



Claims Analysis and Dispute Resolution

Causes, Analysis, and Prevention

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1. CONSTRUCTION RISKS

- The responsibility of construction project management of any considerable size involves risk to all parties involved.
- External circumstances such as changes in legislation, tax regimes or the general economic climate may, among many other factors, impact upon the progress and/or costs of the works.
- Practically all projects are subject to some degree of internal risk such as:
 - unpredictable site conditions
 - need to complete some element of design after commencement of the works,
- Contract should address how all these risks are apportioned between the parties and the responsibilities, obligations and liabilities arising in the event that any particular risk materializes.

1.1 Design risks

- Construction projects usually contain some risk related to the design of the structures or buildings.
- Risk may be small, where the design is relatively straightforward and the project conditions well known and documented.
- Risk may be significant when difficult or innovative design is involved or where the precise nature of the project conditions cannot be established.
- If the design is undertaken by the client and the construction to that design is executed by the contractor, then the differentiation between design and construction risk will usually be quite easy to determine.
- If there are elements of specialist design with which the contractor or subcontractors are involved, the contract needs to make clear the elements for which the contractor has responsibility.

FIDIC Sub-Clause 4.1 Contractor's General Obligations:

".....The Contractor shall be responsible for the adequacy, stability and safety of all Siteoperations and of all methods of construction. Except to the extent specified in the Contract, the Contractor (i) shall be responsible for

all Contractor's Documents, Temporary Works, and such design of each item of Plant and Materials as is required for the item to be in accordance with the Contract, and (ii) shall not otherwise be responsible for the design or specification of the Permanent Works.....”

“..... If the Contract specifies that the Contractor shall design any part of the Permanent Works, then unless otherwise stated in the Particular Conditions:

.....

(c) the Contractor shall be responsible for this part and it shall, when the Works are completed, be fit for such purposes for which the part is intended as are specified in the Contract; and

(d) prior to the commencement of the Tests on Completion, the Contractor shall submit to the Engineer the “as-built” documents and operation and maintenance manuals in accordance with the Specification and in sufficient detail for the Employer to operate, maintain, dismantle, reassemble, adjust and repair this part of the Works.”

FIDIC Sub-Clause 8.9 Consequences of Suspension:

“ The Contractor shall not be entitled to an extension of time for, or to payment of the Cost incurred in, making good the consequences of the Contractor's faulty design,”

FIDIC Sub-Clause 11.2 Cost of Remedying Defects:

“..... All work referred to in sub-paragraph (b) of Sub-Clause 11.1 [Completion of Outstanding Work and Remedying Defects] shall be executed at the risk and cost of the Contractor, if and to the extent that the work is attributable to:

a) any design for which the Contractor is responsible”

FIDIC Sub-Clause 13.2 Value Engineering:

“ If a proposal, which is approved by the Engineer, includes a change in the design of part of the Permanent Works, then unless otherwise agreed by both Parties:

(a) the Contractor shall design this part,”

Observance of such procedure and the approval scheme will of course impact on potential liability for design defects and subsequent liability for the costs of any defects.

1.2 Professional indemnity insurance

The requirement to obtain, and maintain, insurance cover for design matters may be a requirement of the contract.

FIDIC Sub-Clause 17.1 Indemnities:

The Contractor shall indemnify and hold harmless the Employer, the Employer's Personnel, and their respective agents, against and from all claims, damages, losses and expenses (including legal fees and expenses) in respect of:

- a) bodily injury, sickness, disease or death, of any person whatsoever arising out of or in the course of or by reason of the Contractor's design (if any), the execution and completion of the Works and the remedying of any defects, unless attributable to any negligence, wilful act or breach of the Contract by the Employer, the Employer's Personnel, or any of their respective agents, and*
- b) damage to or loss of any property, real or personal (other than the Works), to the extent that such damage or loss arises out of or in the course of or by reason of the Contractor's design (if any), the execution and completion of the Works and the remedying of any defects, unless and to the extent that any such damage or loss is attributable to any negligence, wilful act or breach of the Contract by the Employer, the Employer's Personnel,, their respective agents, or anyone directly or indirectly employed by any of them.*

FIDIC Sub-Clause 18.1 General Requirements for Insurances:

"..... Wherever the Contractor is the insuring Party, each insurance shall be affected with insurers and in terms approved by the Employer. These terms shall be consistent with any terms agreed by both Parties before the date of the Letter of Acceptance. This agreement of terms shall take precedence over the provisions of this Clause.

Wherever the Employer is the insuring Party, each insurance shall be affected with insurers and in terms consistent with the details annexed to the Particular Conditions."

FIDIC Sub-Clause 18.2 Insurance for Works and Contractor's Equipment

"..... The insuring Party shall insure the Works, Plant, Materials and Contractor's Documents for not less than the full reinstatement cost including the costs of demolition, removal of debris and professional fees and profit. This insurance shall be effective from the date by which the

evidence is to be submitted under sub-paragraph (a) of Sub-Clause 18.1 [General Requirements for Insurances], until the date of issue of the Taking-Over Certificate for the Works.....”

FIDIC Sub-Clause 18.3 Insurance against Injury to Persons and Damage to Property

“The insuring Party shall insure against each Party’s liability for any loss, damage, death or bodily injury which may occur to any physical property”

FIDIC Sub-Clause 18.4 Insurance for Contractor’s Personnel

“ The Contractor shall effect and maintain insurance against liability for claims, damages, losses and expenses (including legal fees and expenses) arising from injury, sickness, disease or death of any person employed by the Contractor or any other of the Contractor’s Personnel.....”

1.3 Risk analysis and management

- Risk analysis can be carried out by any party to a construction project, for that part of the project with which they are concerned.
- There is only one party that can undertake a comprehensive analysis of the risks, and investigate a reasoned allocation and mitigation strategy, and that is the employer or project sponsor.
- Many contractors conduct a risk assessment as part of the tender process, but this is limited to consideration of the risks within their own scope of work and contractual arrangements.
- The prime mover in this process has to be the employer, and the focus of the process should be the whole scope and lifetime of the project encompassing all aspects including finance, environmental, construction, operational and ultimately redundancy or decommissioning.

When deciding on risk transfer, the following matters are taken into account:

- Which party is likely to be best able to control the events leading to and consequences of a risk if it occurs?
- Should the client retain some involvement in controlling the risk?
- Which party should carry the risk if it cannot be controlled?
- Is any premium charged for the transfer of risk likely to be acceptable to the transferee?

- Will the risk, if it occurs, result in other risks arising? If so, those risks need to be considered as above.

Case:

- A contract for capital dredging and reclamation works to be undertaken in commercial docks.
- Part of the tender information issued to the bidding contractors included a marine survey described in the tender documents as ‘indicating the depths of water in the dock with the lock gates closed’, i.e. the lowest level of water to be anticipated in the docks.
- The contractor undertake the reclamation phase of the project only to discover his vessels grounding on the dock bottom at times when the dock gates were open and the minimum level of water was therefore being exceeded!
- The depths of water shown on the tender survey information did not exist.
- The contractor was somewhat worried and ultimately had to reorganize his program and methods at some considerable cost, for which he looked to the project client for reimbursement.
- It emerged that the survey provided as part of the tender information was six years old at the time of tender.
- The docks were subject to silting as they were located adjacent to an estuary, and no maintenance dredging had been undertaken in the intervening period in the area of the works.
- The whole costly episode could have been avoided if the employer, or engineer, had recognized that the survey information was out of date and either obtains an up-to-date survey and issuing it with the tender documents, or not issuing any survey information but making the facility available to the renderers to undertake their own survey.

1.4 Risk registers

- Many large projects now include a risk register agreed and maintained jointly by the client and contractor.
- It is interesting to consider that this ongoing review and updating might impact on the risk allocation in the project and therefore will need to be carefully monitored to ensure that there is no significant transfer of risk from one party to the other without proper sanction.

- This could result in the contractor suffering a reduced level of cost recovery or reduction in time allowed for an event.
- The project manager is likely to treat any absence of early warning as a lost opportunity to take alternative action or issue other appropriate instructions in relation to the event.

Risks and records

- The root cause of many claims and disputes under construction contracts is the failure to place risk plainly on one party or the other.
- Further disputes as to the valuation of change and disruption also occur where the risk is placed plainly on one party and where the contract allows the party carrying the risk to claim additional payment in defined circumstances.
- The risk allocation may be plain but the financial consequences of its occurrence may be open to a range of opinion and argument.
- There may also be circumstances where the risk distribution is defined, and the entitlement to claims for additional payment clear, but the value of the additional payment cannot be calculated from the contract provisions.

Records may not be sufficient in particular instances and there should be a mechanism for the parties to record with reasonable accuracy:

1. The progress of the works with reference to physical milestones and significant events.
2. The deployment of resources, both labor and plant, in a manner which identifies the scale of the resources and allow identification of the activities undertaken in the recorded period.
3. Deliveries of critical materials and items for incorporation in the works, such as equipment packages for mechanical installations.

1.5 Reimbursable risks

- There are reimbursable risks and non-reimbursable risks.
- The principle often adopted in contract drafting is that the party best able to control the risk is the party who should be responsible for that risk.

1.6 Non-reimbursable risks

- There are risks that are identified as being clearly the responsibility of one party in any event, but without additional payment if they occur.
- But that does not mean they will not impact on other parties to the contract.
- For instance, most construction contracts place the risk of obtaining the quantity and quality of labor resources plainly on the contractor, but if the contractor cannot provide the required resources, the employer, or owner, will almost certainly be affected in that completion of the project is likely to be delayed.
- While the contractor will not be able to recover additional costs in respect of any prolongation of the contract period, and related resource costs, through the construction contract, the employer will usually suffer costs of his own from the delayed completion.
- Most contracts provide some recovery for the employer, usually in the form of “liquidated and ascertained damages”, but these will often not provide full recompense for all costs incurred.

FIDIC Sub-Clause 8.7 Delay Damages:

“..... If the Contractor fails to comply with Sub-Clause 8.2 [Time for Completion], the Contractor shall subject to Sub-Clause 2.5 [Employer’s Claims] pay delay damages to the Employer for this default. These delay damages shall be the sum stated in the Contract Data, which shall be paid for every day which shall elapse between the relevant Time for Completion and the date stated in the Taking-Over Certificate.

However, the total amount due under this Sub-Clause shall not exceed the maximum amount of delay damages (if any) stated in the Contract Data.....”

- It is not unusual in large engineering projects for such damages to be restricted by a cap expressed as a percentage of the contract price, resulting in major delays being even more harmful to the employer.

1.7 Sources of change and disruption

- Many disputes over additional payments arise from the failure to record and detail the consequences of risks when they do arise.
- A full and well-supported presentation of a problem will usually be the first requirement to ensuring that the cause and effect are understood by all and are capable of rational analysis and resolution.

The process of analysis

- In breach of contract cases lawyers often refer to the required chain of analysis as being:

Duty – Breach – Cause – Effect – Damage

Duty: This first step is concerned with establishing the obligations and responsibilities of the parties to the contract.

Breach: Have any of the obligations and responsibilities established under the ‘Duty’ analysis been breached?

Cause: What is the cause of any breach in the financial obligations and responsibilities?

Effect: This is where the quantum analysis often begins to assume equal importance with the liability analysis.

Along with the effects of the liability analysis it will be necessary to analyze the financial effects of the liability breaches.

Damage: Where a damages claim is being considered it will be necessary to consider aspects of sustainability and proof of the financial effects.

Are any of the financial impacts too remote to be claimed?

Are the records of events and costs sufficient to support the claim being made?

Should the financial impact have been mitigated from that being claimed?

1.7.1 Inadequate pre-contract design and documentation

- This problem should not be confused with contracts where design information is issued at the outset in an incomplete form for known and planned reasons.
- The most common incidence of contracts commencing with incomplete design is that of major projects where the length of time required completing the design before commencement of work on site would be unacceptable to the employer.
- There is nothing essentially wrong with such an approach and it is often necessary for large schemes to begin the early phases of construction before the design of later stages is completed.

1.7.2 Design development

- It is often the case that design will continue to develop after the construction contract has been let, for sound technical reasons.
- The same reservations apply in that the contract must be set up to outfit for such development.
- If substantial portions of the works either cannot or will not be fully defined or designed, or the design is likely to alter in significant respects, then the payment and planning provisions should be structured to outfit for the anticipated design development.
- If the agreements at the outset do not realistically reflect the intended manner by which the works will be procured then future problems are almost guaranteed.

1.7.3 Changes in employer requirements

- Just as design may change for technical reasons there will be instances where the client's requirements may change, often for unpredicted reasons.
- Most lump sum and measurement contracts where the design is undertaken by a team of consultants on behalf of the client, provide for such changes as variations to the contract and contain detailed provisions for quantification of such variations.
- Problems can, however, arise with design and build contracts, or other variations on this theme such as EPC (Engineer, Procure and Construct) contracts in the oil and gas industries, if the contract does not include sufficient detailed information to establish the chain of analysis discussed above.
- A common example of the problems that can be encountered is the provision of large elements of the work as performance-specified equipment or packages.
- If a contract includes the provision of a large piece of mechanical equipment costing, say \$2 million, but the definition of the package is by specification of its required input and output performance and a change is required to one or more of the input or output requirements, the analysis of the financial impact of that change becomes very difficult without recourse to information from outside the contract, if such information is available.

1.7.4 Unexpected occurrences

- For client or contractor, and preferably both, the most appropriate means of monitoring such matters is the establishment of a risk register backed with a risk management and mitigation strategy that will enable events that occur to be managed both physically and contractually with the minimum of disruption and the best prospect of avoiding a dispute over claims that arise.

2. Reporting Status

- When considering any type of change, consideration is given to the base from which change is quantified.
- The base whether has to be the construction contract between the parties, and that does not vary with differing post contract circumstances.
- The analysis of change, and evaluation of payments, must therefore always refer back to the base of the construction contract.
- *Planned change* is that which can be identified in advance and managed in an orderly and timely manner, the obvious example being variations to the scope of the works which can be detailed and instructed in advance of the need to execute them.
- *Unplanned change* includes those events that cannot usually be predicted but occur as the works progress, a common example being the encountering of ground conditions different to those anticipated before the works commenced.

