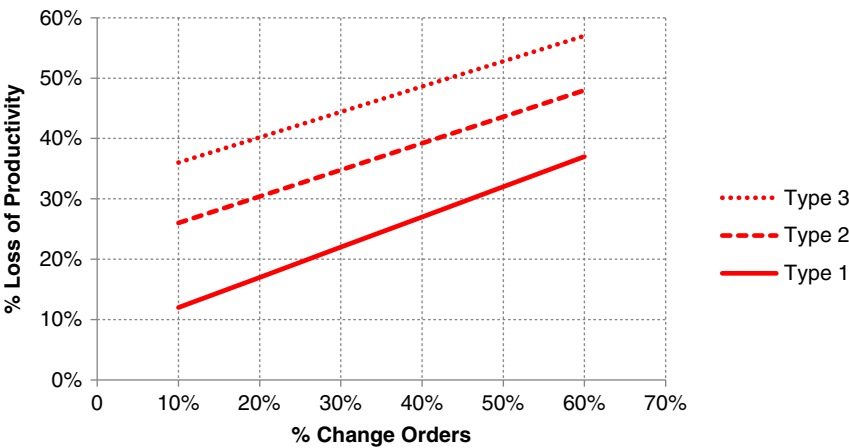


Figure 9.2 Leonard curve – mechanical and electrical work.

3 Leonard, C.A. (1988). 'The Effects of Change Orders on Productivity', M.S. Thesis, Concordia University; Montreal, Quebec.

More recent research has been undertaken by Professor William Ibbs (University of California at Berkeley).⁴ He produced a more intensive study of production loss and change impact, showing the effect of multiple changes on productivity in larger projects, with a greater number of projects used in the database and not limiting the research to projects that were involved in litigation. His database of records includes design and construction. The Ibbs model has more 'degrees of freedom' than Leonard's and is derived from a database containing some 2000 projects. These comprise design-bid-build vs Design and Build, and industrial vs. commercial vs. heavy/civil; it also contains both Owner and Contractor input, so it is more representative of good and bad projects, and has been admitted in International Chamber of Commerce arbitration and US court testimony. It has also been used to quantify the loss of productivity for design efforts using these projects, and not just construction projects.

9.5.2.1 Example Where There Is a Change Proportion of 30%

For a project suffering a change percentage of 30%, the productivity index (PI) calculated from Figure 9.3 returns a value of 37% production loss ($[2.4621 \times 0.3^2] - [2.169 \times 0.3] + 1.0589 = 0.629789$; $PI = 1 - 0.629789 \times 100\% = 0.370211 \times 100\%$; therefore $PI = 37\%$).

Professor Ibbs undertook further analysis of projects to discover what impact the timing of changes had on productivity. The statistics produced gave the results under three headings: 'Early Change', 'Normal Change' and 'Late Change' (Figure 9.4).

The preceding research shows that production loss is greater where the changes are considered as 'late changes'; therefore, as shown below in a calculation for a 30% late

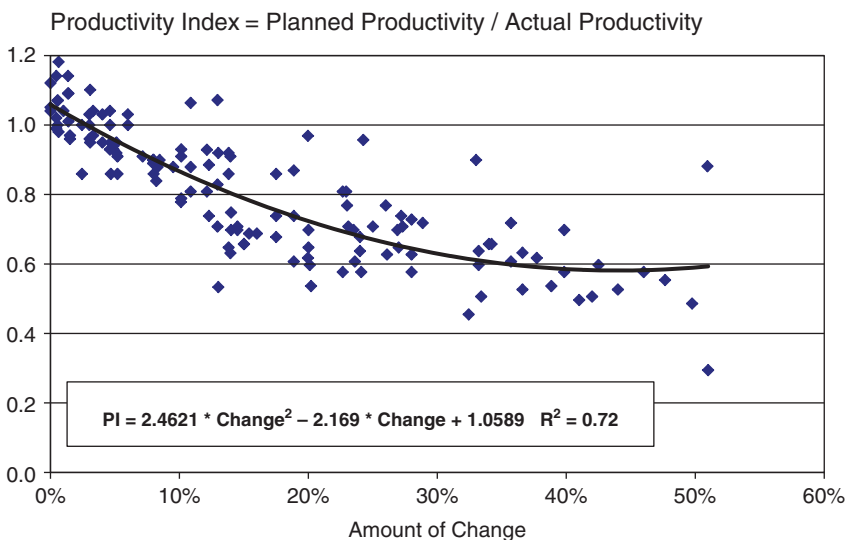


Figure 9.3 Ibbs curve for combined data.

4 Ibbs, W. (2005). Impact of change's timing on labor productivity. *ASCE J. Construct. Eng. Manage.* 131 (11): 1219–1223. [https://doi.org/10.1061/\(asce\)0733-9364\(2005\)131:11\(1219\)](https://doi.org/10.1061/(asce)0733-9364(2005)131:11(1219)). And Stynchcomb, P. and Ibbs, W. 2016. *Change Orders, Productivity, Overtime: A Prime for the Construction Industry*. Mechanical Contractors Association of America.

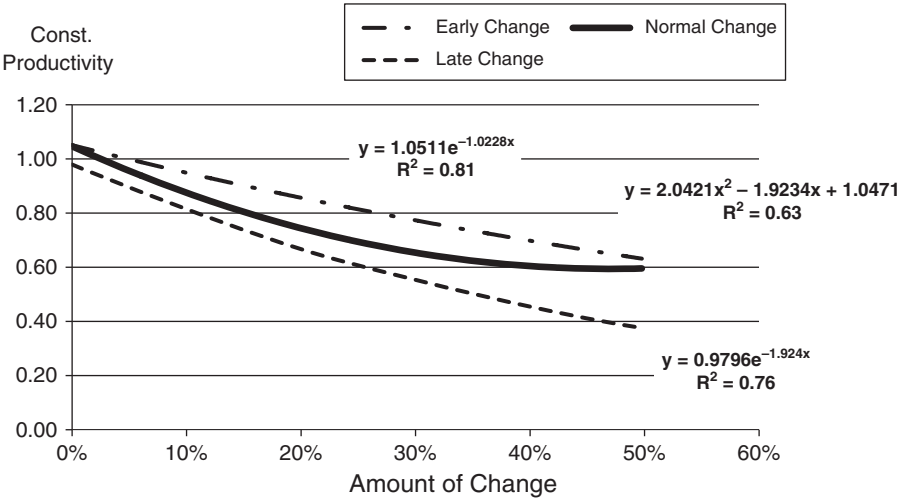


Figure 9.4 Ibbs curve separating out early normal and late change impact.

change volume, the production loss increases to 45%.

$$Y = 0.9796e - 1.924x$$

In this instance, $0.9796e - (1.924 \times 0.3) = 0.55$. Therefore, $PI = (1 - 0.55) \times 100\% = 45\%$.

What the studies show is that it is possible to derive a mathematical formula to describe the link between the degree of change/timing of change and the impact that such changes have on production.

However, the main issue to prove with a claim submission is that the graph refers to similar work executed under similar conditions to the subject contract. While the graphs show recorded trends on several projects and can be persuasive that similar trends may have occurred, to be successful with such a claim, the data to compare the production loss claimed must be collected from the project in question. The site records must be investigated to identify the recorded labour hours expended on contract work and time spent on variation work to order to assess the proportion of time absorbed by variations and the likely impact this would have on productivity.

9.6 Disruption Can Be Separated Under Two Headings

9.6.1 Direct Effects

Where little or no change has occurred in the measured quantities of work to be performed, but the overall activity takes much longer, the resident resources are retained for the extended period, resulting in lost productivity. In extreme cases, standing time may occur with resources held in place, waiting for the work to restart. The resources would be underutilised during this delay period, for which no corresponding increase in EV has occurred. In such instances, the disruption element for production resources can be assessed during the relevant period by comparing the recorded production with what should have been achieved.

Disruption may manifest itself in production losses to specific resources deployed at isolated locations. If the relevant work is not critical or specific to a location, the delay to the operation may be allowed to run its course and a claim for the increased costs in that area made as a separate heading. Where the disrupted work causes delay to the completion date or a sectional completion date, an extension of time also needs to be calculated.

9.6.2 Indirect Effects and Cumulative Impact of Events

On a project that suffers continual change and delays, the impact of disruption tends to be progressive and pernicious in terms of its effects both on production and morale. In addition, severe disruption and general productivity losses can cause critical delay to the project. If operations become disjointed and fragmented to such a degree that the originally planned sequence is wholly lost, the work may degenerate into a 'work where available' philosophy. Once the regular and planned work patterns have broken down to this degree, a cycle of crisis management begins to rule, and production losses escalate. This has a detrimental effect on labour morale and production, resulting in delay and slower output on seemingly unaffected operations. It can also lead to an increase in labour turnover, absenteeism and resource problems, as workers become disenchanted with the project and their restricted ability to make money, and so leave. Severely disrupted projects may suffer recruitment issues as both direct labour and subcontractors become aware of the situation and the high turnover of personnel, and insist on receiving premium payments before they are willing to work. In a worst-case scenario, strikes and labour disputes may occur, causing further stoppages and delays.

However, while this statement may ring true, especially to anyone who has had the misfortune to work on a severely disrupted project, it is still necessary to produce enough evidence to prove what happened. These records must show that an attempt was made to identify such costs and production losses as far as possible using contemporary records rather than relying on conjecture or remembered events from witnesses.

9.7 Typical Claim Heads

9.7.1 Out-of-Sequence Working

Where resources were planned to move sequentially through the project in a set direction and they are prevented from doing so, additional costs arise. The impact of a delay or disruption to the sequence means that all subsequent operations are delayed, or additional resources are required to maintain programme and momentum; often, a combination of all these effects occurs. This induced acceleration may itself reduce productivity, as there would be further learning curves for the replacement resources, potential 'economies of scale' are lost and, at worse, more standing time occurs, defeating the object of the exercise. Where resources are relocated to alternate work, this may lead to potential additional costs; the following activities will also be affected:

- Planning.
- Material deployment.
- Resources relocated; this may involve a delay while machinery is also relocated/tracked around the site to the new work front.

- Setting out or provision of construction information for the new location.
- Additional task lighting or other temporary works may also be required.

Where a considerable number of such events occur, the impact on planning and organisation is severe. The impact of a delay or disruption to the sequence means that all subsequent operations are delayed, and work becomes disjointed. In severe cases, additional resources are mobilised in an effort to maintain programme and momentum, and to mitigate the delay being suffered; often, a combination of all these effects occurs. When operations become fragmented in this manner and the Contractor makes attempts to mitigate delay, the risk of standing time or reduced productivity increases as, for each new location, there is a learning curve for the replacement or relocated resources, and it also affects material delivery and procurement, potentially negating any economies of scale envisaged when the work was originally planned.

The following are some examples of the impact of moving resources from one activity to another due to fragmented working or disruption caused by changes or late replies to queries etc, On each movement to a new location or when replacement resources are drafted in to continue with other planned work:

- Mobilisation time and training of a new work crew in using specialist equipment.
- Time lost moving labour around the site, including transport costs where the site covers a large geographical area.
- Time lost transporting plant and equipment to and from locations.
- To overcome a delayed release of material from a varied or disrupted activity, it may be necessary to mobilise or manufacture additional formwork. This may result in a reduction in the number of uses expected from formwork compared to that priced within the tender thus, leading to more re-facing/refurbishment costs for the shutters per square metre than planned. Such losses may include earlier replacement of formwork and/or more re-facing/refurbishment costs for shutters per square metre than planned.
- Mobilising additional plant where possible; specialist plant such as piling rigs or asphalt plant and their operators are not readily replaced or augmented.
- The repeated learning curve for the newly mobilised resources, whereas originally the team familiar with the work would have carried it out after completing the previous operation that is now delayed.
- Material wastage at each additional storage location. Also, some materials brought to the site may have a specified shelf life before use (e.g. certain grouting materials), and extended storage may result in such materials being thrown away.

Similarly, there may be instances where workers are stopped and then relocated to another area when the planned work is not available, and then returning when access to the original work area is once again available. Invariably, while waiting for access to work areas, the need to increase resources reveals itself as the work areas are fragmented or delayed and the impact on the overall programme becomes apparent. This necessitates the procurement of additional resources (labour, plant and supervision) to progress out-of-sequence or delayed activities in an attempt to recover the impact on overall completion, resulting in additional costs. Further, once mobilised, these additional resources tend to be retained to deal with the ongoing disruption and additional work areas being attempted, leading to increased manpower and supervision levels or the 'thickening' of resources.

9.7.2 Relocation and Disjointed Working (Site Moves)

Where a Contractor is routinely left waiting for replies to information requests/technical queries or delayed due to instructions/from waiting for access to work areas, it may move workers onto other operations to mitigate standing time and other costs. When the original operation is restarted, having been granted access or re-access and/or information provided or instructions received, the workers often cannot restart the activity until they have completed the alternative tasks they were given. Alternatively, other resources are moved to the work when the original resources are no longer available, having been relocated elsewhere.

Time lost in relocating resources to another activity can be demonstrated preferably from written reports or site records, or alternatively by oral evidence from personnel present at the time, supported by labour records showing where the resources were relocated. This would need to be supported by labour records showing which resources were moved and where they were relocated. This would show that the movement of resources around the site increased as compared to the regular and planned sequence of work. Diaries or allocation sheets would be required, but they would need to be expanded upon to explain the delay and reasons for the relocation. To effectively argue this case, further details are usually needed to explain when and what happened, which may need a narrative from a witness (usually the supervisor or engineer affected) who can explain the factual records further and provide background evidence of this phenomenon to support the costs incurred and explain the delay claimed. Similarly, the additional costs would probably include raising purchase orders for additional materials, receipts for out-of-sequence deliveries or the higher costs of expedited material deliveries; it is also important to record the location where the materials were deposited/required.