2.1 Planned Change

- Most contracts for construction projects incorporate provisions for certain changes to occur, principally to safeguard the employer's right to damages if the completion date is not achieved.

FIDIC Sub-Clause 8.7 Delay Damages

“..... If the Contractor fails to comply with Sub-Clause 8.2 [Time for Completion], the Contractor shall subject to Sub-Clause 2.5 [Employer's Claims] pay delay damages to the Employer for this default. These delay damages shall be the sum stated in the Contract Data, which shall be paid for every day which shall elapse between the relevant Time for Completion and the date stated in the Taking-Over Certificate.

However, the total amount due under this Sub-Clause shall not exceed the maximum amount of delay damages (if any) stated in the Contract Data.....”

- Contracts may contain provisions whereby the quantities of work provided to the contractor at the time of tender will be adjusted wholly or in part to reflect the actual quantities of work executed.

FIDIC Sub-Clause 13.1 Right to Vary

“Variations may be initiated by the Engineer at any time prior to issuing the Taking-Over Certificate for the Works, either by an instruction or by a request for the Contractor to submit a proposal.....”

Each Variation may include:

(a) changes to the quantities of any item of work included in the Contract (however, such changes do not necessarily constitute a Variation),

(b) changes to the quality and other characteristics of any item of work,”

- There is always a need for three steps required in any circumstance to establish an entitlement to additional payment:
 1. Confirm that the circumstances are within the variation provisions of the contract, express or implied.
 2. Confirm that the variation, if within the variation provisions, gives rise to an entitlement to additional payment.
 3. Determine the rules, if any, for the evaluation of the additional payment.

2.1.1 Ordered variations

- The steps for variations conclude with the need to determine the rules set out in the contract for the evaluation of variations.
- In many instances the rules will seem straightforward but care should be taken in reading and considering them as many rules raise issues that may not be immediately apparent on a first reading.

FIDIC Clause 13 Variations and Adjustments contains the provision for the engineer to request a quotation from the contractor for any proposed variation, including any consequential delay for agreement before the order is given and work commenced on the variation work.

- In practice it is not always possible to fully define the scope or agree the costs arising and **FIDIC Clause 12** recognizes this by setting out the rules for valuation by the engineer if agreement has not been reached as provided by **FIDIC Sub-Clause 12.3 Evaluation:**

“..... Except as otherwise stated in the Contract, the Engineer shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine the Contract Price by evaluating each item of work, applying the measurement agreed or determined in accordance with the above Sub-

*Clauses 12.1 and 12.2 and the appropriate rate or price for the item.
However, a new rate or price shall be appropriate for an item of work if:*

- (a) (i) the measured quantity of the item is changed by more than 25% from the quantity of this item in the Bill of Quantities or other Schedule,*
- (ii) this change in quantity multiplied by such specified rate for this item exceeds 0.25% of the Accepted Contract Amount,*
- (iii) this change in quantity directly changes the Cost per unit quantity of this item by more than 1%, and*
- (iv) this item is not specified in the Contract as a “fixed rate item”;*

or

- (b) (i) the work is instructed under Clause 13 [Variations and Adjustments],*
- (ii) no rate or price is specified in the Contract for this item, and*
- (iii) no specified rate or price is appropriate because the item of work is not of similar character, or is not executed under similar conditions, as any item in the Contract.....”*

- Where the varied work is of similar character to the work in the bill of quantities then the varied work is to be valued at the bill of quantities rates and prices as may be applicable.
- Where the varied work is not of a similar character, or is not carried out under similar conditions or is executed during the defects correction period then the bill of quantities rates and prices are to be used as the basis of valuation.
- These rules, however, raise two issues on careful reading:
 1. How does one determine what the character of the work is, or the conditions under which the work is performed?
 2. What is a “fair valuation” as contemplated by FIDIC sub-clause 3.5? Fair to whom?

*“.....Whenever these Conditions provide that the Engineer shall proceed in accordance with this Sub-Clause 3.5 to agree or determine any matter, the Engineer shall consult with each Party in an endeavour to reach agreement. If agreement is not achieved, the Engineer shall make a **fair determination** in accordance with the Contract, taking due regard of all relevant circumstances.....”*

- *The Concise Oxford Dictionary* defines that ‘*condition*’ is the state of something or someone, with regard to appearance, fitness, or working order.
- For ‘character’ the most useful definition given is that it is the distinctive nature of something.
- So, an examination of the contract documents would be needed to determine relevant factors, which may include, for instance:
 - If the work is described as being executed in abnormal circumstances, e.g. outside the boundaries of the site or in existing buildings, in tidal areas or areas susceptible to flooding, or is subject to other extraneous factors that will affect the cost of executing the work.
 - If, from the contract documents, it can be established that work will have to be undertaken at a time that will affect the cost of the work.
- The character of the work might most usefully be considered to be factors inherent to the work itself rather than the conditions under which it is executed, for instance:
 - The general arrangement of concrete work that dictates how many repeat uses of formwork will be anticipated, or
 - The amount of detailing in brickwork that will affect the overall rates paid to subcontractors for bricklaying.

2.1.2 Evaluation of changed conditions

- Matters that might be relevant to the “conditions” of work may include:
 - Abnormal or exceptional locations for the work.
 - The timing of work.
 - Work close to existing structures or installations.
- The “character” of the works might include:
 - The general arrangement of the work.
 - The amount of detailing that might be required in particular work.
 - In some circumstances, the quantity of work to be executed.

2.1.3 Fair rates and prices

- It is perhaps part of the ‘fair’ element of such clauses that both parties can see the detailed build-up to the total amount claimed and therefore have the opportunity to assess the reasonableness or otherwise of the prices used.
- The pricing should be fair to both parties and provide the contractor with an economically practical price while not requiring the employer to pay an unreasonably excessive amount.
- Provision of a detailed particularization makes the establishment of fair rates and prices more attainable as the cost of the elements can generally more readily be compared to other data than the price for the whole.

For example;

- Labor rates can be compared with published and other available information on rates for the particular trades, costs of materials checked with suppliers, etc.
- Such changes can have an effect beyond that of the direct economic consequences of the change to the particular construction operation.
- If the operations are critical to the progress of the works towards the contract completion date there may be consideration of delays as a result of the changes.
- If the changes to conditions or character of particular operations affect other construction operations there may be disruption to those operations, with economic consequences with or without effect upon the completion date.

2.1.4 Changes in quantities

FIDIC Sub-Clause 13.1 Right to Vary

“Variations may be initiated by the Engineer at any time prior to issuing the Taking-Over Certificate for the Works, either by an instruction or by a request for the Contractor to submit a proposal.....”

Each Variation may include:

(a) changes to the quantities of any item of work included in the Contract (however, such changes do not necessarily constitute a Variation),”

- Contracts based on a “design and build” delivery will leave quantities to the contractor, and some contracts where design and construction are separate may

still require the contractor to take responsibility for determining the quantity of work to be performed.

- If the quantities are not incorporated in the contract then there will be no entitlement to any adjustment of price consequent on changes in quantities.
- If the quantities define the work in the contract then there will usually be an entitlement to adjustment of the contract sum consequent on quantity changes.
- Where quantities are not incorporated in the contract there may be an issue on the calculation of any rate to be applied to subsequent variations in the scope of the works.

Example;

- if an item for pricing requires the contractor to provide a lump sum for painting to concrete soffits and he includes the sum of \$5,000 (having assessed the requirement as being 500 m² at \$10 per m²)
- But subsequently discovers that the requirement was only for 400 m², what rate applies to any variations for further painting to concrete soffits?
- Is it the \$10 per m² assessed by the contractor, or the \$12.50 per m² he is recovering based on the actual quantity of work in the lump sum item?
- The answer should be the \$12.50 per m², as the contractor is bound by any errors in his pricing. He would still be bound if the actual quantity for the lump sum item were discovered to be 1000 m² thereby halving his rate to \$5 per m².

Example;

- It has been known for the civil works for a new build large power station to be measured on the basis of notes in a preamble to the quantities stating, among other matters, that “only major items have been measured, minor items are deemed to be included with the major items”.
- There was no definition of “major” or “minor” items in the notes; it had to be assumed that everything not measured was a “minor” item.
- It does not take an expert in measurement of construction work to anticipate that such an approach will almost inevitably result in dispute as to:
 - Where major items of construction had not been measured, which were larger than many “minor items” which had been measured, were these errors rather than omissions?
 - Where new construction items were required by variations and instructions, were these all “major” or “minor” items, or were they a mixture of the two?

- Lump sum contracts use the quantities to establish the lump sum and changes in the quantities do not automatically affect the contract sum.
- By contrast, remeasurement contracts anticipate that the tendered quantities will be completely remeasured to reflect the actual quantities of work undertaken and the contract sum adjusted accordingly.
- Remeasurement of the contract work raises two issues:
 - Do the bill quantities contribute to the establishment of the “character” of the work covered by the rates and prices in the bill?
 - Can changes in quantities alter the character of the works, or otherwise require the rates and prices to be adjusted?
- The answer to the first question would logically seem to be “yes”.
- It is difficult to predict circumstances on a civil engineering contract when the extent and mix of quantities would not be considered by the contractor in forming a view as to the nature and form of the required construction operations, the “character” of the works.

2.1.6 Preferential engineering

- Ordered variations and measured changes in quantities should be reasonably clear changes to the contract.
- Two areas of frequent disagreement that cause difficulty in evaluating any entitlement to additional payment are:
 - (1) *Preferential engineering*: changes arising from agreement of design details between the members of the project team that incorporate differences to the content of the contract.
 - (2) *Variation by stealth*: changes made to the design of a project during the approval of contractor design by the client’s project team, a process not infrequently encountered on projects of a design and build nature.
- The common basis for such changes is that they were “thought to be within the contractor’s existing obligations”.

2.1.7 Unconfirmed instructions

- There may be instances where there is genuine disagreement as to whether or not an instruction issued by the engineer or architect does in fact constitute a change under the contract, giving rise to an entitlement to additional payment.

2.2 Unplanned change

- There may be occasions when changes occur or are required as a result of inappropriate circumstances.
- A common occurrence is the encountering of exceptional physical conditions, be they geological, meteorological or man-made.
- It should be remembered that depending upon the terms of the contract, less tangible factors such as changes in economic circumstances, for instance in the shape of tax changes or exchange rate fluctuations, may require consideration.
- When considering physical factors causing unplanned change, the first consideration, after definition of the physical condition, has to be the assessment of the factors in the contract that have been impacted by the change.

2.2.1 Programs and method statements

FIDIC Sub-Clause 8.3 Programme

“..... The Contractor shall submit a detailed time programme to the Engineer within 28 days after receiving the notice under Sub-Clause 8.1 [Commencement of Works]. The Contractor shall also submit a revised programme whenever the previous programme is inconsistent with actual progress or with the Contractor’s obligations. Each programme shall include:

- (a) the order in which the Contractor intends to carry out the Works, including the anticipated timing of each stage of design (if any), Contractor’s Documents, procurement, manufacture of Plant, delivery to Site, construction, erection and testing,*
- (b) each of these stages for work by each nominated Subcontractor (as defined in Clause 5 [Nominated Subcontractors],*
- (c) the sequence and timing of inspections and tests specified in the Contract, and*

(d) a supporting report which includes:

(i) a general description of the methods which the Contractor intends to adopt, and of the major stages, in the execution of the Works, and

(ii) details showing the Contractor's reasonable estimate of the number of each class of Contractor's Personnel and of each type of Contractor's Equipment, required on the Site for each major stage.

- It is unusual to find that the contractor's program has been incorporated into the contract.
- There are two related reasons for this:
 - At the time of entering into the contract, the program may be only in outline form, suitable for estimating and tendering purposes and may not incorporate the full detail required.
 - If the tender program was to be incorporated into the contract it would become an obligation on both parties.
- Most construction contracts do not incorporate the contractor's program but restrict the contract terms to dates by which the whole, or parts, of the works have to be completed.
- Some contracts, particularly contracts for "minor" works, do not refer to or require a program at all.
- These programs would then provide a basis for the assessment of change to the sequence and timing of works following a change.
- But a program is merely an expression of intent, i.e. it shows an intended sequence and timing but the assumptions and intentions inherent in the program may become invalid for a number of reasons, including:
 - Errors in the contractor's analysis when calculating the program.
 - The contractor's inability to obtain the resources he considered he needed as and when he thought he would need them.
 - The impact of changes made as the contract progresses including ordered variations etc.
 - The impact of extraneous factors such as weather conditions.
- This raises the issue of the validity of the "contract program" when considering the impact of any particular change.

- In the vast majority of contracts for works of a substantial nature the program will be impacted and changed itself by many factors, including those noted above, before the impact of a particular change that needs to be addressed.
- The proper basis for analysis of the impact of a change in terms of effect upon the sequence and timing of the works must be the program in position immediately preceding the change to be analyzed, incorporating all known relevant information and revisions at that time.

2.2.2 Delay and Disruption

Limitations on liability

- When undertaking any assessment of quantum under a construction contract for an event it may be necessary to observe any limits placed on liability by the terms of the contract.

FIDIC Sub-Clause 17.6 Limitation of Liability

“..... Neither Party shall be liable to the other Party for loss of use of any Works, loss of profit, loss of any contract or for any indirect or consequential loss or damage which may be suffered by the other

The total liability of the Contractor to the Employer, under or in connection with the Contract other than under Sub-Clause 4.19 [Electricity, Water and Gas], Sub-Clause 4.20 [Employer’s Equipment and Free-Issue Material], Sub-Clause 17.1 [Indemnities] and Sub-Clause 17.5 [Intellectual and Industrial Property Rights], shall not exceed the sum resulting from the application of a multiplier (less or greater than one) to the Accepted Contract Amount,.”

- The practical implication of such provisions is that they can effectively limit a quantum assessment, as there is little value in compiling detailed evaluations for sums that exceed individual limits or aggregate caps on liability, although some work may be required to demonstrate that the limits set by the contract have been achieved or exceeded.

3. EFFECT OF CHANGE ON PROGRAMMES OF WORK

Changes to work will often have an impact on the direct cost of the work affected, which may in some circumstances have a consequential effect on the cost of other, unchanged, work. In this context the expression “direct cost” is used as meaning the unit cost of the work affected by the change, i.e. the labor, materials, plant and equipment, and related overheads cost of the construction operation affected. The direct consequences of change may not be the only effect upon the contract works, as the contractor’s working methods may be affected by the change and/or the completion date may no longer be achievable. It is also possible that the change, in addition to its direct impact and cost, might cause a disturbance to the contractor’s site organisation and costs without having an impact on the completion date.

These latter costs are the “indirect” consequences of change. Before considering how to evaluate such impacts of change it is necessary to appreciate the appropriate means of analyzing the time and delay consequences of change, and to consider some of the advantages and disadvantages of certain approaches to the problem of analysis.

There is, however, an important point to bear in mind with any delay or disruption analysis based on programming material. The prime purpose of the contractor’s program is to provide a tool for the management of the project. It has another purpose for the contractor in being an important part of his pricing and tendering analysis. The use of the program to analyze delay and disruption is, or should be, a subsidiary purpose and it is necessary before undertaking any analysis to determine as far as possible that the program is the management and pricing tool that it should be, and has not been doctored or structured with delay and disruption analysis as an intended purpose. Such abuse of the program is sometimes found in the hiding of float, by extending activities beyond their true durations, or by artificial timing of activities in the hope of basing a claim. An example of the latter would be the early delivery of employer provided materials or equipment, before they are reasonably required, in the hope of being able to produce a “late delivery” based claim.

3.1 Use of programs

There is usually only one certain factor common to the programs at the outset of any construction project, and that is that each program will contain errors requiring

it to be updated and amended periodically to maintain it as a viable means of managing and monitoring the construction works. The errors in the initial program might mean that it is more optimistic or pessimistic than necessary with regard to the relevant completion date, and it might well contain a number of such errors, both optimistic and pessimistic in terms of the achievable periods of parts of the works, which, if the contractor is fortunate may cancel each other out leaving the overall completion date realistic. The reliability of initial programs tends to vary considerably and will depend to a large degree upon:

- The extent to which the design of the works has been completed at the time of tender.
- The extent to which major subcontract or supply packages have been defined, and the relevant subcontractors and suppliers have progressed their tenders and any related design information.
- The degree of reliability of information used relating to site-specific factors such as weather conditions, ground conditions, etc.
- The reasonableness of assumptions made in the program as to the likely outputs to be achieved by labor and plant resources.
- The accuracy of lead periods required for materials or manufactured items required.
- The amount of time and effort expended in ensuring the program has considered factors such as the above as far as reasonably possible.

The last item in this list may seem obvious but it is often the case that the initial program contains errors that could be eliminated by careful consideration of the relevant preceding factors. It is also the case that the initial program may be unreasonable by being too detailed. This may seem an unusual, or even unreasonable, criticism of a program but for major projects with a site period of 18–24 months or more it may not be possible to predict all the above factors with sufficient accuracy for a fully detailed program for the full period to be compiled at the outset. In such circumstances it would seem much more sensible to produce detailed programs for, say, the first six months, with a less detailed program for, say, the following six months and a series of planned “milestones” thereafter. The degree of reasonableness in the milestones will need to be assessed in the light of the operations needed to achieve them, but such an approach obviates the need to put forward fully detailed programs for works two years or more in the future which cannot be predicted with reasonable accuracy to the degree suggested by some programs.

Provisional sums in programs

The problem of accuracy in initial programs can sometimes be compounded by the use, or misuse, of provisional sums in tender documents. While there may often be legitimate reasons why an element of the work cannot be fully detailed at the time of tender, such sums need to be used with care and in a manner that allows the contractor to understand the scope of work being tendered.

FIDIC 13.5

For a provisional sum to be “defined” under these rules, information as to the nature of the work, its construction and relationship to the building is required to be given together with indicative quantities and any specific limitations. For provisional sums so defined the contractor is deemed to have made due allowance for the required work in his planning and programming of the works and the pricing of his preliminaries.

In some instances a ‘half-way’ situation may be encountered where the sum does not provide all the required information but has been included in the program anyway. In such a situation, is the contractor deemed to have included for the full effect of the works in the provisional sum? It seems only reasonable that he should be considered to have included the effects only so far as the information provided allows.

In contrast to “defined” provisional sums the use of similar “undefined” sums is allowed for work where the information required for a defined sum is not available. In this case the contractor will be deemed not to have allowed in his programming, planning and pricing of preliminaries for the work covered by the sum. There is therefore little to be gained, from the employer’s point of view, by the use of such sums other than to have the work content included in the contract. However, when all the required details are issued to the contractor he will be able to revise his program and preliminaries pricing accordingly, in accordance with the contract conditions, meaning that such sums, if substantial, are a guaranteed source of future requests for additional payments.

The base cost

Underlying any evaluation of change in terms of its impact on time and progress of the works is the need to appreciate how the base cost was determined, and not only what it does contain but what it is deemed to contain whether or not the contractor

actually made any, or any adequate, allowance. Once the matters discussed above have been considered and any necessary amendments made to the initial program, then it is possible to ascertain if the contract allowances made by the contractor were likely to be reasonable and adequate.

A degree of caution is required in such exercises in ensuring that 'standard' information is used appropriately when assessing the reasonableness of the contractor's program and cost assumptions. For instance, the contractor's assumptions of outputs to be achieved by resources in various construction operations need to be tested against independently tested information applied in the light of appropriate experience. However, the application of standard "S" curves, and other statistical devices, for the distribution of general costs such as the setting up, operation and dismantling of site establishment facilities, should be modified to reflect the actual manner in which costs for a particular contract will be incurred. It is not unusual to find that expenditure is incurred in steps rather than in smooth curves. An initial mobilization cost will be followed by a curve of cost as the early operations commence and proceed, but the opening of further work fronts as the early work makes the introduction of other resources possible will cause steps in cost, i.e. there will be relatively high expenditure in a short period to establish the new operations, followed again by a cost curve commencing from the top of the step. This process will apply to each element of the total costs, usually categorized as labor, plant, materials and site establishment. The concept of the "S" curve should therefore be understood to be a graphical representation of underlying costs that generally change in steps, with the steps for each element not necessarily occurring at the same time.

3.2 Use of as built programs

In many instances there will be a need to consider the use of as built program information, i.e. a program that demonstrates the actual sequence and duration of the various operations on the site rather than the sequence and timing anticipated by the contractor at the outset. Strictly speaking these are not programs in the sense of the contract program; they do not predict the durations and sequences but show factual information. As such it is often accepted that such programs are an accurate representation of the progress of the works, but in reality there can be significant difficulties with the compiling and interpretation of such programs.

Sources of information for as built programs

By definition an as built program is compiled after the works have been executed and the common source of information is the contract progress reporting system. Such systems vary enormously depending upon the requirements of the contract and the nature of the work being undertaken, but many such systems suffer from a common shortcoming in that they record an operation, or section of work, as complete only when every piece of work required in connection with that operation or section has been finished.

This may seem reasonable when the objective is to report to management the progress of the various parts of the project, but it can introduce distortion into the representation of the works' progress if used unamended for as built programs. For instance, the construction of a reinforced concrete retaining wall may be a critical activity in the program of works. It might be that a section of the wall is brick faced, but the brick facing is not critical in that it can be carried out after completion of the reinforced concrete elements but with an activity float that means it does not hold up succeeding activities. In such a case, if the brickwork is included as part of the retaining wall construction, completion might be recorded when the brickwork is complete and not at the critical point when the reinforced concrete work was complete, so releasing following activities. In such circumstances the sensible approach is to ensure the non-critical element of the construction is shown as a separate activity.

However, problems can still arise when using progress recording and reporting systems as the source of information as many activities, even if critical, release following activities before they are 100% complete, when the outstanding work preventing reporting of completion is minor or insignificant. Such instances are often identified in progress reporting systems by the recording of an activity as, say, 97% or 98% complete for some period before completion is recorded on the execution of the outstanding minor element.

In compiling programs, including as built programs, links are often made between operations. These links are often between the completion of one piece of the works and the start of an ensuing operation, a finish–start relationship in planning terminology. However, it is often the case that a preceding operation, or section of the work, does not need to be absolutely complete before the ensuing work commences. For instance, in works of a mechanical nature it is possible to show a finish–start relationship between the completion of the installation of a particular piece of equipment and the commencement of the erection of the pipe work running away from that equipment. The completion of the equipment installation

operation for progress reporting might include the “bolting on” of an ancillary piece of the equipment, perhaps a meter or other measurement device, which in practice does not have any influence on the erection of the related pipe work, which can commence when the main body of the equipment is installed and secured.

Constant resource / continuous working

There is also a danger in using as built records, or any program where the works are represented in bar chart form, which the duration of a bar will be taken to indicate that resources were employed throughout the duration of that bar. In fact that can be a very misleading impression and it is often the case that the resources employed on a particular operation, or section of the works, will vary considerably at various stages as it progresses. The resources represented by a bar will often not be constantly employed, nor will the operation or works necessarily be continuous. As built records will show the commencement of the work and the completion, and often represent the intervening duration as a continuous bar, but this may be far from the true representation of how the work was executed, and the related costs incurred.

Recording of completion

If the final, say, 2% of a section of the work is the painting of an installed piece of equipment, then that operation will not be reported complete until such time as it is painted. If the painting is delayed, intentionally or otherwise, the reporting of the completion of the operation will be similarly delayed. The as built record, by using a bar to represent the installation period, may suggest that the particular operation continued for, say, 20 weeks, when in fact 98% of the work was complete in eight weeks and nothing further occurred until, say, two days’ painting 12 weeks after the main installation. Such distortions in reporting systems have to be detected and eliminated when considering the distribution and incurring of related costs to be analyzed as part of the calculation of the costs incurred by changes or disruption to the sequence or timing of activities.

3.3 Change without prolongation

It is, of course, quite possible that change to the scope of the works, either in quantity or specification terms, can cause change to the sequence or duration of program activities without having an effect on the date for completion of the project. Such an effect is often termed “disruption” in that the anticipated sequence of working has been disrupted and another effected in its place. The revised sequence, and/or durations, of activities may not impact on the completion date because the affected activities were not on a critical path through the programmed activities to the completion date, i.e. they lie on a sequence of activities where there is “float” in the program. **FIDIC 8.5**

If the critical path is the longest sequence of activities from commencement to completion, float is the amount of time on non-critical activities that can be absorbed by the activities, over and above their intended duration, without impacting on the critical path.

It should be remembered that there may well be more than one critical path through a program, and in detailed programs for large and complex projects this will often be the case. It is equally important to remember that the critical path, or paths, may change as soon as there is a change in the timing or duration of any activity on site. When evaluating the impact of change it is therefore essential to consider that impact against the program current at the time the change took place.

The concept of float in programs raises particular issues in the evaluation of claims for “disruption”, i.e. claims for additional payment as a result of changes to activity durations or sequence which are alleged to incur additional costs but have not affected the contract completion date.

Who owns the float?

The first problem to address, before the issue of cost, is that of ownership of the float. For whose benefit does the float in the program exist? Is it for the benefit of the project employer so that a certain amount of change can be accommodated without the completion date is being changed? Is it for the benefit of the contractor, who will usually be responsible for the program and progress of the works, so that he can suffer some difficulties of his own making without running the risk of damages for late completion?

Is it for the benefit of the contractor's suppliers and subcontractors so they too have a measure of protection against their defaults? Or is it a combination of all these, with benefit distributed on a first in need gets the benefit basis?

Float is often referred to as the contractor's "time risk allowance" in that it is seen as being built into programs to provide the contractor with a cushion for any unforeseen difficulties or problems he may encounter, and for which he is responsible. For that reason many contractors jealously guard the float as being theirs, and theirs alone, on the basis that they created the program and therefore the float contained in it is for their sole benefit.

The matter of 'ownership' of the float is therefore a crucial consideration because it will affect not only entitlement to recovery of additional payment, but in cases where there is a delay to the completion date it may decide which, among various competing potential causes, are the causes of the prolongation.

The Society of Construction Law's Delay and Disruption Protocol also addressed the subject of ownership of float. The effect of the guidance given in the Protocol is that float in a program is not to be regarded as for the exclusive use or benefit of either the employer or the contractor. In the terms of the Protocol the project is the owner of the float and it would be available for all parties as required. Thus if float existed in a program and a delay event occurred, then the float would be available to reduce or eliminate the effect of that delay regardless of liability for the delay. This provision may be contentious as far as contractors are concerned, although the Protocol recognizes that they may still be entitled to compensation if an employer delay uses up float without requiring an extension to the contract completion date, as they will argue that float is incorporated into programs to protect themselves from the problems they may encounter and for which they are liable under the contract.

The possibility is that as a consequence of such recommendations, contractors will attempt to hide or disguise float in contract programs, particularly any "end float" that may be available between the completion of the works and the contract completion date, despite any encouragement to the contrary, although many will argue that in practice "end float" rarely if ever occurs. The Protocol approach is that contractors should include in the activity durations for any perceived risks and leave true float available to the project.

FIDIC Clause 8.4 Extension of Time for Completion

The Contractor shall be entitled subject to Sub-Clause 20.1 [Contractor's Claims] to an extension of the Time for Completion if and to the extent that

completion for the purposes of Sub-Clause 10.1 [Taking-Over of the Works and Sections] is or will be delayed by any of the following causes:

(a) a Variation (unless an adjustment to the Time for Completion has been agreed under Sub-Clause 13.3 [Variation Procedure]) or other substantial change in the quantity of an item of work included in the Contract,

(b) a cause of delay giving an entitlement to extension of time under a Sub-Clause of these Conditions,

(c) exceptionally adverse climatic conditions,

(d) Unforeseeable shortages in the availability of personnel or Goods caused by epidemic or governmental actions, or

(e) any delay, impediment or prevention caused by or attributable to the Employer, the Employer's Personnel, or the Employer's other contractors.