Relocation of workers requires more than just moving the labour and plant. Details must be provided, so that the alternate work can be done – for example, the issue of drawings, additional (out-of-sequence) setting out, together with the provision of materials, tools and equipment to the new location. Production losses may occur due to a further learning curve at each new location if that replacement work is substantially different from the work that the resources should have been doing, had the delay not occurred. This production loss would be repeated with each additional site move. The site records must show what happened and a person identified who can speak to the facts and/or provide further evidence of this phenomenon.

On a large project where the Employer has several Contractors, working access and egress can become a problem. Where access is blocked or impeded by the presence of other Contractors, dated photographs and formal notice letters, together with diary notes or record sheets, provide excellent evidence in support of such standing time or disrupted working.

9.7.3 Manufacturing – Precast Units, Structural Steelwork, Etc.

Manufacturing is inexorably linked to the site installation programme. Where site works are delayed and fragmented due to various events, this causes changes to the timing and sequence of work, which in turn may affect the production and storage of manufactured units or force manufacturing to be suspended. If manufacturing continues with no compatible release of work on the site due to the earlier delays, storage becomes a problem.

This often results in a logjam within the fabrication facility, restricting the available storage areas, affecting the delivery sequence and reducing production. The choice is then whether to continue manufacturing and locate additional storage areas, thus incurring rental and double handling costs together with the risk of the material deteriorating due to excess storage time.

If production is halted or slowed down, the issue is the overhead cost of running a fabrication plant, which is very high and relies on the throughput of saleable items to absorb the overheads and support costs. Generally, factory-type fabrication requires a complete management support structure to maintain the facility that is recovered through the manufactured goods. For example, structural steelwork factories usually have a very high uplift cost, over and above the unit hourly rates of its workforce, as the production is usually estimated in man-hours per tonne, and the hourly rate for fabrication resources – welders, riggers, markers/cutters, etc. – carries the whole overhead of the plant based on the length of time the fabrication is anticipated to take. This percentage can be well over 200% to cover the running costs of the entire plant and all its attendant personnel and staff, which is only recovered based on the throughput of completed work (normally measured in tonnes).

When the planned production cycle is disturbed, the costs can escalate out of proportion, and other works may be affected if an existing unit is suffering delay and being retained in the workshop for longer than estimated. The choice is then one of abandoning the disrupted items and progressing onto another item that is not suffering delay, or otherwise incurring increased costs due to the occupation of the fabrication yard by the delayed project.

9.7.4 Specialist Plant and Equipment

Revising the sequence of operations may result in underusage of specialist equipment or the provision of additional equipment. This may be because of the delayed release of specialist items from the disrupted area; hence, they are not available for work elsewhere. The following are some examples:

- Specially manufactured formwork for repetitive detail where the original intent was to work sequentially through the project by re-using these special forms. Where the planned sequence is lost, and sections become delayed, replacement formwork may have to be manufactured to enable the subsequent tasks to commence prior to the release of equipment from the affected area. This involves two heads of additional cost: manufacturing and a new learning curve for resources in the alternate location.
- Cranes or piling rigs and large items of earthmoving equipment, which may have to be tracked or transported to alternate locations and then returned. If this disruption to such specialist plant is excessive, the need to mobilise additional plant may arise.
- Tower cranes may suffer excessive standing time if the primary workload reduces due to delayed activities that result in resources being redeployed. Also, logistics may suffer if the work areas are being completed out of sequence. Visual overlook of works by the crane operator may be compromised by other sections/elements already built. This can result in additional banksmen being needed to maintain safe working practices.
- Specialist paving machines may have to be disassembled and transported to the new location and then reassembled (e.g. concrete road trains or slip form machines).

9.7.5 Summary

The preceding paragraphs describe situations where, in many instances, the calculation of disruption occurring at specific locations or due to isolated causative events does not reimburse the overall combined effect of disruption. Elements such as additional resources deployed over part, or all, of the remaining period, perhaps on an ever-increasing basis, are not automatically recovered. Similarly, crowding of the work-face may occur when additional resources are deployed to mitigate the effect of delays, but consequently may result in general overmanning of tasks and reduced productivity. Therefore, once the full entitlement to delays is established and the overall periods and overlapping of resources, etc., identified, a calculation is made showing the overall labour recovered through the measured work performed under individual discrete claim heads versus the total labour deployed. This calculation should identify the production loss and show that isolated valuation of the change/root cause does not recover all the additional costs incurred. There will be a deficit due to the combination of the disruption suffered and the supervening effect of one causative event upon another resulting in a ripple effect or snowballing of costs not severable from the overall costs incurred at that point in time.

9.7.6 Overlapping of Tasks/Increased Number of Work Areas

The original programme may show a sequential flow of work from one area to the next in a logical geographical pattern, allowing resources to move progressively between work areas, gradually reducing transport distances from the main compounds. If such patterns became fragmented, the records should show that more tasks were being attempted concurrently than originally planned and in differing locations, leading to the need for increased supervision and more complex logistics and transportation. If it is possible to show that there was an increase in the number of work fronts or tasks undertaken, thus causing an overlap of activities, this would support the production losses arising from the crowded and/or disjointed work faces and time lost due to supervisors and resources travelling between locations and diverse operational tasks.

The traditional method of demonstrating the increased overlap of work patterns was a PPM (Planned Progress Monitoring)⁵ exercise, sometimes referred to as 'counting the squares' (tasks) or activity density counting. This measures the originally planned activities undertaken per week and compares this value with the as-built activity loading per week. This indicates the number of tasks undertaken per week compared to the planned number; and, if converted into an 'S' curve, it can show the impact of delays during the period of disruption/acceleration and/or overlapping of activities. This value gives a measure of the additional operations undertaken per week and supports the need for additional supervision, support staff and logistic support, as well as the potential overcrowding at the work face.

9.7.7 Crowding

Crowding (overmanning) at the work face is normally calculated by comparing the workspace per man planned (m^2 per man) to the actual (m^2 per man). This is easier to

⁵ Professional Practice Group, Directorate of Quantity Surveying Services, UK Department of the Environment (1980).

do at an isolated and measurable location than it is in linear operations such as railways, pipelines and road projects, due to the length of the overall site and the number of available locations for work at any one time, spread over the entire site. The US Corps of Engineers⁶ produced a graph showing the effect of crowding on labour efficiency; this plotted the crowding percentage on the Y-axis and labour hours lost to inefficiency on the X-axis. By way of an example, this indicates that, at a 15% crowding percentage, the production loss was 5%, and at a 35% crowding percentage, the greatest production loss was 17%. The crowding percentage is calculated by the formula:

$$\text{Crowding Percentage} = \left(\left(\frac{\text{Actual Manpower}}{\text{Scheduled Manpower}} \right) - 1 \right) \times 100\%$$

$$\text{Crowding of Work Areas} = \frac{\text{Work Area Size (square metres)}}{\text{No of Workers in Area}} = \text{m}^2 \text{ per man}$$

Unfortunately, the US Corp of Engineers did not detail the background research used to support their findings but used this principle for over 20 years before it was rescinded. However, there is nothing wrong with the principle involved, and the preceding formula can be used to calculate the ratio for the planned workforce and the actual workforce deployed to show the increased resources per unit of area and indicate the crowding at the work face. In addition to the US Corps of Engineer's paper, several learned studies have been carried out (mostly in the United States) related to inefficiencies and production loss caused by overcrowding at the work face. These studies do not represent proof, but show indications based on chosen sample projects of production achieved where work area per man ranged from 250 ft² per worker (where output was taken as 100% efficiency) down to 110 ft² per person, at which point a 33% inefficiency on hours worked was calculated. While such studies may be persuasive in supporting a claim, they are not a substitute for proof based on detailed labour records showing what happened on the subject site.

9.7.8 Increased Procurement Costs

Procurement and lead-in times may also affect the production achieved where the planned delivery sequence and stockpiling of materials and equipment has been lost. This can result in:

- The need to pay for expedited express delivery costs.
- Provision of additional storage areas and/or congestion of the available storage and lay down areas.
- Additional site transportation for materials deployment.

9.7.9 Thickening/Increased Supervision

This refers to a project where the impact of numerous changes and varied works instructed result in the Contractor mobilising additional staff and supervision to cope with the degree of change suffered and the amount of paperwork generated by numerous changes on a construction project.

⁶ US Army Corps of Engineers (July 1979) Modification Impact Evaluation Guide – since rescinded.

The planned intent would have anticipated an economical progression of resources, supervision, logistic support, etc., all moving sequentially through the project in a logical manner towards completing the work. When this orderly sequence is lost, the supervision and logistical support become overstretched. Travelling between work areas increases, and, in addition, shortages of materials and equipment can arise in fragmented areas due to altered sequence and peak demand for materials necessary to match production. When the overlapping of activities, location of work fronts and resources becomes dislocated and unwieldy, management suffers in terms of supervising and supporting the operations. Once this has occurred in several areas, the ability of supervisors to manage the works diminishes, such that additional supervision, safety, logistics and engineering resources are needed to maintain momentum. All these additional resources will require accommodation and welfare facilities. This unplanned increase in the supervision, support personnel and equipment required is referred to as 'thickening'. These costs can be separated from the overall management and personnel costs for the period deployed. Invariably, once mobilised, these additional resources tend to be retained until completion, and further explanation is required to support the case that they were not always required, but that their deployment was driven by the peak demand and disrupted work sequence caused by the events cited. Thickening also occurs due to the degree of revised drawings and instructions being dealt with leading to increased paperwork and research against each drawing and raising the relevant information request to question errors or omissions discovered. A simple ratio of the numbers or sources of change events handled can support the increased level of engineering and other support staff due to the time required to deal with each new drawing or query and/or instruction. A schedule should be kept of all requests for further information, detailing the date, the question raised, date of reply and whether more requests were then made if further explanation was needed.

An average cycle time can be calculated for reading drawings, identifying missing details, contacting the Engineer/Architect, receiving responses, mobilising resources and procurement of materials based on the new information. Typically, when staff are questioned about this process and the time lost in dealing with information delays analysed, it often relates to about 1 day per event. For example, assume it takes about 2 hours for a search through the drawings and other information to be made before a conclusion is reached that further details are required. This is followed by a written request for information issued to the Engineer/Architect, etc. There is then a time lag while an answer is provided. When a response is issued, this has to be checked against the drawings to ensure that it does answer the questions raised, and then the work can be organised on site. It is not uncommon to find that, where a technical query has raised several questions, the answer may not resolve all of the issues. On a site where the drawings are constantly evolving as work proceeds, the delay and disorganisation caused by numerous missing or conflicting details can multiply, resulting in disruption and loss of sequence as planned work is abandoned while waiting for responses to questions.

Each event may cost 2–4 hours in looking for details and raising questions, followed by a delay while an answer is given. Responses to technical questions and provision of further information might take anything from a few hours to a few weeks before the details are provided, and can be checked and then put into action on the site. If there are, say, 1000 requests for further information issued on a project, and each takes about 1 man-day of engineering time to resolve, this equates to an engineer working for 1000

instructions or responses $\times 1$ man-day each = 1000 man-days $\div$ typical working period (45 weeks $\text{yr}^{-1} \times 5$ days = 225 man-days yr^{-1}) = 4.44 man-years. In practice, of course, there is not one engineer dealing with these changes over a period of years; instead, the task is divided among several engineers and supervisors during the course of the project. The simple arithmetic used in the preceding example is merely to show the amount of time spent dealing with such matters. Delays due to lack of information or provision of revised details impinge on the supervisor's ability to manage and oversee construction of the project. This is not idle theoretical arithmetic; it is common to find in projects where there are hundreds of site instructions and requests for further information, together with new drawings, sketches and other events taking place, that the number of supervisory, technical and support staff will increase due to the time lost in dealing with these events. Providing a detailed note of all staff deployed on a project is kept (start dates, end dates and discipline), the increase in numbers will be recorded. Statements can be obtained from the personnel to support the argument about the time taken in dealing with such changes and information requests. From experience, it is unusual for staff to record the time they spend on such activities daily; however, once the workload increases, the management will react and deploy more staff to progress construction and deal with the paperwork. Once mobilised, these additional resources are inevitably retained on site for much longer periods than a net extension or time and/or the prolongation period identified for late completion, as they are driven by the overall increased workload. Such costs can be tabulated separately as a thickening claim for the period of their deployment.

9.7.10 Seasonal Shift

The initial delaying of work and subsequent fragmentation of the planned activities may lead to a seasonal shift of operations. Work planned for the drier, less-weather-susceptible months may be delayed into a period of traditionally wetter or colder weather, causing further delay. This will result in stoppages and reduced production due to ambient temperatures, weather conditions and available daylight hours. This will often necessitate the application of additional resources to maintain production at the planned level. Where it can be shown that this time shift was driven by a claimable event, the increased incidence of wet time/downtime can be attributed to the enforced seasonal shift of operations. In a worst-case scenario, as the weather deteriorates, the work may be delayed such that the weather-susceptible operations like excavation and earthworks construction must be postponed to the following spring, resulting in a considerable overrun on the completion date. If the delays causing time shifts are extensive, the overall balance of planned summer/winter working split for the project may change. The impact of reduced working hours, weather delays and reduced daylight hours can be claimed together with the costs of task lighting and any special measures instigated – for example, winter concreting additives or other measures, and provision of protection for weather-susceptible operations (e.g. tenting over areas or providing shelters for workers closer to the work face).

9.7.11 Inflation

Where key delays are identified, the impact may result in the projection or delaying of work into periods of greater inflation and/or changes in resource availability and

increased hourly rates. The volume of work moved into such periods may result in an increased exposure to inflation that can be identified and valued. For example, where work load is time-shifted beyond its planned duration and there is an annual wage rise, this results in increased labour costs for all the subsequent work beyond the date when the hourly rates were increased.