If the Contractor considers himself to be entitled to an extension of the Time for Completion, the Contractor shall give notice to the Engineer in accordance with Sub-Clause 20.1 [Contractor's Claims]. When determining each extension of time under Sub-Clause 20.1, the Engineer shall review previous determinations and may increase, but shall not decrease, the total extension of time.

FIDIC Sub-Clause 8.4:

".....The Contractor shall be entitled subject to Sub-Clause 20.1 [Contractor's Claims] to an extension of the Time for Completion if and to the extent that completion for the purposes of Sub-Clause 10.1 [Taking-Over of the Works and Sections] is or will be delayed by any of the following causes:

a Variation (unless an adjustment to the Time for Completion has been agreed under Sub-Clause 13.3 [Variation Procedure]) or other substantial change in the quantity of an item of work included in the Contract,

a cause of delay giving an entitlement to extension of time under a Sub-Clause of these Conditions,

exceptionally adverse climatic conditions,

Unforeseeable shortages in the availability of personnel or Goods caused by epidemic or governmental actions, or

any delay, impediment or prevention caused by or attributable to the Employer, the Employer's Personnel, or the Employer's other contractors.

Disruption to regular progress

If the available float means that extensions to the period of particular activities do not extend the completion date for the project, then the main contractor is unlikely to be able to recover payment for contract management resources and support facilities that would be in place for the duration of the contract period as he will be deemed to have included this in his pricing for the cost of his management for the contract period, and will be restricted to recovery of the direct costs of the extended activities. These might include:

- Additional direct supervision costs of the affected activities.
- Additional labor and plant costs caused by reductions in output, i.e. the contract amount of work for the activity executed over a longer period.
- Extended costs of temporary works required for the particular activities, e.g. scaffolding etc.

3.4 Prolongation of the works

There will of course be many occasions when the extended periods of particular activities do impact on the, or one of the, critical paths in the program and thereby cause the contract completion date to be extended from that originally intended. It should be recognized that the purpose of the provisions in most construction contracts for the completion date to be postponed for defined events or circumstances is twofold: firstly to protect the contractor against claims from the employer for damages due to non-completion, and secondly to preserve the employer's right to deduct damages for late completion notwithstanding the defined breaches of contract by the employer. Without the provisions for postponement of the completion date any breach by the employer, or his agents, of the contract provisions would enable the contractor to claim that he had been prevented from completing in accordance with the contract by the employer's breach and that his obligation was thereafter only to complete in a reasonable time. The extensions of the completion date provisions serve to preserve the contract mechanism for determining the date of completion in the face of defined changes or breaches.

Once the entitlement to additional payment for an extension to the contract completion date has been determined, there are two matters of principle to take into account when making the evaluation:

- (1) Unless the contract expressly provides otherwise, the contractor's entitlement to additional payment for an extension to the contract completion date should be based on the actual additional cost to the contractor of the extended period.
- (2) The evaluation should be made by reference to the period of the works when the relevant event impacted on the progress of the contract works, and not by reference to the period between the original completion date and the extended date, i.e. the extended period at the end of the works.

These principles highlight two difficult areas of evaluation. There is a need for detailed delay analysis, not only to determine which events caused the delay to the contract completion date, but also to identify the periods of the works when the delay occurred. Only rarely will the delay actually be the end period extending beyond the original completion date.

3.5 Analysis of time and delay

3.5.1 Introduction

Why are claims for delay often the biggest claims on construction projects? The short answer is that time equals money. Where delays have occurred due to reasons that are the responsibility of the employer, the employer's losses arising out of delays can include:

- Ongoing fees to consultants and agents.
- In-house cost management and staff costs.
- Lost revenue from letting or sale income particularly, for example, on retail and leisure projects.
- Compensation to the contractor for not only his time-related and inflationary costs but also those of his subcontractors and suppliers. Indeed, contractor's claims for time will often cause or will certainly usually be associated with claims for disruption and economic working.

Where delays are caused by contractor-responsible events then the losses can again be significant. For the contractor these can include:

- The contractor's own project running costs, including both site preliminaries and head office costs.
- Increased costs due to price inflation.
- Loss of contribution from the project to the contractor's margins.
- Financing or loss of interest on other heads of loss incurred.
- Similar claims from subcontractors and suppliers.
- Damages deducted by the employer, in the form of agreed liquidated and ascertained damages or calculated unliquidated damages.

Uncertainty and unpredictability of ground conditions, weather conditions, the performance of third parties such as statutory undertakers, and similar matters that are outside of the parties' control, add to the frequency of delays and claims for delays. This leads onto the matter of human shortcoming.

Late information from architects, engineers, other consultants or specialists is the most obvious manifestation of human shortcoming and its ability to delay construction projects. Equally, even where information is provided on time, wrong information will subsequently have to be amended or become the subject of query or the seeking of clarification. This is another regular cause of delays.

Such incorrect information and its subsequent correction often lead to change and variation. However, the construction industry is perhaps relatively unusual in its acceptance that change will be made during construction; designers and/or more particularly the employer himself will want to make changes to the original design

as covered by the contract and will expect the contractor to carry out the subsequent varied work. Accordingly, construction contracts are usually drafted in such a way as to make provision for the instruction of variations; for valuation of the work that arises and the assessment of the time effect of such events.

The scope for change and the need for change to the design, as with so many of the other causes of delay that occur on construction projects, is exaggerated of course by the time that a project may take – the span of the period of construction. Projects spanning several years are not unusual and it is perhaps inevitable that during the course of such a project legislation and/or technology and/or client requirements and/or market requirements will change such that it is clearly desirable that contracts make provision for the instruction of such change and therefore variation to the scope of work as originally contracted for.

The lengthy nature of many construction projects increases the extent to which those projects experience a variety of climatic, weather, and seasonal conditions. Construction contracts vary in the terms in which they deal with such conditions. Many adapted contracts lay the risk of weather conditions at the door of the contractor. However, the standard forms tend to make weather conditions a neutral event. That is, they make weather conditions a ground for consideration for extension of time but not reimbursement of the contractor's costs. Furthermore, the terms in which standard contracts define the weather conditions that are to be considered vary, and this is an area of some regular difficulty in defining for example what is "exceptional" and also what the effect of any such weather that is experienced has been on the construction process.

Such complexity is in practice often added to by the following factors:

- The consideration of claims for delay often starts with the arrival of a notice of delay issued under the contract, whether or not it complies with notice requirements in the contract.
- An inability or failure to maintain sufficient or appropriate records.
- A lack of awareness at the appropriate time that delay has actually occurred.
- Inadequacy or even a lack of an original program.
- Inadequacy or shortage of subsequent updated or revised programs.
- Difficulties in separating causes and effects. This particularly involves 'chicken and egg' analysis of whether an event that has happened late was the cause of the delay or happened late because of delay resulting from other and earlier events.
- Concurrent causes of delays, particularly where these involve a mixture of employer risk events and contractor culpability issues.
- Differentiating between critical and non-critical delays.

- As noted previously, the existence of a number of alternative delay analysis techniques, each of which is capable of giving a quite different result from the same set of facts.
- How the delays should be evaluated in terms of their financial consequence.
- Contract provisions, which can vary, and contribute to the complexity of delay analysis.

3.5.2 Basic requirements

Tender programs are a starting point for such a plan. From the point of view of employers considering contractors' tender programs, or for that matter contractors considering tender programs received from subcontractors, it is all too often the case that sufficient consideration is not given at tender stage to the nature and adequacy of such programs. The first question that a tender program should answer is whether the party that has prepared the program has understood the scope and complexity of the project or work that it is undertaking to carry out and whether it has illustrated that it can indeed build or construct it. Such questions should be asked not only for the purpose of the program's subsequent use in any analysis but most obviously as essential matters of tender evaluation. The program should be considered to see that it illustrates sufficient detail and logic linking as well as activity durations. Thus, for example, an A3 single page program with no logic links, as part of a tender submission for a multi-million pound roads project spanning several years, should immediately sound alarm bells for the recipient. Whether a tender program has been produced using a recognized planning software package should also illustrate the capabilities of the tenderer.

The contract program should become a tool for monitoring progress. It should therefore be in an updatable format using recognized and available software. Of equal importance both to the project management processes and subsequent analysis of delays and their effects is whether the contract program identifies program information requirement dates or indeed other requirements that the contractor or subcontractor has, such as access dates or the completion of work by other parties. It is not uncommon for contract forms to set out express requirements of the contract program, e.g. the clause 14 requirements of FIDIC in terms of the approval and timing of such a program.

Having established a planned intent, the next requirement for delay analysis is notice of subsequent events that are said to have caused delay. The need for notices is usually a contractual requirement. Whether it is a condition precedent to entitlement is a legal issue not considered in this book. Even where notices have been given, issues often arise as to their sufficiency. Do the notices sufficiently

detail the event said to have caused delay and also the effect or likely effect of that delay? Furthermore, were notices given early enough to allow the other party not only to assess and monitor that delay but also potentially to take action to prevent or reduce it?

Records can contain various pieces of information and vary in quality and form. The records required for subsequent delay analysis need to identify what happened, when it occurred, what its local effect was and what its project effect was, i.e. both the effect on activities and on completion as a whole. Furthermore, even when records are kept there are often issues as to the quality of those records. Records need to be regularly and consistently kept; records of limited periods or parts of a project can be of little use unless the delays being considered were of similar limited periods or parts. The need for consistency also applies to their format. Records kept in a variety of formats, by time or part of a project, can be of use but add to the complexity of subsequently attempting to apply them to a delay analysis.

Finally, the accuracy of records is of paramount importance. A delay analysis which is based on inaccurate records is likely to be of little value and potentially damaging for the party involved. Inevitably, some records may be inaccurate and analysis may need adjustment. However, where records are shown to be extensively inaccurate, not only can the costs of delay analysis be unnecessarily wasted but credibility can be damagingly lost.

It is often surprising which records are quite useful in the analysis of delays but have been overlooked by a party. A party may believe that it has limited suitable records available when actually it has rather more than it thinks. Experience of delay analysis shows that the following categories (listed in no particular order) can provide useful records that may be put to good use:

Weekly site reports	Pour records	Non-conformance reports	Meeting minutes
Inspection sheets	Cube tests	Correspondence	Safety records
Clerk of Works reports	Delay notices	Delivery notes	Plant returns
Diaries	Wage records	Orders	Instructions
RFIs	Requisitions	COIs	RFAs
Movement diagrams	Authorization to proceed	Photographs	Company accounts
Memoranda	Videos	Invoices	Sketches
Labor returns	Applications	Working drawings	Daywork sheets
Valuations	Drawing revisions	Labor allocation sheets	Surveyors' books
Drawing register	Staff allocation sheets	Bonus calculations	Tracked programs
Plant allocation sheets	QA records		

Having considered the basic requirements for an analysis of time and delay, such as programs, notices and records, some of the common problems encountered in carrying out the resulting analyses are discussed below.

3.5.3 Float and acceleration

It should be understood that there can be two different types of float in a program – “end” or “total” float and “free” or “activity” float. “End” or “total” float applies to the total contract works activities and appears as a difference between the completion of the last activity and the contract completion date.

“Free” or “activity” float applies to an individual activity only, within the total network of activities. In practice, ‘total’ or ‘end’ float is rarely seen in contractors’ programs and even where it might be available is often hidden by artificial extension of activities so that the contractor can hope to have the benefit of such float without the knowledge of other parties. There is, of course, no obligation on the employer generally to fulfill his obligations so as to allow the contractor to complete before the contract date, and there is generally no additional payment for delay that can be shown only to have prolonged the period of works by consuming the end float. The contractor will be assumed to have included in his contract sum for the management and support of the project to the contract completion date.

There is, of course, a potential answer to the problem of further delay when no float exists to accommodate it, and that is to reduce the time required for the remaining activities so as to prevent or reduce the delay to the completion date. If the delay, or potential delay, is the responsibility of the employer, then the contractor will require compensation for any additional expenditure, it being obvious that acceleration to overcome contractor delays will not generate entitlement to payment from the employer, although it could generate an entitlement against a responsible subcontractor or supplier, depending on the relevant contract terms.

Constructive acceleration

The term “constructive acceleration” is often used to describe measures taken by a contractor to overcome delay for which he has not been granted an extension of time. It may also apply in situations where the contractor receives an extension to the contract completion date but argues that the decision to award the extension came too late to prevent him instituting measures to overcome delay for which the employer is responsible. In effect the contractor’s case is that he has been put in the position of having to accelerate in order to avoid an overrun of the contract completion date that would have resulted in damages being levied against him, because he had wrongfully been denied an extension to the completion date to which he was entitled.

There can, however, be a problem with acceleration claims where the party being requested to pay for the acceleration may well not have been aware of the delaying events at the time, and will very often not have been aware of the acceleration measures for which payment is requested. In such circumstances it is not reasonable that payment can be demanded for such measures and, in the absence of express provisions in the contract, it is suggested that such claims should not be treated as proper claims for additional payment.

It has sometimes been suggested that constructive acceleration claims cannot be entirely eliminated because sometimes the contractor is not aware until after he has implemented the accelerative measures what the true causes of delay were. This seems to be a somewhat disingenuous line of argument as, if the contractor did not know at the time that he was overcoming employer delay, it does not seem reasonable that the employer should pay for such measures.

3.5.4 Concurrent delays

The identification of the period and timing of delay is the first step in moving to evaluation of additional payment. Sadly, in practice it is rarely the case that there is one delaying event causing one extension to the contract period. On large and complex contracts there may be several causes of delay, some critical and others non-critical, which will all need to be identified both as to their timing and effect.

A further complication will usually appear in that some, and sometimes all, of the various delays will overlap or cause delay to different activities in the program at the same time. In other words they will be “concurrent”.

The situation can then become further complicated in that some delays may be the responsibility of the employer, some the responsibility of the contractor, some cost neutral events (such as weather) and yet others the responsibility of subcontractors or suppliers. In such situations it is necessary to separate the effects of different delays.

The following series of very simple charts is intended to illustrate the issue of what is, and is not, concurrent delay. Figure 3.1 shows a very simple sequence of activities with a critical path running through design, the ordering of bricks, brickwork and copings.

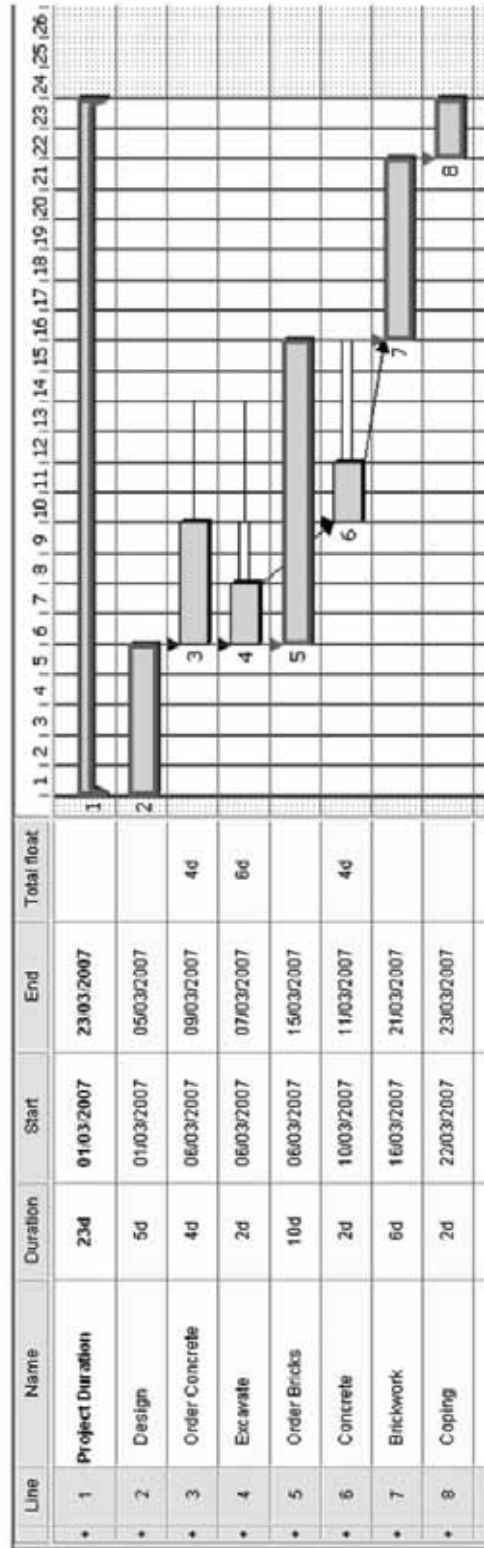


Figure 3.1 Sample programme sequence.

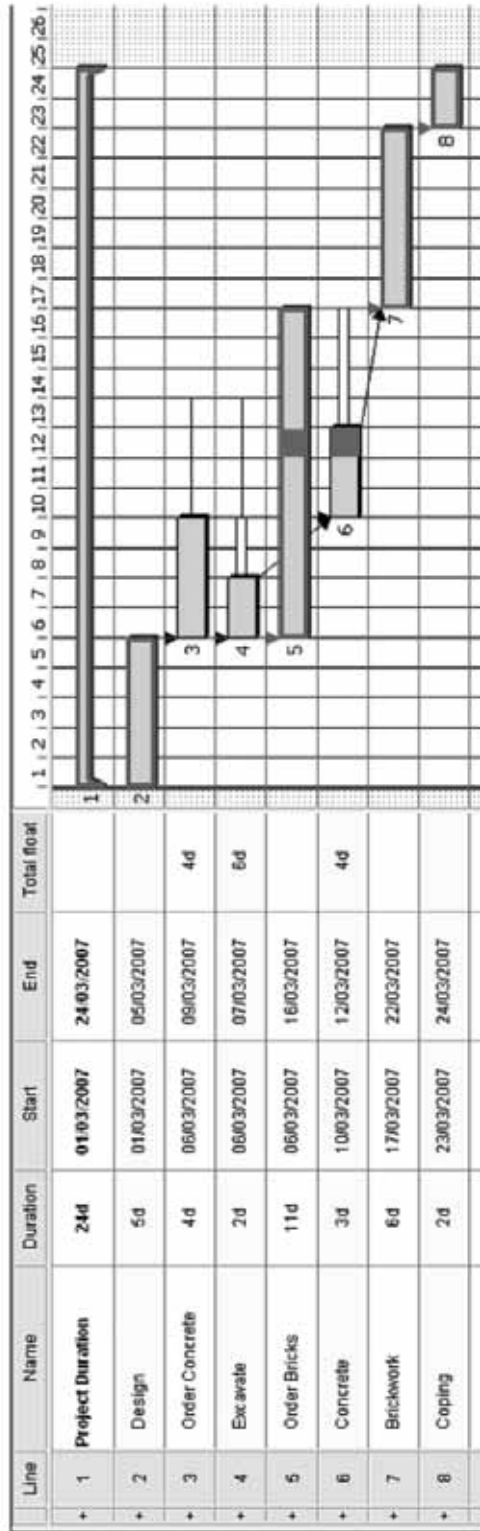


Figure 3.2 Sample programme sequence with non-concurrent delays.

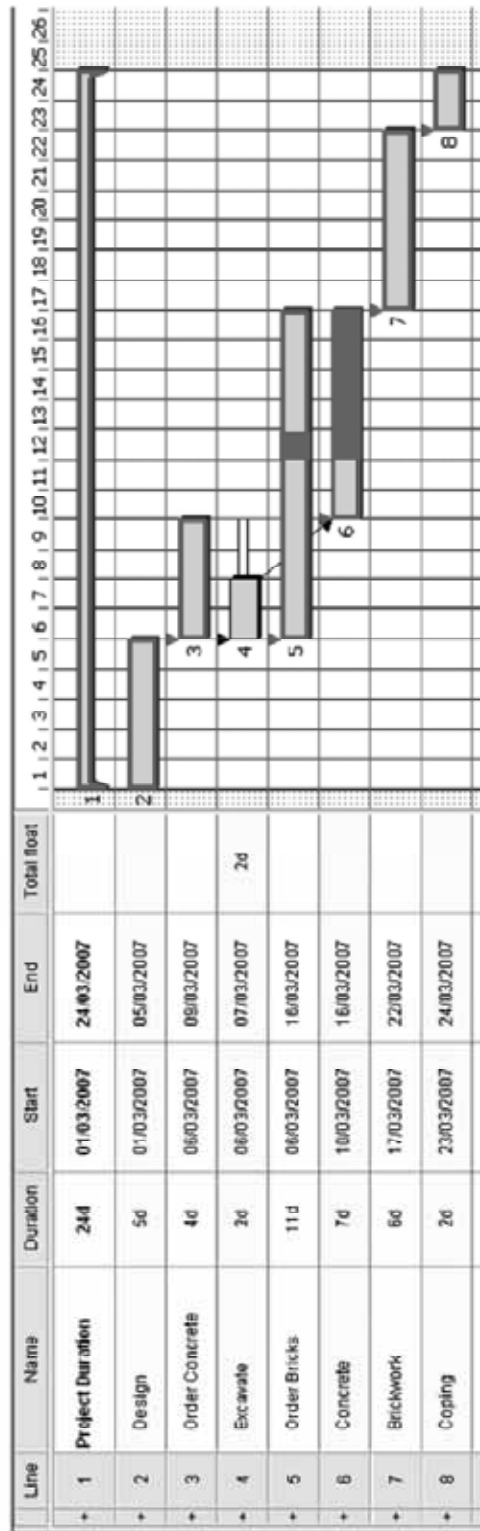


Figure 3.3 Sample programme sequence with concurrent delays.

Figure 3.2 identifies two periods of delay. Firstly, a one-day excusable delay to the ordering of bricks and secondly, a one-day non-excusable delay to the construction of the concrete footing. In this scenario the responsible delay to construction of the concrete footing is not on the critical path and is therefore not truly a concurrent delay. The one-day excusable delay in the ordering of bricks caused a one-day delay completion and would rank for consideration of extension of time.

Figure 3.3 also identifies two periods of delay. Firstly, the same one-day excusable delay to the ordering of bricks, but the non-excusable delay to the construction of the concrete footing is now five days. In this scenario the delay to completion is again one day, but it is now being caused by two concurrent events — the five-day responsible delay to construction of the concrete footing and the one-day excusable delay in the ordering of bricks. These are now concurrent delays with a one-day critical delay effect on completion.

There are different possible scenarios for concurrent delays, and their related costs. The simplest example is that of two delaying events that occur simultaneously, one the responsibility of the contractor and the other the responsibility of the employer, and which both cause, say, four weeks' delay with immediate effect. Thus there is a delay of four weeks caused by two events running exactly parallel. As one of these delays is the responsibility of the employer, the contractor is entitled to an extension to the contract completion date of four weeks, and relief from any contract or general damages he might otherwise have suffered for that period of delay.

But should he recover all the costs of the four week delay to the contract? The answer has to be no, as he would have had to be on site in any event as a result of his own delay. He should therefore recover the additional costs of being retained on site for the activity for which the employer is responsible, but only as far as the costs can be attributed to that delayed activity and not to the general cost of the prolonged period.

This is reasonably straightforward, but in practice events and the delay periods are rarely so conveniently parallel. A more common scenario is that where there are, say, five delaying events, three of which are the employer's responsibility and two the contractor's responsibility, with the events occurring at different times and the periods of delay being different for each event with some having an immediate effect and others causing a delay some time after the event itself.

The situation can become further complicated where some of the activities are critical while others initially have float.

It is therefore important, when evaluating the additional payments due as a result of delaying events, to have a proper analysis of all delaying events and their effects

and to understand the periods of delay attaching to each event, and whether or not there is any extension to the contract completion date as a result.

3.5.5 “Dot on”

This principle addresses what entitlement the contractor has if, during a period of culpable delay, he is delayed by an excusable event that is at the employer’s risk. For years contractors had argued that notwithstanding their own culpability the excusable event would give rise to entitlement to extension of time on a ‘gross’ basis, that is from the date at which the excusable event occurred and including the period of culpable delay that preceded it. The judgment confirmed that the entitlement should be on a ‘net’ basis, which is just taking account of the content of the excusable event and not its timing. The position is illustrated by the following charts.

In Figure 3.4 the contractor can be seen to be in a period of culpable delay, overrunning beyond the due completion date on both activities D and E. During that culpable delay period a one-day employer risk event has occurred. The extent of the contractor’s entitlement to extension of time arising out of the one-day employer risk event is illustrated in the impacted chart (Figure 3.5). The one day of employer delay is ‘dotted’ onto the due completion date to give an entitlement to one day of extension of time.

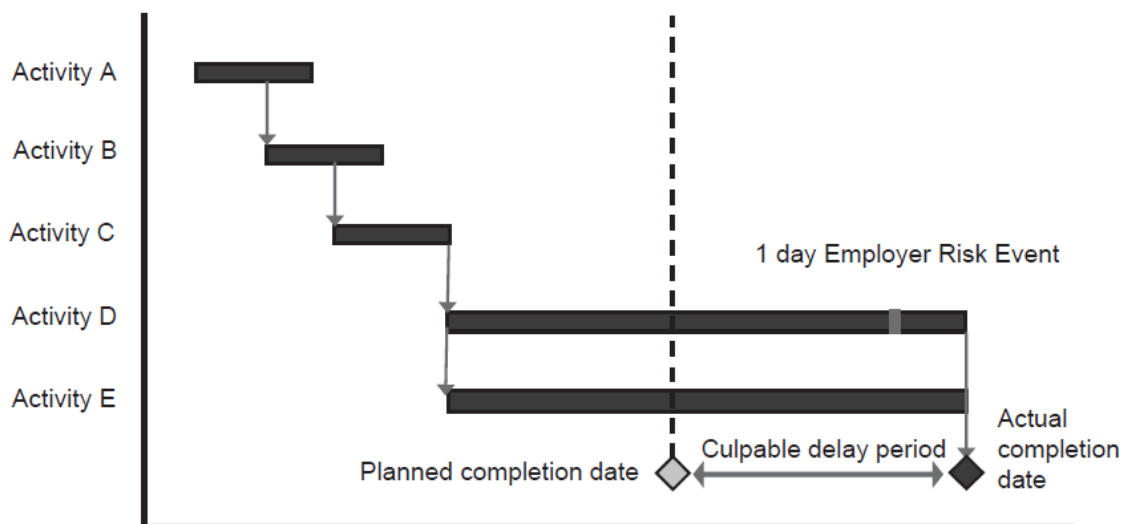


Figure 3.4 Delay in a period of culpable delay.