Further, local premium payments needed to entice labour to the project (or retain existing labour), such as enhanced rates, bonus schemes and attendance money, are not generally reflected in inflation indices, as they are outside any working rule agreement conditions. As such, these costs are not recovered through inflation payments (price fluctuation formulae) made under a contract. These additional costs should be identified and valued.

9.7.12 Acceleration

Acceleration is the application of additional resources to advance progress or achieve programme compression. However, it nearly always involves the rescheduling or re-sequencing of the remaining operations to take advantage of the additional resources and shorten the time for completion – for example, increased overlapping of tasks than originally shown on the contract programme, or starting events concurrently that would have originally been sequential, but which can now be undertaken due to the additional resources provided. However, in projects where there are substantive delays, it is common for the Contractor to employ acceleration measures to overcome or mitigate delays for which it should normally receive an extension of time. This tends to occur where the Contract Administrator (CA) has either refused to award an extension of time or merely ignores the Contractor's claim for additional time. All major contracts are drafted on the presumption that the CA will act rather than sit on his/her hands and hope the Contractor does something.

Further, if the CA does nothing in the face of claims for an extension of time, he/she puts the Employer at risk for the argument that time has become 'at large' due to the CA's failure to properly administer the contract. In these circumstances, the Contractor will launch a claim for constructive acceleration, arguing that it was forced to implement acceleration and/or mitigating measures to avoid the very real risk of incurring liquidated or delay damages due to the CA's failure to award a reasonable extension of time. Obviously, all this relies on the Contractor having a valid claim in the first instance, but every site suffers delays due to a variety of reasons, and most projects have variations and additional works instructed which presupposes that some measure of extension of time (however small) is nearly always valid.

For any CA, it is far better to make a realistic assessment of delays claimed and award an extension of time than to do nothing and risk a claim for time being 'at large' – even if that is later found to be inadequate after a full analysis of the events cited. The reasons that the CA might be reluctant to assess an extension of time is because most forms of contract contain a clause which prevents the CA from later reducing the time for completion once it is set either in the original contract or by subsequent extension of time awards.

9.7.13 Constructive Acceleration and Mitigation

Where a delay event affects the commencement of work, it will reduce the period for construction unless the Engineer has awarded the requisite extension of time, causing

the remaining work to be compressed into a shorter time. This imposed period of acceleration is often referred to as 'constructive acceleration' and generally causes the Contractor to speed up the remaining work by the application of additional resources and revising the sequence of work to reduce the time required for construction.

Mitigating measures are a source of controversy as it is often argued that mitigating a delay should not involve additional costs; however, this may depend on the terms of the contract, as some require the Contractor to actively mitigate delay wherever possible, and this might involve additional cost. While there may be a contractual obligation on the Contractor to mitigate delay, this does not mean the Contractor should bear the costs incurred in overcoming a delay of the Employer's making, nor should it have made some allowance for taking such measures within the tender. Mitigating measures invariably cause additional costs and entitle the Contractor to claim for recovery of the costs incurred. For example, reallocating labour and equipment to alternate tasks rather than suffering standing time will mitigate, in part, the costs of a delay, but there will be an associated cost of moving to another location and setting resources to work. Similarly, reorganising the schedule and re-sequencing operations may mitigate or even avoid a critical path delay entirely, but may also involve additional cost. However, it is rarely possible to completely sidestep a delay event without consequences. Re-ordering works may keep the workforce employed rather than suffering standing time, but it may not overcome the delay to completion. There are always non-critical tasks that can be undertaken as a fallback or contingency operation to avoid standing time when something happens elsewhere, but these tasks do not usually affect the 'critical' activities that must be executed to achieve the prescribed completion date. The various accelerative or mitigating measures applied may, in turn, result in production losses and disruption due to extended hours, night work, crowding at the work face or inefficiencies caused by the loss of 'economies of scale', resulting in additional costs due to underutilisation of the equipment and resources deployed. The following is a typical list of discrete heads of additional cost and supporting records needed:

- Additional formwork and falsework, ground supports, scaffolding, etc. – a record of formwork manufacturing costs and the dates/duration of such manufacture.
- Direct costs of mobilising additional plant and equipment and/or specialist equipment – for example, dewatering plant, piling rigs, hot or cold asphalt planers, mobile cranes, etc. This will require records of purchase orders, invoices, delivery charges and time sheets for the plant deployed.
- Other additional temporary works – extra lay down areas, storage facilities or increased parking zones for plant and vehicles. Records of the construction or procurement of lay down areas or provision of off-site or on-site facilities.
- Mobilising additional labour – note though that the mere fact of mobilising additional resources does not necessarily lead to production losses if the additional resources are working efficiently. There may be no other additional costs apart from the mobilisation and demobilisation of such resources, but they may require additional transport to and from the site if this is provided or paid for by the Contractor.
- Additional accommodation or welfare facilities for additional resources deployed – photographs and records of establishing the facilities and removal costs once the work is completed.

- Additional supervision to control the additional labour – a schedule of all management, supervision and engineering staff should be maintained, so that the increase can be tracked, and costs calculated.
- Additional stores controls, site safety and security teams – these may be subcontractors or direct employees, but they must be recorded from payments made, usually based on recorded timesheets.
- Extending the working hours per day will result in additional paid break times; overtime premiums paid to workers; costs of extended plant hire/operator overtime/out-of-hours servicing, etc. Records should be kept of when the revised work schedule was introduced, and of the payments made to the personnel.
- Night shifts and attendant supervision, lighting, security, etc. Records should be kept of when the revised work schedule was introduced, and of the payments made to the personnel.
- Weekend working – overtime payments and additional supervision costs (perhaps premium payments to staff). Records should be kept of when the revised work schedule was introduced, and of the payments made to the personnel.
- Bonus payments to meet specific targets. Records should be kept of when the revised work schedule was introduced, and of the payments made to the personnel.
- Production losses due to crowding of the work face (including traffic jams on haul routes) – additional resources may place demands on work areas, access and egress points and site facilities. This requires calculation of the work areas and numbers of men and equipment deployed to each location, so that the ratio of labour to the work face area can be calculated.
- Production losses arising from continual extended hours and weekend working introduced over a considerable period – there are statistical analyses available which show that production will ‘tail off’ if extended working is implemented over a protracted period, giving a reduced cost–benefit curve and adding to the overall losses suffered. There are several studies that have been undertaken that show a steady reduction in productivity when long-term extended working hours are introduced.
- Additional temporary task lighting – records and/or photos together with invoices or plant records for the task lighting provided, and whether tower lights or other lighting systems were used.
- Traffic management – road cleaning, traffic controls, cones, safety barriers, etc. This requires the hours and costs recorded for the gangs and equipment deployed.
- Production loss/increased costs – this will need some form of calculation – measured mile, EV analysis, etc., For these calculations to be meaningful, the records of labour and plant deployed, with details of work done and production or quantities achieved, are needed.
- Reduced efficiency in periods of acceleration and extended working hours – as in the preceding text, records of labour and plant deployed, with details of work done and production or quantities achieved, are required.
- Efficiency can be shown to drop over prolonged use of extended working hours and weekend working or 24 hour shift working periods; this will generally be empirically based on historical studies that show the tail off in production over time due to extended working hours.
- Loss of efficiency during night shifts – it is noted that existing studies indicate a general reduction of about 20% in night shift operations. However, this may depend on

the type of work performed and whether there are any other circumstances that affect working hours and production. For example, the contract may limit the extent of night-working to a set period rather than being freely available for the entire night.

- Relocation of resources and materials due to changes in the planned sequence and timing of works. This will need witness statements, diaries and record sheets or daily allocation sheets to prove that the resources were relocated, and where they were sent. Time spent relocating and time lost setting up at the alternate location should be recorded or noted in diaries.
- Additional lay down or assembly areas, and additional storage areas or campsites for additional resources. Where these are provided, the cost of preparing the ground and setting up facilities must be recorded separately.
- Seasonal shift of work – summer/winter work juxtaposition; this will be dependent on proving that the delays caused the seasonal shift. Thereafter, the weather records and reduced working hours in winter periods, etc., can be used to show the additional cost of time lost during this period.
- The additional number of site moves/relocations – where the claim states that there were more site moves than planned, it is necessary to show the planned movement of resources around the site as compared to what transpired, and to maintain records of the resources affected. This may also involve moving temporary site stores or other welfare facilities from location to location.
- Logistics and transport changes due to revised sequence. This may include the provision of additional site transport forklifts, tractors, trailers, etc. It will require records of the changes made and the duration.
- Stockpiling and/or double-handling of materials – where the timing of work or seasonal shift of operations has caused work to be done in a different manner, this may involve double-handling of materials or excavated material that cannot be removed from the site due to the timing of work. This will require records/photographs, etc., to show the stockpiled materials, and detailed reasons why this occurred.
- Crowding of work areas and/or overmanning. Also, peaks and troughs of resource demand that result in team levels being maintained in the lower demand periods in order not to lose valuable resources. This will need a detailed schedule of labour deployed and work locations.
- Additional transportation of labour – crew buses and/or travel expenses. Costs and invoices or timesheets are needed to show the transportation values.
- Additional welfare facilities – toilets, drying rooms, canteens, etc. These may be obtained from plant invoices or site costing information for the facilities mobilised and their weekly cost – including the cost of maintenance and emptying, etc.
- Shortages of materials and equipment, including small tools, due to altered work patterns and out-of-sequence requirements for such items. This will require details of additional purchases made and the reasons why they occurred.

- To summarise the preceding examples, the typical records needed are:
 - Labour and plant deployed.
 - The quantity of work done/outputs achieved.
 - Site moves/relocation and time lost.
 - Stoppages.
 - Photographs.
 - Marked-up drawings, coloured and dated to show work done and when, and locations of offices, storage areas, welfare facilities, etc.
 - Pour records for concrete works (dates and volumes).
 - Steel deliveries and tonnage erected.

10

Presentation

10.1 Introduction

The style of any claim submission must be clear and factual; it must not become a personal vendetta against the other party or its Contract Advisor. It should contain the evidence in support of the claim and explain the contractual reasons that entitle the Contractor to make the claim. All calculations and analyses should be transparent and clearly explained, showing the methods used and any assumptions adopted. The supporting information should be cross-referenced, identifying where in the appendices the documents can be found. Where possible, complex issues should be broken down and simplified to aid understanding.

A detailed claim that tells the convincing story of what happened and why, supported by factual records and other evidence, will be compelling. The narrative must put flesh on the bones of the bare factual skeleton and explain the link between the events complained of and the impact these had on the completion date and costs. Where a delay is alleged, it must be explained factually and diagrammatically, whether a critical path analysis is used or simple diagrams to explain the delay and how it affected the general progress of the works. Even where a delay is not critical (i.e. it does not delay overall completion), it can cause delay and prolongation of an element of a project and cause substantially increased costs. This type of sectional or 'mini-prolongation claim' may be related to major sections of the works and the teams deployed to construct and manage the operations that were delayed. Forensic delay analysis has become something of a dark art, mainly due to the number of software applications available and the confusing array of computer simulations that can be prepared. However, provided the as-built records of the relevant events are clear and comprehensive, it should be relatively obvious whether the matter complained of caused a delay or not.

What happened, when and how it affected the work and resources deployed should be described based on factual evidence, witness statements and other contemporary documents (photographs, reports, etc.). The primary issue must always be to answer the six questions: 'Who?', 'What?', 'Where?', 'When?', 'Why?' and 'How?'.

The original planned intent as depicted or inherent in the baseline programme should be explained. Why it changed, what changed it, and when and where should explain the causal link between the event and its timing impact on the programme of works. Such evidence is mostly factual and is reliant on the quality of records maintained by the site construction team. How an event affected the planned sequence timing and duration of the works may be more subjective. The best evidence comes from contemporary

records, which should record what work was underway when a change or delay event occurred; why the works were delayed by it; and how this affected the planned activities and sequence of construction.

Assembling the facts and trying to show what happened and why long after the event is time-consuming and open to criticism because it is more subjective and depends on the skill, experience and project knowledge of the person explaining the delay events. The time and place of an event and what happened are the most essential facts. This is one of the reasons why policemen carry notebooks (and, these days, cameras) to record clear and simple facts and observations as soon as possible after or during an incident.

Records of resources required to carry out additional work or who have been delayed are the basic information required to demonstrate the direct costs and impact of an event. In addition, a description of the work affected, its location and importance enable a quantification of the impact to be considered. Claims are rarely founded on minor events that had little impact on progress. Good record keeping is therefore essential, but does not necessarily involve pages of notes and information. A simple note of the instruction that was received, its time and date, where and what work was affected, and how the instruction was put into action, together with a note of the resources affected, will suffice. A good site diary sheet should contain, for each section of work or location, who was working there, what they were doing and what the weather was like each day. When this 'normal day' is interrupted by a variation or other event that changes what the resources were doing, or resulted in standing time, this should all be carefully noted. Similarly, notes of demobilisation from a location, return visits to complete work, or a subsequent return to already completed work to add or alter something required by a drawing revision or instruction – these are all essential evidence of disruption and delay. If an activity was completed and then a subsequent instruction received that requires a return to that work to carry out some additional work or alterations, this will detract from labour efficiency and cause disruption to the workforce and the critical path.

Do not assume that the claim submission is only going to be read by the opposing parties' construction team. It may be passed to their lawyers or, eventually, be part of a submission for adjudication, and so the narrative should avoid jargon and, where some projects use acronyms for elements or sections of works, these should be spelt out in full the first time they are used, with the acronym inserted in brackets following its full description (e.g. 'WBS' may mean 'West Bound Carriageway', and 'HRSG' may mean 'heat recovery steam generator'). A well-researched claim, supported by appendices containing factual records and explaining the history of the event and its effects, is essential to convince the other party to consider their position and accept the claim on its merits. The claim narrative needs to tell a convincing story explaining the matters that occurred, and their timing and impact on the progress of work. It should be cross-referenced back to the appendices and exhibits prepared and follow a logical course through the event and onto a conclusion supported by the facts. The narrative should put flesh on the bones of the recorded facts. It must explain the causal link between the events and their individual or combined effect on the progress and performance of the works.