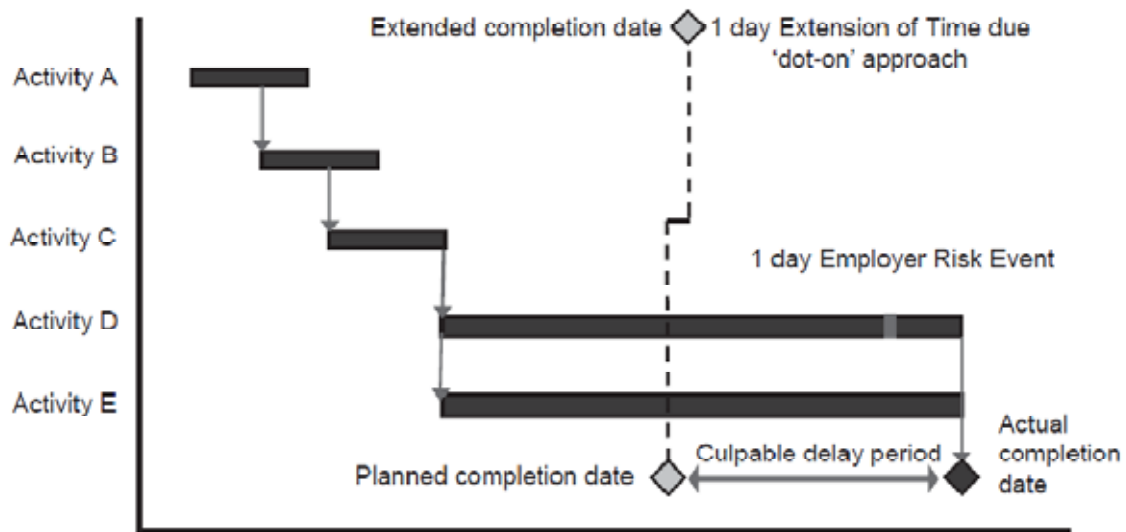


Figure 3.5 Delay in a period of culpable delay 'dotted on'.

3.5.6 Dominant delay

It is sometimes argued that the better means of assessing the effect of concurrent delay is to consider the scale and impact of the various relevant events. If it is apparent that one event is a major change of much greater impact than the other event(s) and impact(s), then that should be regarded as the true cause of the delay. So, for instance, if there were two employer delays and one contractor delay, but the contractor delay is a major problem causing 20 weeks' delay and the employer delays are two minor events causing two weeks' concurrent critical delay, then no extension of time is due in this analysis, due to the contractor's delay, which is deemed to have overridden the employer delays.

The correct approach is to grant the extension of time for the employer delay but pay for only the costs related to the activities delayed by the employer, leaving the contractor, in the above scenario, potentially liable for the costs of the balance of the delay caused by him.

This can work both ways, i.e. to the benefit of the employer or contractor. If, for instance, a contract completion date is delayed by, say, 20 weeks because of matters for which the contractor is liable, then the employer cannot hide behind that delay in ordering additional works that would in any event have delayed the completion date by, say, six weeks, simply because the contractor delay is greater than the employer delay. So, in the example described above the contractor would be entitled to an extension of six weeks to the completion date, thereby alleviating

any potential damages liability, but would not recover the full costs of that extension of time due to his concurrent delay.

3.5.7 Delay analysis techniques

There are a large number of alternative methods for the analysis of delays.

They include:

- windows analysis;
- snap shot analysis;
- impacted as planned;
- collapsed as built;
- as planned vs. as built;
- time impact analysis;

Whilst there are many more delay analysis techniques available and in use, these are all broadly based on just four basic techniques. These can be used at different stages, some during the course of a project (prospectively) and others only at the end of a project (retrospectively).

The principal methods that can be used prospectively during the currency of the project are generally derivatives of two basic approaches: impacted as planned and time impact analysis.

The principal methods that can be used retrospectively at the end of a project include the two prospective methods above but also two that can only be used with the benefit of as built data. This gives four alternatives:

- impacted as planned;
- time impact analysis;
- collapsed as built;
- as planned vs. as built.

There are therefore broadly four methods. Their approaches and their merits are outlined as follows.

Impacted as planned

This technique takes the as planned program and impacts into it the delay events. This is illustrated by the following simple example set out in Figures 3.6 to 3.8. Figure 3.6 shows a very simple as planned sequence of activities A to E. Let us say that this sequence is subject to a delay to the duration of activity C as shown in

Figure 3.7. If the impacted as planned approach is applied to the delay in Figure 3.7, the resulting impacted completion date is set out in Figure 3.8.

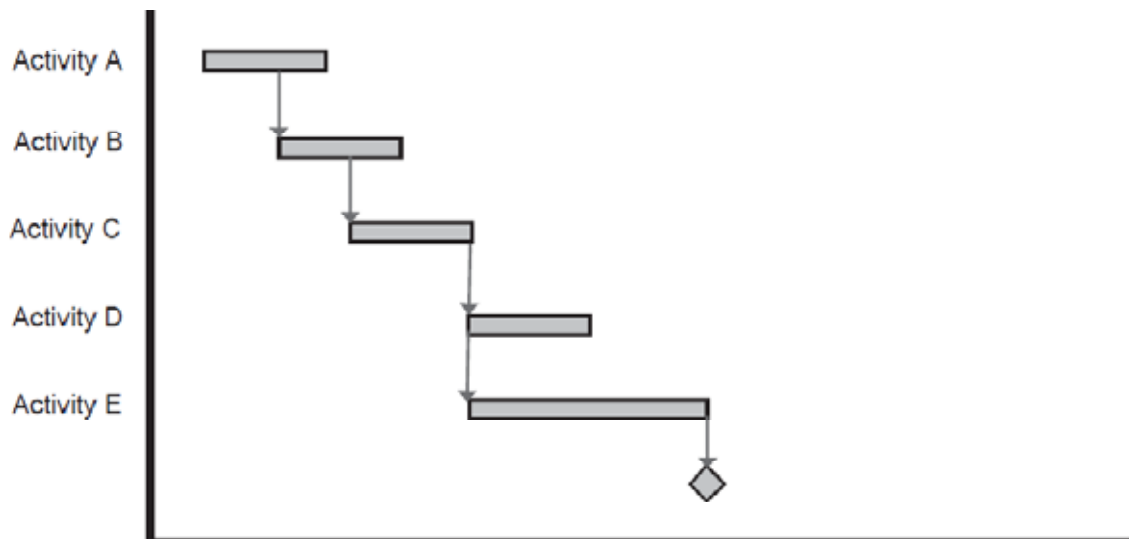


Figure 3.6 Sample activity sequence for delay impacting.

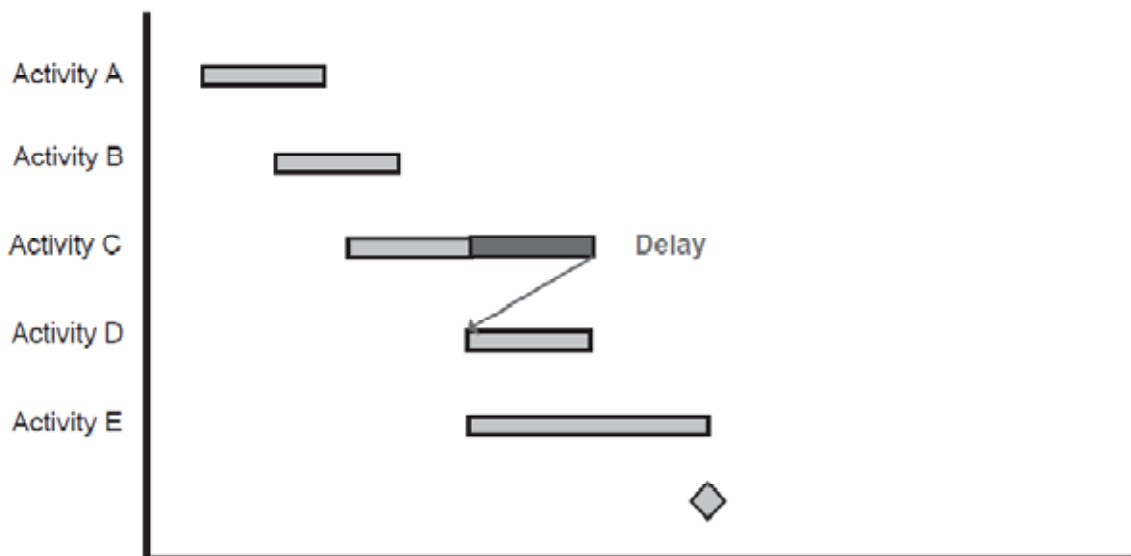


Figure 3.7 Sample activity sequence showing delay to activity C.

As set out in Figure 3.8, the conclusion on the impacted as planned approach illustrated in this simple example is that the delay to completion is by a period identical to the delay to the duration of activity C, that activity having been on the critical path.

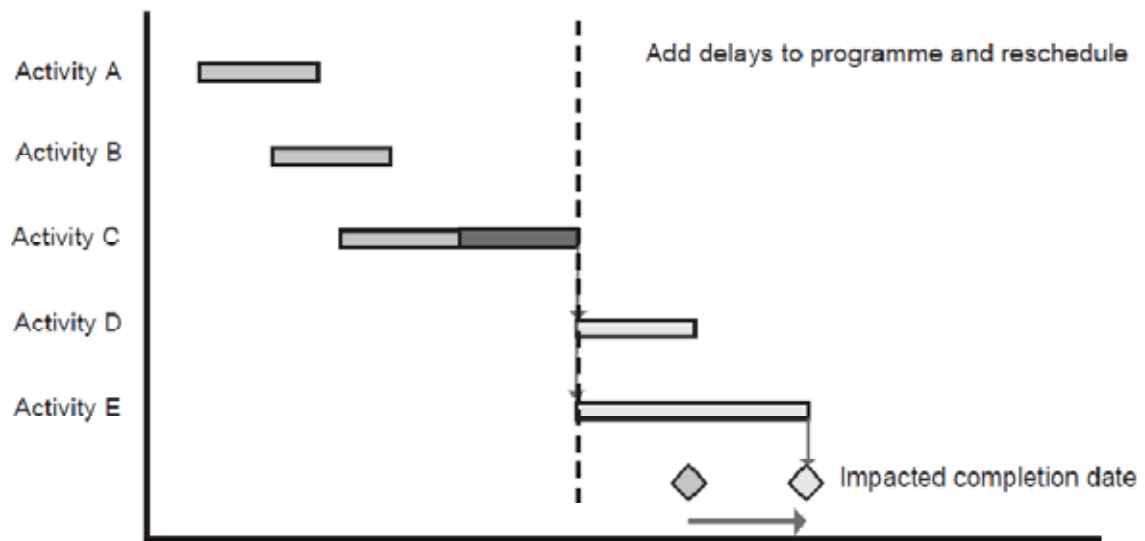


Figure 3.8 Result of the impacted as planned approach.

As with all of the available delay analysis techniques this approach has its advantages and disadvantages. The main advantage is that it is very quick and simple both to carry out and to understand and the result is therefore relatively transparent. Furthermore the approach does not require an as built program and can therefore be followed in the absence of as built records, prospectively during the course of the work. The main disadvantage and criticism of the impacted as planned approach is that it results in theoretical conclusions. In particular, the resulting completion date arising from such an approach is very often a date later than that upon which the work is in fact actually completed. Advocates of the approach will then often go on to say that the analysis correctly proved the delay but that it also shows acceleration and mitigation of the delays. In other words, the entitlement arising from the delay is somewhat longer than the actual delay that resulted and that therefore the approach can be used as a basis for both a prolongation and an acceleration claim! Clearly such arguments need to be tested on the detailed facts in each case.

The further disadvantages of the impacted as planned approach include that, whilst as built records may not be required, there is a need for a reasonable and robust as planned program. That program needs to be adequate and properly logic-linked. In the absence of such a program problems arise. If the program used is not reasonable, robust, adequate or properly logic-linked then the analysis can give rise to highly misleading results. The parties may in that case seek to create such a program retrospectively.

However, this can be very subjective and can lead to further disagreement as to whether this is being carried out properly and which of alternative approaches is correct.

Time impact analysis

This technique can be regarded as a more sophisticated development of the impacted as planned approach considered above. Again, it takes the planned program and impacts into it the delay events, but only after having updated the program for progress just before the delay events occurred.

It is therefore an iterative approach, updating the program and impacting each event in turn. The approach is illustrated by the following simple example.

Taking the same as planned sequence of activities A to E with links as set out in Figure 3.6, and assuming that activities A to C were already in delay, the program to be used for impacting would be updated to add progress as it actually stood at the time of the delay event (Figure 3.9).

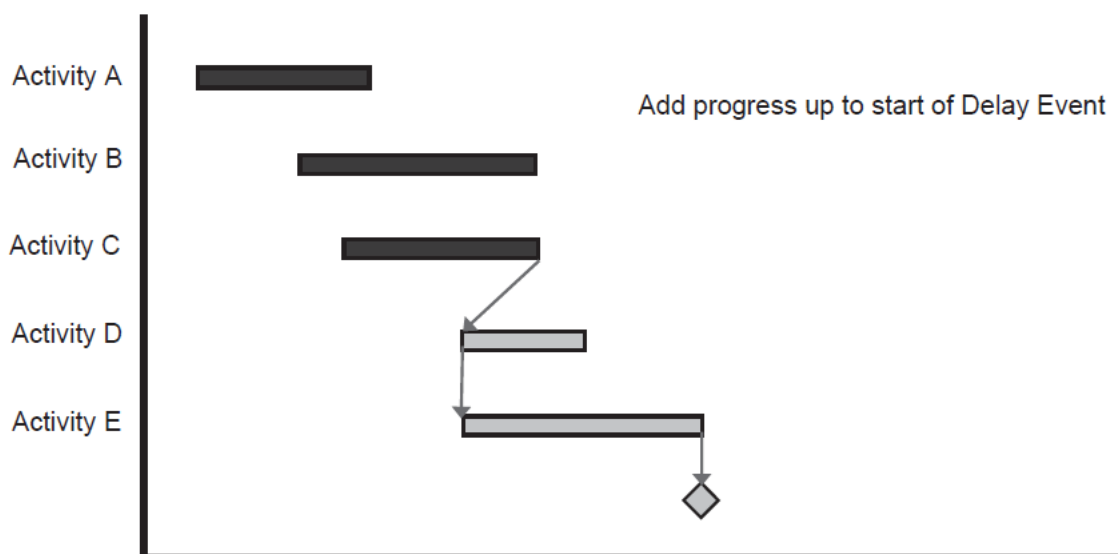


Figure 3.9 Sample activity sequence showing existing delays to actual progress.