Complex voluminous claims have a habit of masking or confusing the essential facts – or worse, deliberately misconstruing them. The more complicated a claim

submission becomes, the less it is likely that the other side will accept any of it or even understand it. The true art of submitting a claim, which may arise from a very complex series of issues or interactions between issues, is to identify and simplify the issues and explain the complex matters in a straightforward manner, so that the entitlement to additional time or payment is clarified rather than obfuscated. This is especially true with complex spreadsheets, computer programmes and delay analysis techniques, which are often misunderstood by the receiving party or later by an arbitrator or judge, should the matter proceed to settlement by a formal dispute procedure. One technique for simplifying a narrative is to explain what the problem is about, and how it caused the delay or costs claimed, by imagining that you are explaining the case to a friend down at the local pub, where you paraphrase and summarise the essence of the claim and its causes so he can grasp what you are talking about. Such a simple, no-nonsense approach helps concentrate the mind on the important issues and the headline matters to be addressed.

The main problem is that the receiving party will probably want to ignore the claim, because it will otherwise involve making additional payments to the claiming party (usually the Contractor, although it could also be a Subcontractor claiming against the main Contractor). Therefore, it is far better to simplify an argument than to complicate it. The former will aid the understanding of the recipients, and the latter will confuse matters. The more complex and confusing an analysis is, the less likely it is to find favour – for example, judges and arbitrators do not want to wallow through complex technical arguments; they need a simple, no-nonsense narrative that shows how the matters claimed affected the project and why the other party is liable, and then a marshalling of the factual evidence to prove what is claimed. Finally, each main topic, paragraph and subparagraph should be numbered, so that it can easily be referred to when discussing the claim with the other party.

10.2 Typical List of Contents

This is not meant to be an exhaustive list, since each claim will differ depending on the size/value and type of claim being made, and the level of information needed to prosecute it to a satisfactory resolution.

10.2.1 Executive Summary

This is where the submission sets out a high-level summary of the claim, detailing the amount claimed and any extensions of time sought as appropriate. The intention is to provide a headline summary of the claim, so that the reader is advised from the outset what is being claimed and why. This ‘focuses the mind’ of the recipient on what the claim is about and how much it is worth.

10.2.2 Introduction

This section details an introduction to the project and explains what works were to be constructed, listing the parties to the contract and their advisors, and simply sets out the main reasons why the claim has been prepared.

10.2.3 Basis of Claim/Contractual Entitlement

This section sets out the contractual basis for the claim and the relevant clause or clauses of the contract that entitle the contractor to make the claim.

10.2.4 History of Events

This is where the story behind the claim is unfolded, setting out clearly and concisely the events that occurred and what the contractor claims happened as a result of those events. This should be in chronological order, referring to supporting documents and other evidence, and also indicate where this is detailed in the appendices to the submission.

10.2.5 Delay Analysis

The method of analysis used should be stated and explained, together with any references to appendices containing programmes or other relevant information. It should also explain how the items or events have been analysed using the programme to determine the impact of changes or other delays, with references to identify where they are described in detail (e.g. 'Appendix No ...'), and mention which programme was used for the analysis. The detailed evidence should be set out in an appendix, but the summary of the findings should be within the claim narrative, setting out the effect on the completion date of the matters in issue. Do not confuse the reader with planning jargon; explain the processes and principles in plain English. The main aim of the submission is to simplify what happened, and to explain how it affected the programme and progress of the works. Too much emphasis on software 'trickery' and terminology will detract from the analysis and the argument being made. Details of software terms, etc., are best left for an appendix, setting out a glossary with definitions of any planning, engineering or other specialist terms used. If some form of time-slice or windows analysis has been undertaken, this section should include the tables explaining the progress impact identified at each stage. This may include schedules of delays identified at the relevant time, and abstracts from the programmes (the full programme should set out in an appendix). A tabular summary of the delay identified should be included.

The main body of the submission narrative should summarise the findings and conclusions, cross-referenced to appendices and other documents where appropriate, to ensure the narrative is cohesive and explaining the conclusions reached based on the investigations undertaken. Where possible, the narrative should contain extracts from the programmes showing how the relevant events were inserted into the programme, or where they exist on the as-built programme assisting the reader in following the argument.

10.2.6 Evaluation

The cost incurred due to extra work or delay is valued in this section, setting out the calculations and references to the supporting details set out in an appendix. This should include a summary of the approach adopted in preparing the evaluation, an explanation of any internal cost records or systems that were interrogated to produce the costs and

a method of verifying that these were reasonable costs properly incurred for the project in question. It should refer to appendices where the detailed records and supporting cost information are provided.

10.2.7 Summary/Conclusion

This should be a simple statement drawing together the various sections of the claim in terms of the extension of time and money sought in recompense for the delay and/or disruption suffered. It should also be set out in a tabular summary format.

10.2.8 Appendices

This is where the body of supporting evidence and calculations are contained to avoid making the narrative sections of the claim submission too cumbersome. Typical appendices would include:

- Technical assessments.
- Engineering calculations.
- Geotechnical report or similar technical expert evidence obtained.
- Delay analysis and programmes used.
- Evaluation or quantum calculations, reports and schedules with supporting figures.
- Costs information:
 - Supporting calculations, quantities, production losses, etc.
 - Schedules, etc., abstracted from time sheets, invoices, etc., relating to the evaluation.
 - Data records if electronic sources are used.
 - Certified extracts from costing systems that can be verified.
- Witness statements (where appropriate).
- Graphics:
 - Diagrams to explain where and what the claim relates to.
 - Drawings or sketches of the work area together with layout plans, etc., marked up to show the affected area and the type of work.
- Relevant documents:
 - Schedules of correspondence/instructions, requests for information (RFIs), etc., especially copies of the relevant notices given.
 - Copies of relevant correspondence including in date order copy emails (do not print out entire email chains; it is clearer to include the headline email once for each exchange).
 - Monthly progress reports, meeting minutes, etc.
 - RFIs/technical queries issued.
 - Site instructions/change orders, etc.
- Contract programmes:
 - Original programme.
 - Updates (monthly/quarterly).
- Relevant drawings:
 - Reduced-size copies of the related contract drawings.
 - Drawing schedule, and extracts to show the documents and dates when such changes were issued.

- Photographs:
 - Progress photographs.
 - Event-specific photographs showing the variation/matters in issue during construction.
- Contemporary records:
 - Copies of time sheets.
 - Allocation sheets.
 - Diaries.
 - Staff schedule.
 - Plant hire records.
 - Relevant invoices.

11

Disruption Claim Examples

11.1 Disruption

It is considered good practice to isolate, so far as is practicable, the various cause-and-effect calculations for each claimed event as part of the overall disruption claim. This is in addition to calculating the direct costs of labour, plant, and materials, etc., that the variations or changes have caused on site where extra work has been instructed. One of the more complex issues is where there are numerous drawing issues and information delays that do not significantly vary the works but result in a delay to construction due to the lateness or timing of their introduction. This results in a project that has not, on the surface, changed dramatically, but has nevertheless suffered delay and disruption resulting in additional costs and/or late completion of the works. Providing there are records of the drawings issued and what they affected, together with schedules of the questions and answers to various technical queries or requests for further information, it should be evident that the design was incomplete when work began and required explanation or correction before it could be built.

The following sections explain the key methods of calculating disruption and production losses once it has been established that the root cause was not of the Contractor's own making. However, even where there is ample evidence of variations, changes and delays for which the Employer is liable, it is still necessary to adjust any costs identified for any delays, errors, or omissions caused by the Contractor. In the following examples, I adjusted the production losses identified for any such errors and also for recovery received in respect of variations and changes instructed.

11.1.1 Measured Mile

The worked example that follows is based on a pedestrian re-paving contract where the site records kept were generally very good and these could be accurately compared to measured areas of work performed. This provided the core information necessary to compare the quantity of work performed with the resources used for the entire site. This data was required to select a baseline area where little or no disruption occurred that could then be compared to the production achieved elsewhere on the site.

The Contractor claimed that the works suffered disruption throughout the construction period due to matters for which the Employer is liable under the terms of the contract. It was accepted that disruption had occurred, but there was an issue with valuing the impact. The main causes of delay and disruption were:

- Additional and varied works instructed.
- The discovery that, once uncovered, the majority of the existing services were found to be sited very near the surface and conflicted with the design for the new drainage and paving, necessitating revisions to the design and/or instructions to overcome the problem.

Any analysis must consider the effects of disruption on the surrounding activities, not just the time recorded against instructions and variations identified. The Contractor's contemporary record sheets (CRSs) did not and could not record all matters relating to disruption and time lost; only the most obvious delays and standing time were recorded contemporaneously. Whilst general production loss arising from the impact of additional works, resource re-deployment, etc., and stoppages on the surrounding works was repeatedly noted in correspondence, minutes of meetings, etc., between the Contractor and the Engineer, it was not always specifically recorded on CRS sheets, and, therefore, it remained to be assessed.

The instructions and variations that caused delay and disruption on this project absorbed nearly half the time for resources deployed. Consequently, the planned timing, sequence and duration of works suffered severe disruption and delay.

The analysis compared planned/achievable production with the recorded outputs and details the reasons identified that caused disruption and delay. The critical delays were caused by the presence of shallow utility services that typically resulted in standing time whilst the Engineer determined a solution and instructed how to incorporate these services into the paving design. The paving design and levels were partly constrained by the detail for the surface water slot drain. Its position, depth and relationship to the adjacent paving level meant that the design depth or falls in the adjacent paving could not be achieved where these shallow services were discovered. Other issues concerned incorporation of existing chambers, gullies and smaller valves or services equipment within the paving design. Although many of these items were clearly shown on the original survey drawings, it was not for the Contractor to overcome this problem; it was a design matter, for which the Engineer was responsible under the contract. The design details had not incorporated these items, and each problem was identified and resolved in a piecemeal manner as work progressed. As noted earlier, in most areas, the paving levels and falls were dictated by the position, line and level of the slot drain. Therefore, the paving could not progress until the final position of the slot drain had been revised by the Engineer to overcome the conflict with the shallow services that had been uncovered. The Engineer resolved the issue by instructing ad hoc revised levels and/or by relocating the slot drain position and outfall to accommodate the offending services. All of this caused the Contractor delay, disruption, standing time and production losses. Delay was suffered waiting for instructions and decisions from the Engineer to determine how this conflict was to be overcome. The effect of absorbing this repeated incidence resulted in a high level of change that caused disruption and loss of efficiency, resulting in a general reduction in output, as explained in the following examples:

- Where part of a team was required to carry out additional or varied works, etc., the remainder of the team would suffer production losses due to the reduced capacity of the team. When such events caused obvious standing time, this was generally recorded as a specific event.

- However, if two or three men were taken from an eight-man team to carry out additional works, the remainder were unable to achieve the planned outputs, and overall production suffered.
- On other occasions where excavation works were disrupted due to the presence of shallow services, the work often had to proceed by hand and the excavation plant was effectively idle, being utilised merely to load away the arisings.

The site records showed that the Contractor increased the labour steadily during the construction period as work areas became available and/or that the Contractor mobilised additional resources in an attempt to mitigate delay. The combination of additional and varied works instructed, together with standing time and relocation of resources due to existing services, compounded to cause production losses and disruption. These events restricted deployment of resources and delayed their release to move from one area to the next.

The Contractor had planned to use two standard gangs of approximately eight men each: four men working on groundworks and four men laying paving. The total paving duration shown on the contract programme was 568 days (excluding surfacing of the road areas and paving brick/blockwork areas). This equates to 4544 man-days (assuming an eight-man gang). Contrast this with the number of recorded days expended on additional works, standing time and other extras, which amounted to 2242 man-days, and it is demonstrable that the works suffered extensive change and delay. The calculations that follow quantified and separated the delay and disruption suffered and evaluated the overall impact on the actual production rates as compared to a realistic baseline measurement of what was achievable on the project.

11.1.2 Planned Productivity

The average production rate within the contract programme for completed paving per day (all work – excavation/groundworks, drainage and paving operations inclusive) can be calculated from the descriptions, areas and duration of the paving items on the programme, as shown in Table 11.1.

As can be seen from Table 11.1, the contract programme average/composite production rate for a completed area of paving was 24.55 m^2 per gang per day and, assuming the deployment of a standard eight-man gang, an output of 3.07 m^2 per man per day. The planned duration of paving operations on the programme was 568 gang-days, which equates to 4544 man-days, assuming a constant 4 + 4-man gang is used in all areas. The total number of recorded days spent on additional or varied works on the Contractor's CRS totals 2242 man-days. This shows that the time expended on additional work was proportionately very high as compared to the planned man-days required to construct the original scheme, as shown in the following text:

- Recorded time on additional work: 2242 man-days
- Planned resource for original work: 4544 man-days
- Proportion of time spent on varied work: 49%

11.1.3 Choice of Baseline/Control Areas

This project was constructed in an overall period of 95 weeks, and, to assess production, a representative baseline measurement of production must comprise a reasonable

Table 11.1 Abstract from contract baseline programme (paving areas only).

Description	Duration	Location	Quantity	Output
		Area	(m ²)	(m ² /gang/day)
West area				
Area 2A southern footpath construction	38.5	2A	872	22.65
Area 4A northern footpath construction	67.3	4A	1710	25.41
Area 3A road construction (paving) (road closure)	56.1	3A	1196	21.32
East area – 1				
Area 5A southern footpath construction	25.9	5A	736	28.42
East area – 2				
Area 8A southern footpath construction	62.6	8A	1250	19.97
East area – 3				
Area 6A road construction (paving) (road closure)	40.5	6A	1047	25.85
East area – 4				
Area 1B northern footpath construction	12.3	1B	274	22.28
East area – 5				
Area 2B northern footpath construction	36.77	2B	730	19.85
East pedestrianised area				
Area 3B/4B footpath construction	92.9	3B/4B	2328	25.06
Central pedestrianised area (shopping mall)				
Area 5B footpath construction (module 1)	49.95	5B	1469	29.41
West pedestrianised area				
Area 6B footpath construction	72.2	6B	2177	30.15
Main street				
Area 1C northern footpath construction	13	1C	156	12.00
Total planned gang-days paving	568	Days	13 945	24.55
Assuming standard eight-man gang	4544	Man-days	Output	3.07

section of the work. The choice of suitable areas to use as a baseline measurement was problematic as the first areas where work started were affected by additional and/or varied works, and suffered extensive disruption and delay from the outset.

This project was divided up into sub-areas on the programme. The work commenced in accordance with the planned intent and generally followed the divisions and areas shown on the programme. However, due to delays and suspension of works in certain areas, or parts of areas, the works were constructed out of sequence and many return visits made to complete areas once the problems caused by underground services, etc., were resolved by instructions from the Engineer.

By inspection of the records and the geographical location of instructions, obstacles and services affecting production, three areas to the eastern end of the site were found to be the least affected by delay events. These were Area 2B (Ch 100–290), Area 5A (Ch 0–100) and the first visit to Area 8A (Ch 120–205). These relatively large sections were constructed over a total period of 16 weeks (76 working days) between March and

May 2008, November and December 2008, and March to April 2009, and accounted for 1729 m² out of the total area of 13945 m², or approximately 12.4%.

To assess productivity and production losses, the following equations are performed:

$$\text{Actual productivity} = \frac{\text{Output (units completed)}}{\text{Input (work effort man-days)}}$$

$$\text{Productivity factor} = \frac{\text{Actual productivity}}{\text{Baseline productivity}}$$

Table 11.2 shows the recorded production levels for the selected baseline areas. The preceding selection includes one relatively narrow footpath (Area 2B), which required more cutting and traffic management per side than wider areas. However, as it was necessary to determine a realistic measured mile that is representative of the various areas, it was considered sensible to include in the selection a narrow area to achieve a fair balance. The records used to calculate the preceding values were considerable as the Contractor had daily record sheets for each variation and nearly every day worked. There were a few minor anomalies where payment records showed some additional time as compared to what was recorded, but these represented less than 1% error when the total hours costed were compared to the daily record sheets.

11.1.4 Conclusion from the Measured Mile Calculation

The 'measured mile' value determined in the preceding text is an average production rate for all related works (excavation, kerbs, sub base, base course, paving slabs, etc.), which form a completed section of pavement. The calculation shows that the overall average production from the three control sample areas is 19.87 m² per gang/day and 2.05 m² per man/day. The planned production average was 24.55 m² per gang/day and 3.07 m² per man/day. As these chosen control areas were those with the least impact from services and variations, it seemed reasonable to take the combined average outputs for the measured mile baseline rather than cherry-pick the best performance from Area 5A.

Table 11.2 Recorded production levels for the selected baseline areas.

Area	From	To	Duration in days	Area (m²)	Output	Unit
Area 8A	26/11/08	19/12/08	18	287	15.94	m²/gang-day
		Man-days	188	287	1.53	m²/man-day
Area 2B	12/03/09	11/05/09	40	703	17.58	m²/gang-day
		Man-days	434	703	1.62	m²/man-day
Area 5A	29/02/08	14/04/08	29	739	25.48	m²/gang-day
		Man-days	222	739	3.33	m²/man-day
Average production rate			87	1729	19.87	m²/gang-day
Recorded man-days			844	1729	2.05	m²/man-day

The site records showed that the typical gang size deployed was generally an eight-man unit as originally planned. The overall average production identified in the control areas was slightly lower than the planned output. However, the figures also indicate that the output achieved was higher in one sample area (Area 5A), which recorded 25.48 m² per gang/day and 3.33 m² per man/day over a period of 29 days, achieving 739 m² of completed paving. This calculation from Area 5A demonstrated that the resources deployed could achieve or better the planned production rates where there were few delays or obstructions encountered.

11.1.5 Disruption Calculations

Having established a baseline model for assessing production and calculating the disruption suffered, it is necessary to separate productive work time from other work elements to ensure that a true comparison for the construction of paving is made. The total man-days expended on this project were abstracted from the daily record sheets, but this total had to be adjusted as described in the following text.

11.1.6 Adjustments to Recorded Man-Days

In order to isolate the production time lost due to the disruption, it is necessary to assess the total recorded hours expended for the time claimed or recovered against specific events. This enables the net production values for man-days to be calculated and compared to the measured mile determined herein. The following list details the items for which adjustments have to be made:

- Time-related labour deployed (e.g. stores control, materials distribution, traffic management).
- Labour deployed on other works (e.g. raising manholes, electrical installations, installation of block paving/planters and bituminous surfacing, which were isolated operations not affected by the changes or delay events).
- Adjustment for the recovery achieved for the additional and varied works carried out based on the recorded times claimed within the measured works account.
- Specific instances of standing time recorded and claimed in the measured works account.
- Additional time lost due to the redeployment of labour to alternate tasks (site moves).

11.1.7 Time-Related Labour Adjustment

The value for labour deployed has to be adjusted for the attendant or time-related labour resources – for example, foremen/supervisors, manhole and street furniture gang, forklift driver/storekeeper and pedestrian/road traffic management personnel deployed. This enables a comparison for dedicated production personnel to be considered against the achievable baseline output derived earlier.

11.1.8 Assessment of Delays for Varied Works

Certain additional works were claimed on a recorded time and materials basis. These were identified in a schedule to adjust the claim for the number of man-days recorded for specific events.

Other varied works may have been claimed and reimbursed based on measurement and payment at applicable Bill of Quantity (BOQ) rates and/or new rates. While this

recovers payment for the work done, it does not account for the disruptive effect of these changes and the extra time these varied works took. The additional time and production loss impacts have to be considered as part of the delay and disruption analysis. Therefore, the time taken for these variations has been included in the schedule of compensable events and is considered separately from the recovery at BOQ rates to avoid double counting.

11.1.9 Site Moves/Remobilisation

Due to continuing delays suffered during construction, the Contractor attempted to mitigate standing time by redeploying resources to other work areas in the hope of achieving some production and/or continuity of work to justify retaining the labour on site. Unfortunately, when this was first attempted (move from Area 2A), the area to which the labour was directed also suffered similar delays and disruption (Area 4A), and thus the delay caused by services and other variations were a continual problem. The impact of variations, delays and suspended works, followed by return visits to complete work, was a continual issue.

Work started in Area 2A and immediately suffered disruption, delay and interrupted work periods due to the discovery of shallow existing live and/or abandoned services, which clashed with the designed paving and drainage levels. The Contractor was not responsible for the design of the project, which required an increased depth of paving as compared to the existing while retaining the original finished paving levels. This design requirement was at the root of these clashes where no alternative design or details had been provided in the event that services, etc., were unearthed at or near the paving level. When these services were exposed during excavation, it reduced the work areas available until a resolution to the design issue was instructed. At first, works proceeded in the restricted area that remained. Once it became clear that instructions were not being issued fast enough to allow the area to be completed, the operations were suspended whilst the Engineer determined what action was required, and the resources were redeployed elsewhere. It should be noted that there was a further complication in the management of the paving operations due to a limit placed on the distance that could be opened up at any one time, and the imposition of restrictions on how close together cordoned-off work areas were permitted in order to maintain access to the businesses along the route. This restriction had been included in the programme of works, which was why the project was divided up into separate 'areas' even where there was no physical separation of the work in the finished project.

Area 2A was not the only section of the site that suffered interruption whilst the Engineer decided what to do about underground services and design clashes. Each time some obstruction was encountered, work was curtailed, and resources were moved to another area to attempt some production and mitigate excessive standing time. These numerous site moves caused a further production loss each time a move took place whilst staff were organising the new area to allow operations to commence.

The contract programme anticipated 15 site moves between locations, whereas the details abstracted from the daily record sheets show that numerous additional moves occurred as compared to the original plan. Therefore, in terms of production losses within the windows analysis, there was a total of 143 additional man-days spent moving resources around the site in an effort to mitigate extensive standing time when obstructions were discovered. The Contractor had also, in some areas, attempted to continue working in a restricted manner by working around or over the existing services, but

this resulted in a slowing down or interruption of production. Once it became apparent that the necessary instructions for dealing with such problems would take some time to resolve, resources had to be redeployed to mitigate excessive standing time. As observed earlier, each time resources were redeployed, some unproductive time ensued while staff were organising safety barriers, plant, and materials, traffic management and setting out to allow work to begin in the alternate area. As a minimum, each time a new area was opened up, it took 0.5–1 day to reorganise materials and equipment before work restarted. Some further time was inevitably lost due to the normal learning curve when commencing work in a new location. Dayworks were raised for some of these instances, but not all. This was partly due to the pressure of work and the impact that these continual changes and additional works placed on the engineering and supervisory staff. This period represents the winding down and start-up time loss that arises when demobilising from one area and remobilising in another. The actual number of days lost for each recorded site move were abstracted from records provided for the personnel affected, and details for each period were noted against the relevant window period.

11.1.10 Delay Events

In summary, therefore, the delay events on the project took the following forms:

- Time taken for additional and varied works instructed.
- Delay and disruption caused by underground services encountered.
- Restricted working around or over an obstruction
- Standing time was recorded and time claimed for trial holes and hand excavation to locate the extent of the service encountered.
- Time lost waiting for decisions and replies to requests for information (RFIs) and/or variations to be issued.
- Relocation of resources to other areas, and returning later to the affected area to complete work once instructions were received.

11.1.11 Restricted Working Areas

The specifications stipulated the pedestrian and vehicular traffic management requirements, and this meant that work areas were restricted and the whole site was not available for construction. The work had to be phased to comply with the specified restrictions. These constraints limited the length and width of the working areas available, and this controlled the level of resources that could operate within each cordoned-off area. Therefore, the impact of additional work and delays due to the obstructions encountered critically affected the overall production, resulting in an irrevocable delay to completion.

11.1.12 Varied Works Instructed

This contract suffered delay and disruption from the outset due to numerous instructions issued. Changes and delays were recorded in numerous ways, such as RFIs, confirmation of verbal instructions (CVIs) given and site instructions (SIs) received, as shown in Table 11.3.

The preceding schedule shows that the works were continually subject to variations and delays throughout the construction period, and that further changes were instructed after the original works were completed.

Table 11.3 Incidence of instructed changes/recorded delay.

Window/ period	Period (days)	RFIs	CVIs	SIs	Totals	Cumulative	Recorded delay (man-days)
1	17	24	4	3	31	31	8
2	26	8	6	10	24	55	15
3	59	7	16	16	39	94	58
4	47	10	14	10	34	128	128
5	27	3	4	11	18	146	77
6	37	10	10	14	34	180	171
7	20	1	6	7	14	194	81
8	48	14	17	26	57	251	184
9	70	9	25	16	50	301	393
10	21	1	8	0	9	310	99
11	28	2	7	8	17	327	68
12	132	60	44	38	142	469	442
13	30	5	3	11	19	488	29
14	48	9	26	9	44	532	148
15	52	8	24	1	33	565	239
					Sub total		2242
Instructions after completion					20	585	63
Totals	662	171	214	180	585		2305

11.1.13 Revised Sequence of Works

The redeployment of resources to alternate areas was instigated by the Contractor as a mitigating measure to avoid excessive standing time. However, on one occasion, the Engineer also instructed the Contractor to change the sequence of works and concentrate all resources on completing the town square pedestrianised areas by a particular deadline. This instruction caused other areas to be abandoned, and productivity suffered whilst key resources were redeployed to the pedestrianised areas.

11.1.14 Actual Production Achieved

It is clear from the records that the planned production was frustrated by the incidence of delay events, and that works became fragmented and disrupted. Resources continued to be deployed, but planned outputs were not achieved. This was particularly evident at the western end of the main high street and in the pedestrianised areas, where the incidence of services and obstructions encountered was greater.

11.1.15 Conclusion

The schedule set out in Appendix 11.A records the production loss identified from the records and the time spent on recorded compensable events.

In addition, the schedule assesses the impact of these changes on the general production efficiency when key resources were deployed on such Employer events. This is

shown in column 21 and is an assessment of the disruptive effect of supervening events on the surrounding activities due to the redeployment of key resources to deal with Employer events.

Recorded time working on varied works or other stoppages:		
Additional and varied works	1269	Man-days
Underground services/obstructions	777	Man-days
Recorded standing time	53	Man-days
Additional site moves	143	Man-days
Sub total	2242	Man- days
Summary		
		Man-days
Total recorded man-days	11 431	
Work on other operations, time-related labour, supervision, etc.	1032	
Paving work man-days expended	10 399	
Planned man-days from programme	4544	
Total man-days lost	5855	
Recorded time on changes, stoppages, site moves, etc., as above	2242	
Balance of production loss	3613	
Total loss calculated from measured mile (Appendix 11.A)	3605	

The preceding data shows that the measured mile calculations can be verified by comparison to the total loss calculated from the site records.

11.1.16 Mathematical Model of Disruption

Using the same example project, the mathematical version can be calculated using Professor Ibbs curves and regression formula, as follows.

Summary	
Planned man-days from programme	4544
Recorded time on changes, stoppages, site moves, etc., as above	2242
Proportion of planned time expended on variations	49.3%
Paving work man-days expended	10 399
Proportion of variations work to time expended	21.56%

Note that all the variations instructed were after an obstruction or other issue had been uncovered during excavation work. Therefore, all the changes instructed on this sample project were ‘late changes’. Figure 11.1 shows the usage of the Ibbs formula for computing ‘late changes’.