Figure 3.9 shows that even before activity D is delayed, activities A to C have already been the subject of delay. Before impacting this program with the effects of the delay being considered, this sequence of activities would be rescheduled to update it for these earlier progress delays to activities A to C to derive a new base line program for impacting. This updated program is set out in Figure 3.10.

From this rescheduled program updated for actual progress, it can be seen that there is already a delay to completion as a result of delays to activities A to C, even

before the delay that is being considered is impacted. If that delay is now impacted into the rescheduled program the new completion date resulting from the delay event is as set out in Figure 3.11.

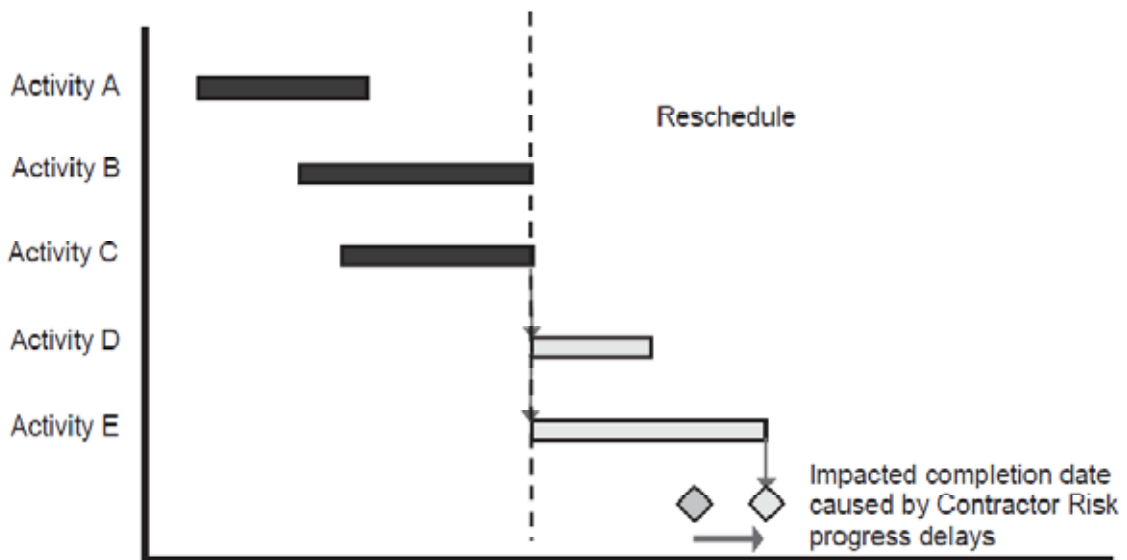


Figure 3.10 Sample activity sequence rescheduled for actual progress.

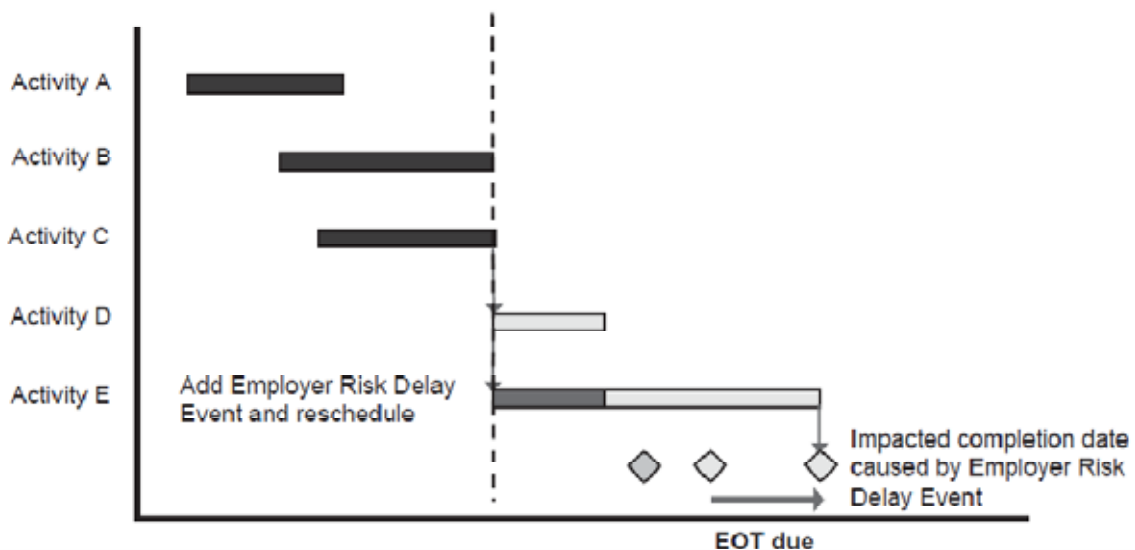


Figure 3.11 Sample activity sequence rescheduled for actual progress.

With this time impact analysis approach the net effect of the delay event being considered is just the difference between the new completion date caused by the

impacted delay in Figure 3.11 and that which had already resulted from the existing delays to activities A to C as established in Figure 3.10.

One of the advantages of this approach, when compared with the impacted as planned approach considered earlier, is the fact that time impact analysis takes account of actual progress. It therefore removes much of the theoretical aspects of the impacted as planned approach. There is still some element of a theoretical result in that as a prospective approach time impact analysis still looks forward to what is likely to happen rather than at what actually happened. However, the theoretical aspect is clearly significantly reduced.

Time impact analysis can also be used to demonstrate acceleration and mitigation, but on a far less speculative basis and without the same extreme results as an impacted as planned analysis. Furthermore, the approach has the support of the SCL Protocol.

One of the disadvantages of a time impact analysis approach is the need for a reasonable and robust as planned program, which includes the issues that were discussed when considering impacted as planned approaches above. Furthermore, with the need to keep updating the program for actual progress before impacting each event, time impact analysis can be extremely time-consuming. In large cases many hundreds of iterations are required for updating the program and impacting for events. This can lead to criticism of what is known as ‘black box syndrome’. The method can result in a huge number of updates and impacted programs to be looked at sequentially and if at any stage an error is made, particularly in the updating for actual progress, then that error can affect subsequent analyses. The method is therefore also highly dependent upon the existence of complete and accurate as built progress records. All of the methods considered in this book are subject to the ‘garbage in, garbage out’ danger. The complexity and lack of transparency of the time impact analysis approach means that spotting garbage in the subsequent results can be difficult. It can therefore sometimes be used to reduce rather than enhance the clarity of a delay submission or report.

Collapsed as built

We have considered the two principal methods of prospective delay analysis that can be used during the currency of a project. We now turn to consideration of the principal approaches that can only be used retrospectively, starting with the collapsed as built technique.

This approach takes the as built program and collapses it back to establish the program as it would have been but for the delay events being considered. A simple example is set out in Figures 3.12 to 3.14.

We start with the as built durations and critical path through a sequence of five activities (Figure 3.12).

Figure 3.12 sets out this sequence of linked activities and their actual periods. The technique then identifies a delay event whose impacts are to be considered (Figure 3.13).

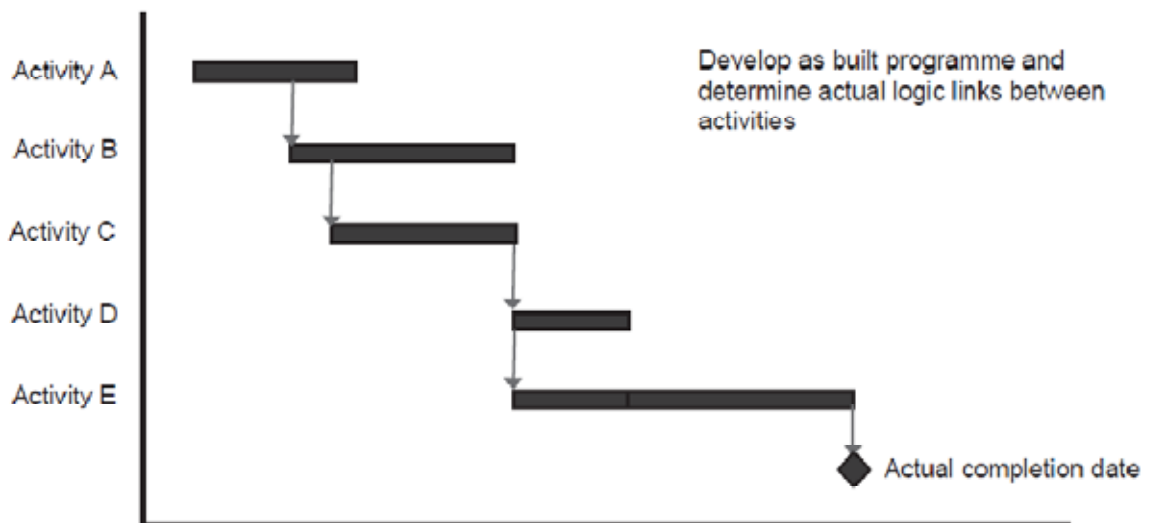


Figure 3.12 Sample as built sequence of activities.

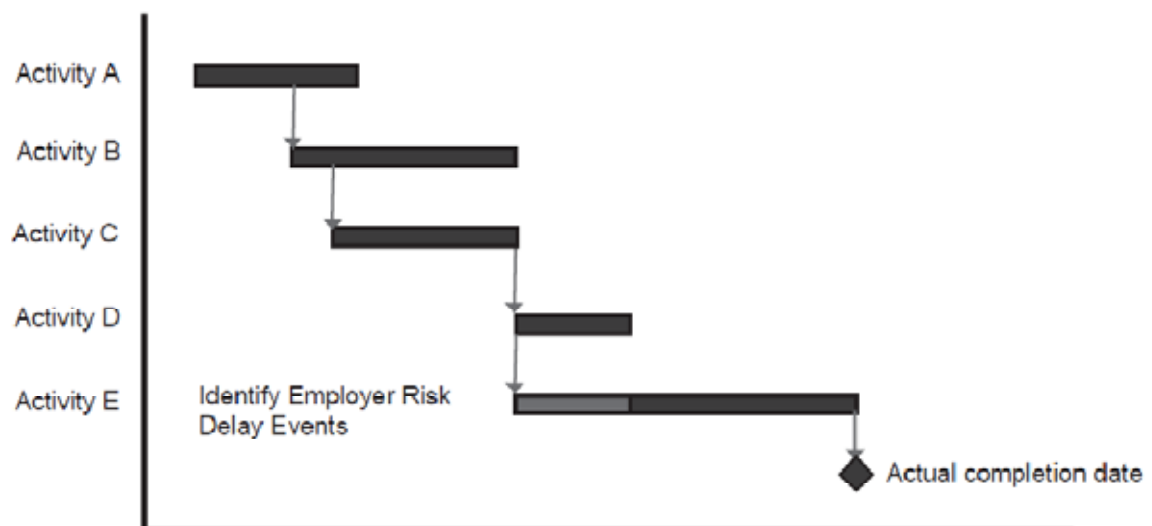


Figure 3.13 Sample as built sequence of activities.

The technique of collapsing this program in order to remove and hence isolate the effect of the identified delay event is shown in Figure 3.14.

The effect of the delay event identified in Figure 3.13 has now been established in Figure 3.14 as being the difference between the actual completion date from the as built program in Figure 3.12 and the new collapsed completion date. That collapsed completion date is the 'but for' date by which it is said the work sequence would have been completed had the delay event not occurred. The difference between the two dates is said to be the extension of time due on the basis that the delay event was an employer risk event.

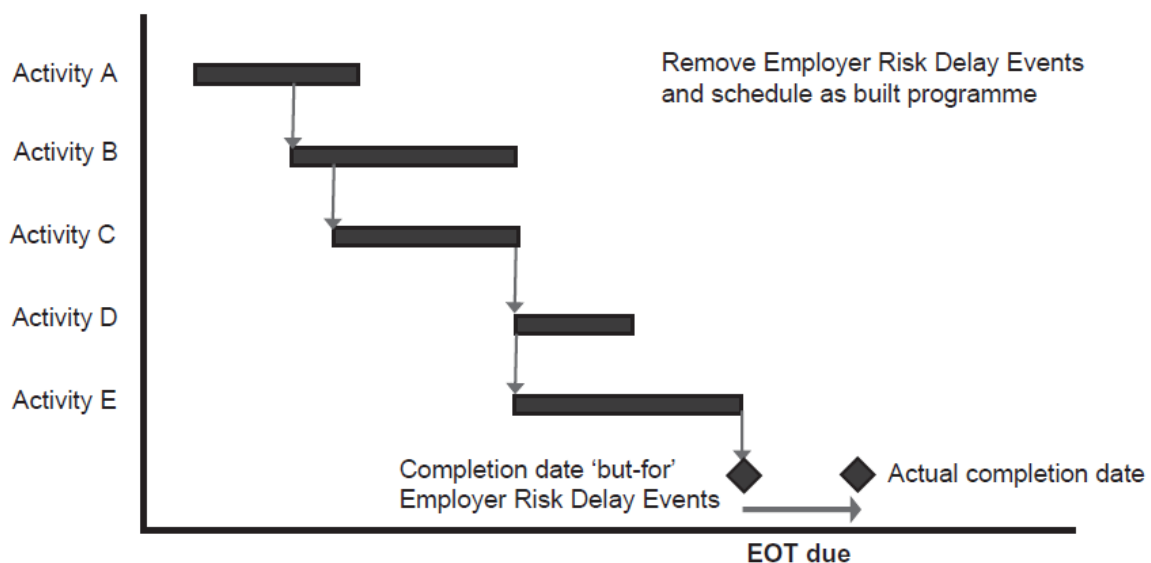


Figure 3.14 Sample as built sequence of activities – collapsed.

Such a collapsed as built technique has the benefit of being simple to understand and relatively simple to carry out. The particular advantage when compared with the impacted as planned approach discussed above is that it does take account of actual progress. Whilst a fully logic-linked and robust as planned program is not required, the technique does require sound as built records and the creation from those records of a robust and properly logic-linked as built program. This preparatory work can be very time-consuming, even if sufficiently detailed records of actual progress are available. In particular, the retrospective logic-linking of the as built program can be very subjective and the subject of contention between the parties. The approach can again be criticized on complex projects as giving rise to 'black box syndrome', although not to the same extent as time impact analysis. However, the approach can be commended for not ignoring concurrent delays.