Construction productivity index (PI) $Y = 0.9796e^{-1.924x}$ where $x = 21.5598\%$
 $PI = 0.9796e^{-1.924 \times 0.215598} = 1 - 0.64699$; thus, the loss of productivity percentage = 35.30%

Using this percentage $\times$ recorded man hours = 10 399 = 3670 man-hours, which is very similar to the measured mile calculation detailed earlier.

11.1.17 Acceleration Costs

If there is a claim for acceleration due to delays or to maintain the contractual completion date, then this must be demonstrated from the records, and the following matters need to be addressed and the case for additional payment set out, as listed in the following text:

- Details of additional resources mobilised, noting when and how it was recorded.
- Details from the reports and meetings to show that acceleration measures were discussed, and whether there was any noticeable improvement in the performance being achieved and recorded.
- Details of increased weekly costs to show that there was an increase in resources (labour and plant).
- In the case of earthworks operations, details of the use of alternate materials to advance work where the existing material was weather dependent, dealt with by introducing a less weather-susceptible material, allowing work to continue during periods of wet weather; this can also be considered to be an acceleration measure.
- Progress records to show that work areas were overlapped more than planned due to the arrival of additional resources, which may also require additional supervision and engineering staff to manage the greater workload being achieved.
- While the application of additional resources may achieve some measure of acceleration as compared to the recorded progress prior to their mobilisation, progress records and reports must be reviewed to consider whether there had been sufficient resources to meet the programme previously.
- Sometimes the application of additional resources may also result in an increase in production losses per unit due to increased crowding or overmanning at the work face or because of congestion of haul routes caused by the additional traffic. Overall production may increase, but the unit cost may still be much higher than originally anticipated.

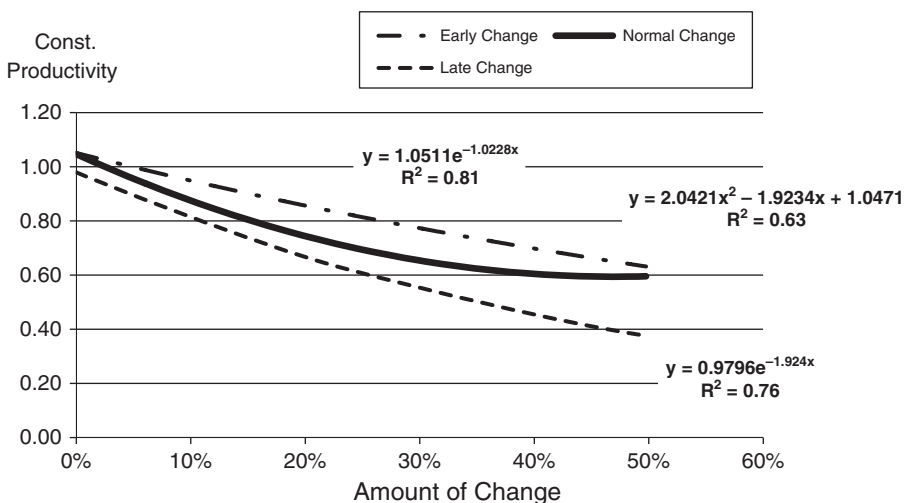


Figure 11.1 Computing 'late changes' using the Ibbs formula.

11.A Disruption Claim Example Schedule refer to 11.1.15

Window Periods Measured			Abstracted Information from Site Records					Productivity Loss Calculations					Recorded Time Against Employer Events					Summary							
Window / Period	From	to	Window Duration	Average Resource Numbers per week in	Each Window Period	Time Related Labour & Adjustment for Other Works	Production Man Days on Paving Works	Actual Production in period m2	Cumulative m2	Planned Production on Original Programme	Affected Production Rate A/P	U/P - Unaffected Production Rate	Loss of Productivity m2/man day (U/P - A/P) (col 13 - 12)	Loss of production as m2 (Actual Resource x Loss of Productivity) (col 6 x 14)	Man Days Lost during the period (Loss of Productivity x Actual Resource) (U/P Book 6 x 14/13)	Changes: SL, R/F1, CVL, Memoirs etc	Underground Services / Obstructions	Standing time recorded	Additional Site Moves (Man Days)	Total Delay Man Days	Unrecorded production loss due to disruption events	Total Employer Liability for Lost Man Days	Comments		
1	10/15/2007	11/1/2007	17	6	67	87	6	0	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0	0	0	At sheet events no paving undertaken	
2	11/2/2007	11/2/2007	26	11	165	185	11	0	0	506	0.00	2.05	0.00	0.00	0.00	0	0	0	0	15	134	145	145	Time lost due to services	
3	11/3/2007	11/3/2007	25	11	185	185	11	0	0	1012	0.00	2.05	0.00	0.00	0.00	0	0	0	0	15	134	145	145	Time lost due to services	
4	1/26/2008	3/12/2008	47	15	473	63	470	599	735	1645	1.48	2.05	0.59	242	118	72	44	4	4	0	128	-11	118	Time loss attributable to recorded changes	
5	3/13/2008	4/9/2008	27	15	245	21	227	366	1099	1244	5.553	2.05	0.44	99	48	205	39	1	10	77	-28	48	48	On site	
6	4/9/2008	5/15/2008	37	18	472	54	418	1037	2185	1291	8844	2.05	-0.55	-250	-112	86	74	0	6	187	-279	-112	-112	No additional production loss this period	
7	5/16/2008	6/1/2008	17	18	325	13	212	366	678	1657	10244	2.05	-0.55	-250	-112	86	74	0	6	187	-279	-112	-112	No additional production loss this period	
8	6/2/2008	7/22/2008	48	20	675	78	596	671	3615	2483	10244	1.13	2.05	0.62	560	268	100	67	0	17	184	84	268	84	No additional production loss this period
9	7/23/2008	8/30/2008	70	30	1483	121	1362	2507	6201	2718	12942	1.80	2.05	0.15	205	100	205	205	5	23	518	-418	-100	-100	No additional production loss this period
10	10/1/2008	10/21/2008	21	25	489	31	435	929	7130	910	13962	2.12	2.05	-0.07	-31	-15	14	14	0	5	100	-100	-15	-15	No additional production loss this period
11	10/22/2008	11/1/2008	10	25	250	21	229	366	678	1657	10244	2.12	2.05	-0.07	-31	-15	14	14	0	5	100	-100	-15	-15	No additional production loss this period
12	11/16/2008	3/26/2009	132	29	2985	168	2816	2191	8689	981	13946	3.18	2.05	1.29	3622	1787	252	116	7	57	431	1335	1707	1707	No additional production loss this period
13	3/31/2009	4/29/2009	30	35	890	55	805	2558	12246	1344	13946	0.78	2.05	-1.13	-908	-442	22	6	1	0	28	-471	-442	-471	No additional production loss this period
14	4/30/2009	6/16/2009	48	26	1439	100	1335	435	12680	1344	13946	5.32	2.05	1.73	2310	1127	95	53	8	0	230	-156	113	113	No additional production loss this period
TOTALS	8/1/2009	8/7/2009	52	20	11431	1032	10389	13945	13945	13946	212	1.73	2.05	0.32	232	387	1389	777	83	143	242	1383	3608	3608	No additional production loss this period

12

Prolongation Costs

12.1 Prolongation

Prolongation claims are made for the reimbursement of extended site and home/head office (HO) overhead costs due to delay by the Employer. A contractual extension-of-time clause never mentions cost; the extension-of-time clause deals exclusively with reasons that allow the Employer to extend the time for completion, not all of which are reimbursable. The Contractor's entitlement to additional payment comes from other enabling clauses that deal with variations and delay events for which the Employer is liable and for which payment can be made. The basic principle is that the costs claimed must relate to the causative event. Therefore, the claim for prolongation should identify the dates and timing of the event or events that gave rise to the extension of time, so that the relevant costs for the period when the delay(s) occurred can be isolated and claimed.

Note that a claim for a delay due to adverse weather is normally treated as a neutral event, with each party bearing their own costs. This means that the Contractor is entitled to receive an extension of time that provides relief from liquidated damages for the period of delay caused by the adverse weather, but no additional costs are accepted. Some contracts deal with weather events differently, and the wording of the contract will dictate what happens in terms of extensions of time and whether any payment can be claimed.

All contracts require the Contractor to prove the additional costs it incurred due to a breach by the Employer. Where that breach causes the works being delayed beyond the prescribed date for completion, this results in increased supervision and overheads costs due to personnel and equipment being retained on site for the additional period. The claim is made for the actual costs incurred and is not related to any Bill of Quantities items for preliminaries or other time-related prices set out in the contract. What is often challenged is whether the costs are reasonable costs, reasonably incurred, due to the breach by the Employer. However, it would be highly unusual for a Contractor suffering delays to load additional staff and other 'on costs' onto the project if they were not actually needed. It is irrelevant whether the rates and prices in the Bill of Quantities for supervision and overheads were enough; if the Contractor was losing money each week because it was obliged to deploy additional or more expensive resources than it originally envisaged, it will only receive payment for the actual costs of the additional period caused by the breach. The principle follows the normal rule for recovery of damages and is intended to put the Contractor back into the position it would have enjoyed but for the breach that occurred.

To prepare the claim, prepare a schedule of all time-related personnel and equipment that are based on site, but which may not directly produce the measured works. The schedule should include all service personnel as well as staff and supervision that are deployed, together with buildings, offices, stores, drying rooms, canteens, toilet blocks, etc. In addition to these core site overheads, the schedule should include all the time-related plant and equipment that is required on site for the duration of the project, but which do not produce the contract works (for example cranes, fork lift trucks etc.). The list will be specific to the size and type of project, starting with personnel deployed full time on the site, together with a list of visiting staff, agency or contract staff and hourly paid personnel.

Table 12.1 Personnel schedule information.

Job title	Name	Date on site	Date left site	Cost per week
Direct staff				
Project manager				
Section manager				
Section manager				
Section manager				
Engineer				
Engineer				
Engineer				
Quantity surveyor				
Quantity surveyor				
Safety manager				
Senior supervisor				
Supervisor				
Supervisor				
Supervisor				
Supervisor				
Site clerk				
Receptionist				
Agency/subcontract staff				
Engineer				
Engineer				
Canteen operator				
Cleaners				
Storeman				
Van driver				
Plant operator				
Etc.				

Items that at first may be considered related to the measured work, for example, a concrete batching plant/mixer provided for the quantity of concrete needed, can become a time-related charge where the volume of concrete has not increased, yet the time taken has been extended due to delays, resulting in the plant being retained on site far longer than planned, and therefore forms a justifiable additional cost to be claimed.

In its barest form, the personnel schedule should show the information as in Table 12.1.

The information in Table 12.1 should be set against the project calendar, so that the numbers and costs of personnel each week can be calculated, and values recorded for the time/dates when the delay occurred.

Figure 12.1 is a typical schedule of staff required for a large 104-week duration project. Figure 12.2 shows this schedule represented as a graph.

ANYTOWN PROJECT PLANNED STAFF SCHEDULE

Contract Wk.No.

<u>Planned Staff Levels</u>	<u>Section</u>	<u>From</u>	<u>To</u>	<u>Total</u>
Project Manager	All	1	102	102
Senior Agent	All	1	102	102
Project QS	All	1	72	72
Planning Engineer	All	1	102	102
Information Controller	All	1	102	102
Storeman / Checker	All	1	102	102
Receptionist / secretary	All	1	102	102
Senior QS	All	1	102	102
Assistant QS	All	1	102	102
Assistant QS	All	1	102	102
Sub Agent	5	6	22	17
Car Park Engineer	3	40	67	28
Main Entrance Engineer	3	1	73	73
Main Entrance Foreman	3	23	78	56
External Works Engineer	3	91	102	12
Centre Block Engineer	4	1	52	52
Centre Block Engineer	4	1	52	52
Centre Block Foreman	4	36	96	61
Centre Block Foreman	4	40	99	60
Centre Block Foreman	4	43	102	60
Totals				1461

Figure 12.1 Planned staff.

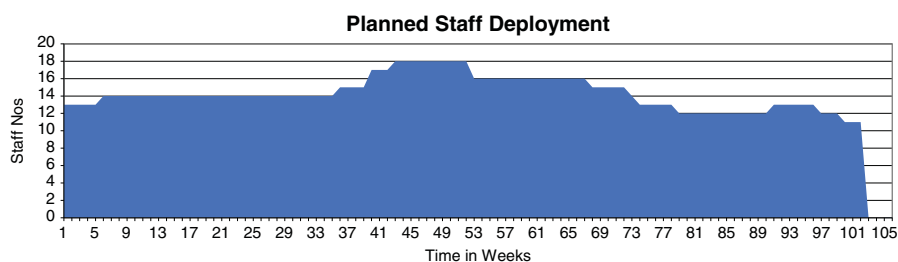


Figure 12.2 Planned graph.

ANYTOWN PROJECT ACTUAL STAFF SCHEDULE

Figure 12.3 Actual staff.

Contract Wk.No.				
Planned Staff Levels	Section	From	To	Total
Project Manager	All	1	110	110
Senior Agent	All	1	110	110
Project QS	All	1	110	110
Planning Engineer	All	1	110	110
Information Controller	All	1	110	110
Storeman / Checker	All	1	110	110
Receptionist / secretary	All	1	110	110
Senior QS	All	1	110	110
Assistant QS	All	1	110	110
Assistant QS	All	1	110	110
Sub Agent	5	6	30	25
Car Park Engineer	3	40	77	38
Main Entrance Engineer	3	1	77	77
Main Entrance Foreman	3	23	78	56
External Works Engineer	3	91	110	20
Centre Block Engineer	4	1	80	80
Centre Block Engineer	4	1	80	80
Centre Block Foreman	4	36	102	67
Centre Block Foreman	4	40	102	63
Centre Block Foreman	4	43	102	60
Totals				1666

Figure 12.3 is a demonstration of a prolongation claim. It shows that the project has overrun to week 110, and the Contractor has scheduled all the staff deployed or allocated to the project (some staff may not be site based, e.g. buyers and sometimes the planning engineer). Figure 12.4 shows this depicted as a graph. A similar schedule would be presented containing details of the number of units and the dates/duration/cost of the offices, stores, utilities, services, plant and equipment required to support the site team. Such details should be obtained from the project cost records and/or invoices for hired equipment. These are called ‘site overheads’ and are sometimes referred to as ‘on costs’ (e.g. the costs of being on site).

In addition to the main site personnel overheads, there will be other elements of time-related plant and equipment that are directly related to the construction period rather than quantities of work measured. These should be set out in an identical schedule, listing their mobilisation and demobilisation dates, together with the costs

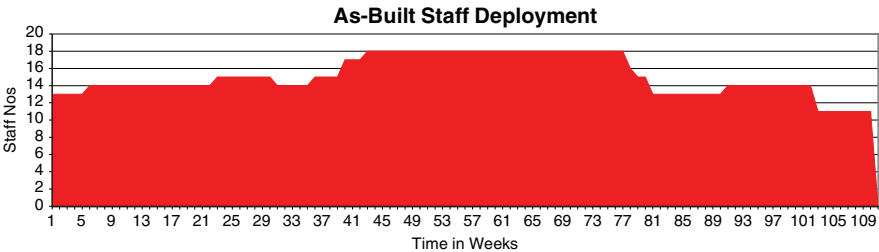


Figure 12.4 Actual graph.

supported by invoices and/or plant hire agreements. The following are some examples of time-related plant and equipment:

- Offices, other accommodation, welfare facilities, drying rooms, toilet blocks and canteens.
- Hired office equipment, for example, copiers, computers, printers, etc.
- Site security personnel or subcontracted security costs (this may even include hired security fencing).
- Safety equipment.
- On major projects, there may also be medical facilities and personnel based at the site. For example, I have been on projects in remote areas where the facilities included a medical centre, doctor and paramedics, together with an all-terrain ambulance.
- Labour camps and similar secure facilities set up for the project.
- Tower cranes, crawler cranes.
- Scaffolding.
- Trench boxes, shoring and other hired temporary works equipment.
- Batching plants.
- Stores, containers and materials distribution plant (tractors, trailers, HIAB trucks, forklifts, hoists, etc.).
- Laydown areas, precast yards, off-site manufacturing areas, bonded warehouses, etc.
- Charges for waste disposal and effluent tanks emptying.
- Rates, taxes, fees or rental paid for the compound areas.
- Extensions of time for considerable periods will also result in additional premiums for Contractor's all risks insurance and other project-specific insurances.
- Bar bending machines and reinforcement storage areas.
- Specific temporary works; for example, de-watering plant and pumps.
- Generators, potable-water towers, fuel tanks for both road vehicles and site plant.
- Telephones, radio masts and other specialist time-related equipment (in remote locations, this could include satellite communications for computer access to the main servers in the Contractor's HO).
- In the case of marine works, this would also include jack-up units, floating cranes, barges, safety boats, etc.
- Extended HO overheads due to the delayed recovery of overheads contribution from the project.
- While the preceding list is not exhaustive, it shows the type of time-related costs that can be included in a claim for prolongation costs.

The detailed costs and lists of personnel and equipment claimed must be clearly set out in the schedule to show, as transparently as possible, the costs claimed, as shown in Table 12.2.

I would also suggest that the schedule be converted into a time-related spreadsheet, showing the number of each unit against the site calendar, so a weekly total can be obtained for any particular week of the project when the alleged delays occurred.

These costs will need to be proven to the Employer, and provision of these details may require access to the Contractor's internal costing system to verify the actual costs incurred together with copies of plant and equipment hire invoices, wages sheets

Table 12.2 Detailed costs and lists of personnel and equipment claimed.

Description	Number of units	On-hire date	Off-hire date	Weekly cost
Main office unit	4			
Toilet block	1			
Drying rooms	1			
Canteen/break room	1			
Stores	2			
Plant shed	1			
Tower crane	1			
All-terrain dumper	1			
All-terrain fork lift	1			
Telescopic loader	1			
Transit van	1			
Generator	2			
Rubbish skip	4			

and salary information to provide sufficient evidence that the costs were properly and reasonably incurred. Much of this information would be confidential; hence, access to such records would be limited, and only a nominated senior person would be permitted to see the details to validate the information used, which may be held at the Contractor’s head or regional offices.

Having established the actual cost of being on site each week, the claim value would be based on the costs incurred at the time of the delay, and not at the end of the project, or conversely not just during the peak period of construction. For example, if there were a delay in weeks 10–18, the costs incurred during these weeks would be applied to the period of delay identified. This method of evaluation would continue for all the delay periods identified.

12.2 HO Overheads

In addition to the direct site-based running costs discussed in the preceding text, it is also common to advance a case for the recovery of off-site or HO overheads for the period of delay. In order to succeed, the contractor would have to keep very detailed records of its HO expenses and relate these to the project to demonstrate how key personnel were prevented from doing other profitable work due to the attention given to the delayed project. This is very difficult to prove, and there is an attraction to adopting one of the well-known formulae for calculation of lost overheads contribution. Where a claim is often presented using a formula, it purports to calculate the under-recovery of overheads contribution from the project because of the delays and the resultant reduction in turnover and profits. While the use of a formula to present this case sounds simple and as an attractive method of recovering the alleged additional costs, it is much more difficult to achieve success. There are several formulae for calculating the loss of

overheads or under-recovery, but they all suffer from the same issues. The English courts have only allowed the application of such formula to a limited extent.

12.3 The Hudson Formula

This formula is named after *Hudson's Building and Engineering Contracts*, a publication that first proposed this formulaic approach in 1970. The basic approach is to divide the contract sum by the contract period in weeks to calculate a weekly value. This figure is then multiplied by the HO overheads percentage, giving the proportion of overheads represented by the contract value. This is then multiplied by the period of delay, in weeks, to determine the claim value. The issue with this formula as originally proposed is that it calculates the values including profit by using the total contract sum, resulting in double counting of this element within the claimed figure, as seen in the following text:

Hudson formula = $(H1 \times H2/H3) \times H4 = H5$		
H1	Allowance (%) in the tender for HO overhead and profit	5%
H2	Original contract price	£8 193 110
H3	Original contract period	502 days
H4	Period of delay	55 days
H5	Recoverable HO overhead and profit	£44 883

12.3.1 Modified Hudson (to Remove Double Counting of Profit on Profit)

From the Hudson formula calculation in the preceding text, the figures are altered to remove the profit and double counting elements to provide a revised figure, as shown in the following text.

Modified Hudson (to remove OHP on OHP): Formula (1) $CH2 \times (1 - CH1) = CH3$; (2) $(CH1 \times CH3/CH4) \times CH5 = CH6$		
CH1	Allowance (%) in the tender for HO overhead and profit	5%
CH2	Original contract price	£8 193 110
CH3	<i>Contract price net of HO overhead and profit</i>	£7 783 455
CH4	Original contract period	502 days
CH5	Period of delay	55 days
CH6	Recoverable HO overhead and profit	£42 638

12.4 The Emden Formula

This formula is also derived from a legal textbook where it was first proposed, *Emden's Construction Law*, and is very similar to the Hudson formula, as shown in the following text:

Emden formula = EM1/EM2 = EM3; EM3×EM4/EM5×EM6 = EM7		
EM1	Total annual HO overhead cost and profit (from audited accounts)	£1 411 000
EM2	Total annual turnover of claimant (from audited accounts)	£30 544 000
EM3	HO overhead and profit as percentage of turnover	5%
EM4	Original contract price	£8 193 110
EM5	Original contract period	502 days
EM6	Period of delay	55 days
EM7	Recoverable HO overhead and profit	£41 468

12.5 The Eichleay Formula

This formula takes its name from an American legal case involving the *Eichleay Corporation*, where a claim was made based on the ratio of total company revenue to the subject project, as detailed in the following text.

1. The contract sum is divided by the total revenue/turnover of the company during the period to provide the proportion of anticipated contribution from the project. This ratio is then multiplied by the total overhead cost in the period to produce an amount of overhead attributable to the contract.
2. The attributable overhead is then divided by the total contract period in days to produce a daily amount of overhead.
3. The daily overhead rate is then multiplied by the period of delay in days to calculate the amount to be recovered due to the delayed completion of the contract.

The following is an application of the Eichleay formula:

Eichleay formula = (1) N1/N2 × N3 = N4; (2) N4 × N5/N6 = N7		
N1	Final contract valuation (excluding HO overhead and profit claim)	£12 388 371
N2	Claimant's total turnover for the actual period of performance (extrapolated from audited accounts)	£34 500 000
N3	Total HO overhead and profit for the actual period of performance (extrapolated from audited accounts)	£1 565 000
N4	HO overhead attributable to the contract	£561 965
N5	Original contract period	502 days
N6	Period of delay claimed	55 days
N7	Recoverable HO overhead and profit	£61 570

As can be seen from the preceding examples, it is clear that using formulae can create vastly differing valuations.

13

Thickening Claims

13.1 Thickening

A claim for other additional costs incurred during the remaining construction period for increased levels of staff and equipment is generally called a claim for ‘thickening’ and relates to the deployment of additional resources, caused by the disruption suffered due to numerous delays or changes. Such a claim is not directly related to the overrun of the planned completion date but arises from the impact of numerous changes on the envisaged resource levels and the need to manage these changes. Part of these additional costs may occur in the same periods as the events giving rise to an extension of time claim, but these costs should be dealt with separately within the claim for prolongation costs for the extended construction period.

The original planned intent would require the mobilisation of resources, supervision, logistic support, etc., increasing as the project gains momentum, with these resources moving through the project following the planned, logical sequence to perform the work. At the start of the contract, the level of staff and supervision would rise progressively, and then level off once the core staff and majority of resources have been mobilised. The typical graphical outline of site costs when drawn is approximately a trapezium shape, showing the initial build-up, followed by a level area during the main period of construction, and the tail off as work is completed and staff can be released for other projects.

When the orderly planned sequence is lost, the supervision and logistical support become overstretched. Travelling between work areas increases, and, in addition, shortages of materials and equipment can arise in fragmented areas due to altered sequence and/or an increase in the peak demand for materials necessary to match production. With the overlapping of activities, locations and work-fronts, the resources increase, the works become dislocated and unwieldy, and management suffers in terms of supervising and supporting the operations. Once this has occurred in several areas, the ability of supervisors to manage the works diminishes, such that additional supervision, safety, logistics and engineering resources are needed to maintain progress. All these additional resources will require offices, accommodation and welfare facilities. This increase in the numbers of supervisory, support personnel and equipment is referred to as ‘thickening’. These costs can be separated from the overall management and personnel values for the period deployed. Invariably, once deployed, these additional resources tend to be retained until completion, and further explanation and reasoning must be provided to

support the claim and show that they were not always required, but that their deployment was driven by the increased demand caused by the delay events and additional works instructed. Resources are inevitably on site for much longer periods than the net extension or time and/or prolongation period identified as they grow progressively to match the work being attempted. Such costs can be tabulated separately as a 'localised' prolongation claim for the period of their deployment, or alternatively for the entire duration of the additional work instructions, information receipt and other delay events identified.

Thickening also occurs due to the degree of revised drawings and instructions being dealt with, leading to increased paperwork and research against each drawing, and raising the relevant paperwork to question errors discovered. A simple ratio of the numbers or sources of change events handled can support the increased level of engineering and other support staff due to the time required to deal with each new drawing or query and/or instruction.

Figure 13.1 shows the increase in resources during construction suffered by the Contractor on a major project. On inspection of this graph, the first thought that occurs is that perhaps the Contractor had underestimated the staff numbers needed and was merely seeking to blame the Employer for its own errors or omissions. However, the second graph shown below the staff chart depicts the degree of change events suffered during the project. As can be seen, there is a direct correlation between the numbers of staff required and the number of technical queries, revised drawings and instructed changes received each week during the construction period.

Nearly all projects begin with the initial issue of the construction drawings, to be followed by later revisions. However, where the original drawings were either inadequate or incorrect and require additional information or correction before the works can proceed, the numbers of technical queries, instructions, sketches and drawing revisions increase. In a project where the design was incomplete or where there is a high level of missing information, the cycle of questions raised, followed by information and/or instructions given, will increase in proportion to the pace of construction. In extreme cases, this can result in dozens of changes, alterations, drawing revisions or instructions being processed each week.

The example claim was prepared to recover the increased costs of additional staff deployed on the project to cope with the extent of changes suffered. The summary graph shows the total number of changes dealt with each week where a change is any form of information release, whether an answer to queries raised or from instructions and/or new or revised drawings issued.

What actually happens on a project of this nature is that the Contractor's Engineer/Supervisor begins to plan out his/her works for the forthcoming week or number of weeks ahead (short-term planning), so that he/she can organise the labour and ensure that the materials, plant and equipment are available. On reading the drawings, an error or omission is discovered – either a mistake, a conflict between drawings or merely missing information. Having discovered that there is some further detail required, the site engineer (should) issue a technical query either in a letter or by using a formal request for information (RFI) form, sometimes called a technical query (TQ) form. The RFI will refer to the drawings and state that there is a missing piece of information that the Contractor needs; in order to progress the works, a deadline for provision of this information is usually given. A reply is then received, usually directly

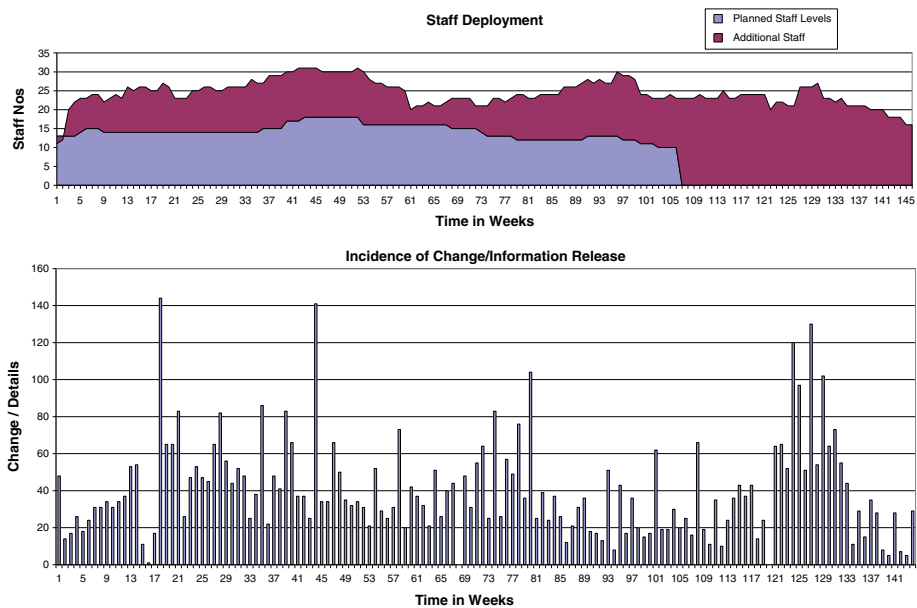


Figure 13.1 Increase in resources during construction.

to the RFI, but it could also be in the form of a new drawing, sketch or an instruction. When the reply is received, the engineer must mark up the drawings with the details provided referring to the RFI and its response, so that work can proceed.

In a perfect world, where the design issued is complete and checked to ensure there are no conflicting details or dimensions, the preceding scenario would rarely occur. However, in reality, discrepancies, missing dimensions or details, and changes are commonplace. On the example project, the preceding problem occurs on an ever-increasing cycle, leading to the issue of hundreds of RFI's and a similar number of replies, together with instructions, drawings and sketches being issued to resolve the queries and allow construction to continue. The progressive and ever-increasing nature of this information flow resulted in the site team being unable to cope, and additional resources were mobilised (together with their respective office accommodation, welfare facilities, plant and equipment).

All construction contracts anticipate the need for further information or corrections to information – it is the nature of the industry. However, the Contractor is not expected to absorb the costs of dealing with these matters, and the various contracts in use all contain clauses that entitle the Contractor to claim reimbursement of the costs incurred together with an extension of time for any resulting delay caused to completion.

Another impact of a project where there are dozens, if not hundreds, of changes, information requests, new or revised drawings, and sketches (not to mention emails) is that the incidence of error on site increases as well. Mistakes happen on any construction site, however well run, but on a project with extensive changes and continually revised information being issued, keeping up to date with the correct drawings and marking them with the new or revised details becomes more than a full-time job. It is common to find that setting out errors and/or hold-ups occur on site due to information being missed or distribution to the relevant site resources not being quick enough to keep pace with construction.

To reinforce the argument about the number of additional engineers, surveyors or supervisors required, it can be shown that each RFI, its reply, new or revised drawing, sketch, or instruction will require time to absorb. Each time an engineer searches through the drawings and finds a missing piece of information, and then raises the relevant RFI, time is wasted. When the reply is received, the engineer marks up the drawings and then organises the work that is instructed or confirmed. This causes a severe drain on valuable staff time as time is lost chasing a paper trail, and the normal day-to-day running of the site begins to suffer, resulting in further additional costs. As a rough 'empirical' guide, a typical technical query or RFI scenario will probably absorb up to 1 day of an Engineer's time dealing with it. This includes the initial time spent searching for the details and finding they are in fact missing, writing out and sending in the query, followed by the time required to absorb, understand and action the reply once one is received. Where the time taken to respond is excessive, more time can be lost reviewing the details and refreshing the memory before the work can be actioned. The example project suffered many thousands of changes and each one of them took approximately 1 day of the site engineer's time. Based on the number of changes/drawings/RFI replies and other sketches instructed (5,919 made up of drawings instructions and replies technical questions), the Contractor would need additional staff. By taking a purely empirical calculation [5,919 changes x 1 day each = 5,919 man days divided by 225 days] [typical working year 45 weeks x 5 days = 225], additional engineers just to handle the paperwork,

plus additional supervision and engineering work in the field to implement the varied or confirmed work.

In addition to managing the paperwork and trying to keep on top of the changes and details being provided, the planned works are often postponed until a reply is given, resulting in the planned sequence and timing of the works being changed. Where the degree of change is extensive, as in the example, the works begin to show signs of fragmentation and become disjointed due to the ever-increasing number of questions and answers preceding the start or continuation of every task. This situation is exacerbated once the extent of change grows and the re-organisation of planned activities becomes extreme, requiring changes to the main programme on a regular basis to maintain control and reflect the actual sequence of work imposed rather than the regular and planned pattern of work originally intended.

Essentially, this 'thickening claim' constitutes part of a disruption claim, since, in addition to the number of changes (resulting in additional costs on site in terms of lost production and increased labour and plant costs), it has also caused a corresponding increase in the number of staff and supervisors required over and above that contemplated at the time of tender. Further, it is not just the construction engineers that suffer from the increased paperwork on such a project. Every source of change must be logged and then distributed to the relevant member of staff and subcontractors. Each change must then be carried out, and its impact valued or measured.

A project with the degree of change shown in the example requires more administration (support) staff, together with quantity surveyors, planning engineers, foreman/supervisors, and drawing office and site engineers, who will all require office space, welfare facilities and equipment. Just maintaining an up-to-date drawing register and distributing copies becomes a massive task requiring full-time staff or an increase over and above those originally deployed. The costs begin to snowball and gather momentum, basically mirroring the revised workflow caused by the number and types of changes being instructed on a weekly basis. Progress and production suffer, and the overall cost of the project skyrocket in terms of staff, labour, plant and equipment.

To achieve success in prosecuting a thickening claim, the Contractor must keep detailed records of the staff deployed, together with where and what they were working on. It is also sensible to provide a written explanation of how the need for additional resources arose when notice was given, etc., to explain and identify the requirement and details of the personnel mobilised. Formal notice of claim must be given as soon as it becomes apparent that the degree of information change is causing not only delay and disruption but also necessitating an increase in the number of staff and support personnel deployed. However, at the beginning of the cycle, the Contractor will invariably attempt to manage the changes with the existing team. It is only when the number of changes and extent of additional paperwork starts to stretch the existing team beyond its limits that the Contractor will mobilise additional personnel. This is especially true if the project is overseas or in a remote area where all resources must be transported to and from the site. Remember that it is common for practical reasons for all new staff and labour to be given job-specific training and a site safety induction. The following examples (Tables 13.1–13.3, Figure 13.2) show the information used in the graphics relating to this chapter which are based on a real project that was severely delayed due to the number of changes instructed during construction.

Table 13.1 Planned staff deployed example schedule.

Planned staff levels	Section	From	To	Total
Project manager	All	1	106	106
Senior agent	All	1	106	106
Project QS	All	1	72	72
Planning engineer	All	1	106	106
Information controller	All	1	106	106
Storeman/Checker	All	1	106	106
Receptionist/Secretary	All	1	106	106
Senior QS	All	1	106	106
Assistant QS	All	1	106	106
Assistant QS	All	1	106	106
Sub agent	5	6	22	17
Setting out engineer	All	5	8	4
Car Park engineer	3	40	67	28
Main entrance engineer	3	1	73	73
Main entrance foreman	3	23	78	56
External works engineer	3	91	106	16
Centre block engineer	4	1	52	52
Centre block engineer	4	1	52	52
Centre block foreman	4	36	96	61
Centre block foreman	4	40	99	60
Centre block foreman	4	43	102	60
Totals				1505

Table 13.2 Actual staff deployed example schedule.

Actual staff levels	Section	From	To	Total
<i>Project managers</i>				
Name 1	All	1	60	60
Name 2	All	34	97	64
Name 3	All	36	130	95
Name 4	All	90	146	57
<i>Agents</i>				
<i>Senior agent</i>				
Name 5	All	2	34	33
Name 6	4	0	0	
<i>Agent</i>				
Name 7	4	3	146	144
Name 8	All	13	20	8
Name 9	3	64	96	33

(Continued)

Table 13.2 (Continued)

Actual staff levels		Section	From	To	Total
<i>Works manager</i>					
Name 10		4	24	77	54
Name 11		3	37	144	108
Name 12		4	78	99	22
Name 13		4	78	146	69
<i>Sub agents</i>					
Name 14	Snr	4	1	60	60
Name 15		All	3	56	54
Name 16		All	24	27	4
Name 17		4	40	146	107
<i>Foremen</i>					
Name 18		3	67	97	31
<i>Gen foreman</i>					
Name 19		5	3	60	58
Name 20		4	127	141	15
Name 21		4	130	146	17
Name 22		4	91	105	15
<i>Engineers</i>					
Name 23	Snr Eng	3	1	6	6
Name 24	Snr Eng	4	1	45	45
Name 25	Snr Eng	All	1	60	60
Name 26	Snr Eng	4	11	146	136
Name 27	Snr Eng	???	13	16	4
Name 28	Snr Eng	3	19	132	114
Name 29	Snr Eng	4	19	80	62
Name 30	Eng	4	1	99	99
Name 31	Grad Eng	4	1	71	71
Name 32	Eng	4	3	60	58
Name 33	Eng	4	15	57	43
Name 34	Grad Eng	4	46	146	101
Name 35	Eng	4	92	124	33
<i>Commercial</i>					
Name 36	PQS	All	1	71	71
Name 37	PQS	All	58	85	28
Name 38	PQS	All	75	146	72
Name 39	SQS	All	4	13	10
Name 40	SQS	All	13	53	41
Name 41	SQS	All	26	54	29
Name 42	QS	All	1	59	59
Name 43	AQS	All	1	146	146
Name 44	QS	All	68	146	79
Name 45		All	93	146	54

(Continued)

Table 13.2 (Continued)

Actual staff levels		Section	From	To	Total
Information control					
Name 46	Design Mgr	All	30	52	23
Name 47	Info Control	All	52	114	63
Name 48	Drg Control	All	4	35	32
Name 49	Drg Control	All	34	114	81
Name 50	Drg Control	All	123	134	12
Planners					
Name 51	Snr Planner	All	0	0	
Name 52	Snr Planner	All	37	146	110
Office and clerical		All			
Name 53	Off Mgr	All	3	146	144
Name 54	Sec	All	0	0	
Name 55	Sec	All	3	144	142
Name 56	Sec	All	86	146	61

Agency staff		Numbers and dates based on invoice amounts			
Another agency					
Engineers					
Name 57	Asst		3	53	51
Name 58	Setting Out Engineer		1	8	8
Name 59	Eng		75	76	2
Name 60	Eng		3	19	17
Name 61	Snr Eng		7	20	14
Name 62	Snr Eng		7	20	14
Name 63	Eng		10	11	2
Name 64	Snr Eng		42	43	2
Foremen					
Name 65	Supervisor		44	45	2
Name 66	Supervisor		62	64	3
Name 67	Supervisor		96	113	14
Name 68	Supervisor		98	146	49
Name 69	Supervisor		117	121	5
Name 70	Supervisor		123	141	19
Name 71	Supervisor		134	138	5

(Continued)

Table 13.2 (Continued)

Actual staff levels		Section	From	To	Total
<i>Other consultants</i>					
Mechanical Ltd	M&E Engineers		87	110	10
	Numbers and dates based on invoice amounts				
SubCon (Land surveyors)	Initial Survey + Setting out				4
	Numbers and dates based on invoice amounts				
AQS Ltd	QS's				66
	Numbers and dates based on invoice amounts				
BQS Ltd	QS's				68
	Numbers and dates based on invoice amounts				
Totals					3552

Table 13.3 Information and instructions received.

No of Changes/Revisions/Variations (excludes 1st issue construction drawings and site sketches)	No of Documents/Changes Issued
1. Construction issue drawings	1883
2. Revised issue drawings	1392
3. Architect's instruction	222
4. COW/RE directions	618
5. Confirmation of verbal instruction	996
6. Technical queries	2691
7. Sub total excel contract drawings	5919
8. Grand total of issues made	7802

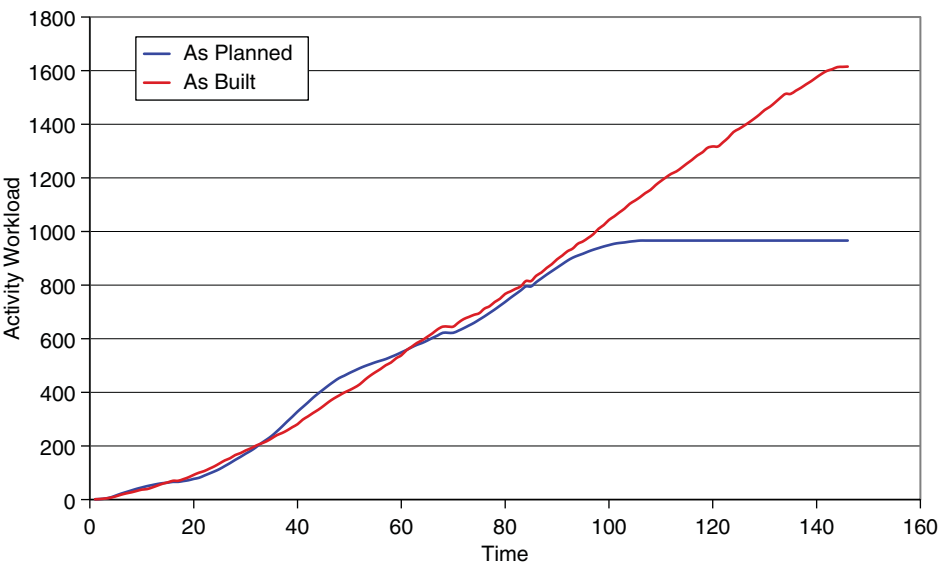


Figure 13.2 Workload comparison graph based on activity count of planned and as built programmes.

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