As planned vs. as built

The last of the four principal techniques for delay analysis, and the second of those that can only be carried out retrospectively at the end of the works, is comparison of the as planned and as built programs. This approach is illustrated by a simple example shown in Figures 3.15 and 3.16. It starts with a program setting out for each activity both the as planned and as built durations. A simple example is shown in Figure 3.15.

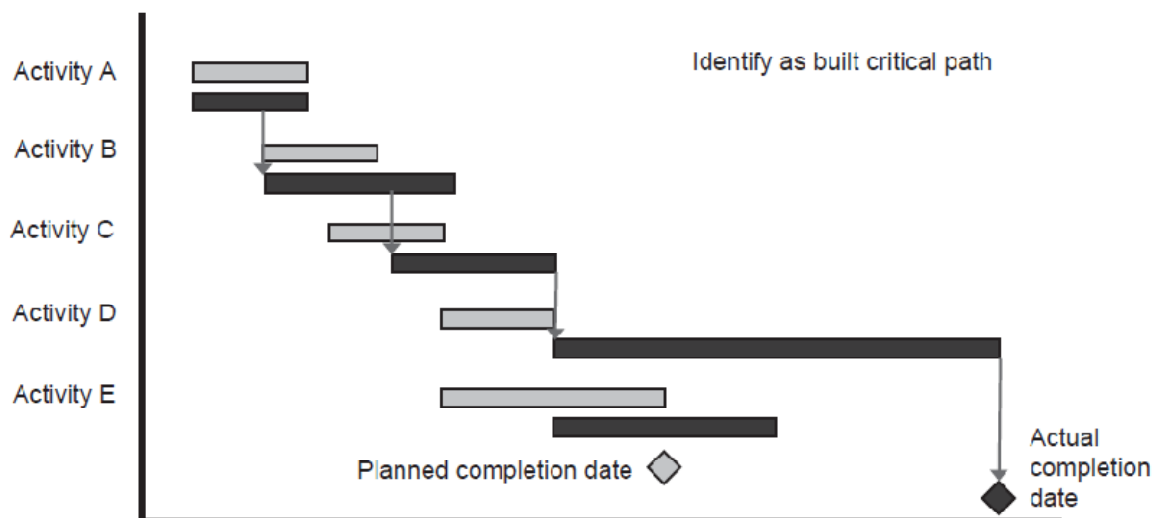


Figure 3.15 Comparative as planned and as built programmes.

By comparison of the as planned and as built periods in this program it can be seen where individual activities have slipped. By the addition of logic links setting out the critical path of the as built program, those activities with slippage that were critical to completion are brought into focus and reveals how some activities, although delayed, were not critical and are therefore irrelevant to the analysis. Consideration of the comparative periods shows that the delay between the as planned and as built programs occurred during activities B, C and primarily D. Analysis can then focus on those three activities. Hypothetically it may be that the considerable delay in the duration of activity D contains a period of delay caused by an employer risk event. The resulting entitlement to extension of time is illustrated in Figure 3.16.

Whilst the above example has been made necessarily very simple it is representative of how an as planned vs. as built approach can be simple to understand and transparent. The further advantage over the two prospective methods described above is that it does rely on actual progress and therefore avoids

theoretical results. The main disadvantage is that this technique requires both a robust and complete as planned program and sufficient records of as built progress to create a logic-linked as built program with a critical path through it. One approach to reducing the extensive research and preparatory work that is required is to start with the as built program and its critical path activities and limit the analysis just to those critical activities.



Figure 3.16 Comparative as planned and as built programmes – delay identified.

However, as with other approaches involving examining the as built critical path, the subjective nature of the assessment of that critical path can be problematic.

This has been commented on above.

Assessment of productivity

Tender productivity

The contractor's intentions must be subject to a test of reasonableness both in total and in terms of the outputs underpinning critical activities and their program durations. This of course begs the question of how the contractor's output assumptions can objectively be tested, given that most contractors will have their own in-house estimating data or will use published data with adjustments to meet their own organizational requirements and/or previous experience.

The answer can only be to build up comparable outputs from published data, making such adjustments as are necessary for the particular circumstances and in the light of experience of similar works.

Achievable productivity

It is, of course, entirely possible that the contractor's assumptions and calculations underlying his tender and tender program were reasonable and sensible at the time of tender but have changed due to factors not related to any delaying event being considered. It is therefore usually necessary to consider the circumstances of the works as they progress, prior to any alleged delaying events, and determine the effect, if any, of such factors.

This can require consideration of extraneous factors such as economic circumstances, including labor availability etc., as well as factors peculiar to the contract such as any differences between anticipated and actual site conditions.

Actual productivity after a change

One of the most difficult challenges in analyzing time matters is that of demonstrating that an instructed change to the works has caused a change in productivity, almost without exception a reduction in productivity. The difficulty arises from the need to isolate, or account for, all other potential causes of change in productivity, and the problem can arise both before the commencement of the affected activity and, sometimes, after the activity has commenced on site.

The ideal situation is to have a reasonable period of the activity undertaken on site without the change that is alleged to cause the productivity drop, so that it is then possible to provide a further analysis of the activity after the alleged cause of the productivity change. This approach is sometimes referred to as the 'measured mile' approach, as it anticipates the analysis of a 'control' period or 'measured mile' against which future performance is to be measured. In practice, life is seldom so simple that one is provided with a period of the unaffected activity and then a further period of the affected activity; other factors often tend to be present both before and after the change, and of course no such 'measured mile' is possible if the activity has not commenced at all.

The answer is usually no more than a reasoned analysis of the type of data discussed above, taking into account the potential effects of the change to the works. This will not usually provide a precise answer, but at least should provide

an answer that is subject to a range of accuracy, thereby enabling an assessment of the time impact, and payment implications, to be made.

3.5.9 Sources of productivity data

The fundamental principles

There are four principal pieces of information required when assessing the time required, or price, for any substantial construction activity:

- 1) Relevant quantities of work required for the activity.
- 2) Construction equipment and methods best suited to the task in the circumstances.
- 3) Outputs that can be expected from the resources required on a sustained basis.
- 4) Level of resources required to complete the activity in the time required, or the time required completing the activity with available or optimum resources.

While the considerations applicable to different activities can be different, the thought process required is similar for all activities, and can be outlined as follows.

Relevant quantities

There is often a substantial difference between quantities measured for payment purposes and those needed to calculate the time and resources required for the same activity. A principle of many common standard methods of measurement of construction works, including the building SMM and civil engineering standard method, is that the works are measured 'net' from the drawings of the final permanent works. This has two implications:

- The 'net' measurement means that quantities shown in bills of quantities or other tender documents are the amounts measured from drawings of the works; they are not a measure of the amount of work required to achieve the final works.
- The measured quantities take no account of bulking or shrinkage of the materials required for any activity during the course of the activity, or of any wastage incurred, whether as a result of transportation or conversion to the final works. So, in the case of bulk earthworks, a number of considerations would be required:
- Where, as is usual, the excavation quantities are measured *in situ* there will be a difference between the quantity excavated from the ground and the

quantity that will be carried away from the excavations by trucks. For instance, a truck may be rated to carry 20 m³ but may only be carrying 15 m³ of earth when measured *in situ* prior to excavation, or less when fully loaded due to the bulking of the material as it is excavated from the ground. The actual extent of bulking will vary with the type of ground being excavated, and this in itself will be a factor in the assessment.

- The capacity of the excavation and haulage units would need to be established to ascertain how much ‘bulked’ material they can excavate and haul per hour or day. Care may need to be taken as published data can be in units different to those used in the UK. In particular some excavators and dump trucks may be rated in American units and conversion may be needed; the American ‘short’ ton of 2000 lbs needs to be identified and converted where necessary.
- The ‘fill’ factors for the excavator buckets and the haulage units will need to be established and converted back to the ‘as dug’ or ‘net’ quantities.

The factors will depend upon the nature of the material, fine material compacting better and achieving greater filling of the bucket or truck than coarse material that will not compact and will bridge voids resulting in a greater proportion of air voids.

From the above information some analysis can be made of the output of excavators and the carrying capacity of the haul units to enable an estimate to be made of the number of trucks required servicing the excavators. This will of course depend on further factors such as the length of haul and speed of the haul units themselves.

It should, of course, be borne in mind that the reverse situation will arise where it is the filling of an earthworks void that is being assessed. The void will be measured net and will be the volume to be filled, but the amount of ‘loose’ or ‘bulked’ fill required to fill the void after compaction will need to be calculated in much the same way as the volumes of excavation need to be calculated. It is the ‘bulked’ fill that will be transported, deposited and compacted, so depending upon the type of material and compaction regime, etc., it will be necessary to have available transport for a greater volume of fill than the final void volume. The above considerations apply to earthwork excavations but a similar process of analysis has to be contemplated for any activity to ensure that the correct quantities are used for any evaluation procedure.

Equipment and methods

Based on the above factors some consideration can be given to the appropriate equipment and outputs that they will provide. With earthwork operations there will

need to be balancing of resources to ensure that excavators are not standing awaiting trucks or stockpiling material unnecessarily incurring double handling, or trucks are not standing too long awaiting filling – ‘under trucking’ or ‘over trucking’.

Once this basic resource analysis has been done, a method statement can be developed for the activity. As the method statements for all the major activities are developed it will be possible to determine an overall method statement for the whole of the works, or section of the works as appropriate.

This method statement will underpin the program and pricing of the works.

There are, however, further considerations before the program and pricing can be completed.

Sustainable outputs

The outputs used for excavators etc. can be obtained for a number of sources including published data from the manufacturers, published pricing books, or data compiled over years by a construction company or individual, based on experience of past similar work.

However, in most cases the output data will refer to continuous working.

Most published data assumes 100% efficiency, i.e. the resource is working to its capacity all the time it is employed. There is little real alternative to publishing data on this basis as it would be impossible to predict all factors that might affect productivity, and to what degree, on all projects.

In practice it would be most unusual for a resource to be working at 100% efficiency throughout an activity. Time will be lost, in excavation operations, for matters such as ‘start-up’ and ‘wind-down’ at the commencement and completion of each working day and at meal breaks, etc., moving from one operation or part of the site to another, obstructions to excavation or hauling of excavated material, cleaning up after bad weather, and breakdowns of the machine or supporting equipment. Other factors may apply to other activities.

The way this is dealt with, both for time analysis and pricing, is to calculate the output and costs of the resource at a reduced percentage efficiency or by a reduced working time per hour employed. Thus the expected output may be assessed as being 80%, and the cost of one hour’s resource will then be attributed to 80% of the nominal output of the resource at 100% efficiency.

This is sometimes expressed in terms of, say, a 50-minute hour, i.e. the resource is calculated to be producing at 100% capacity for 50 minutes and at nil capacity for the other ten minutes in each hour.

The application of such efficiency factors should not be confused with inefficient or poor management of the resource. The factors represent the reality of working on site as opposed to the potential output of resources in ideal working conditions with no interruptions etc. In practice, such conditions do not apply in the field.

Recalculation using efficiency factors

When an assessment of likely sustainable production has been made, the time and cost calculations can be rerun to produce the time periods and costs that will be behind the program of works and the unit pricing.

To give some idea of how this looks in practice, consider the case of an excavation operation to remove 200 000 m³, measured *in situ*, of loam and fine clay soils, with the excavated material being hauled three miles to a spoil heap. Assuming a large-scale cut excavation on an open site with no restriction on machine movements, the contractor will research output data from excavator manufacturers' data, his own recorded data or a mixture of both.

The contractor's basic calculation, assuming an excavator with a nominal bucket capacity of 3.1 m³ discharging direct into waiting dump trucks, will then look something like this:

Theoretical excavation cycle time (using factor of 1.2 for type of material being excavated)

Dig 9 seconds × 1.2 =	10.8
Slew loaded 4 seconds × 1.2 =	4.8
Dump	2.5
Slew empty	5.0
Total	23.1 seconds

23.1 seconds = 155.8 cycles per hour

Bucket nominal capacity = 3.1 m³, with fill factor of 0.90 = 2.79 m³

Efficiency factor = 85% = 0.85

Output = 1 × 155.8 × 2.79 × 0.85 = 370 m³ per hour

This is loose material per hour, i.e. after bulking, therefore the amount of *in situ* material excavated, assuming a bulking factor of 0.72 (0.72 m³ in ground = 1 m³ bulked):

$$370 \text{ m}^3 \times 0.72 = 266 \text{ m}^3 \text{ per hour}$$

The machines can then be expected to remove 266 m³ of *in situ* material per hour, and will require trucks to carry 370 m³ of bulked material three miles loaded to tip and return three miles unloaded after tipping. A cycle would then be worked out for the trucks to determine how many trucks will be required to keep the excavators working at the anticipated sustained capacity.

When that calculation has been made, the cost of excavation and cart away can be made for 266 m³ of *in situ* material per excavator per hour. It can also be calculated that using one machine the excavation will take 752 hours, or 15 × 50-hour weeks. Doubling machine numbers would halve the total period if that were operationally feasible.

It may well be that the norms or other data used by the contractor will consist of the above information in summary form, i.e. the machine in the above example will require 0.225 minutes (60 minutes divided by 266) per m³ of excavation in soils of this type. An appreciation of the underlying analysis is often essential, however, when changes to the rate are to be considered or additional payment due to disruption of the working cycle is to be contemplated.

3.5.10 Effect on contractor's plant and equipment

The productivity considerations set out above will be fundamental to the calculation of costs and prices at the tender stages, and similar techniques should be employed in evaluating the effect of changes on the scheme of working, for whatever reason. It is, however, necessary to consider, in the context of time and delay, which the costs incurred by a contractor for plant and equipment do not always vary in proportion to the time expended. Such costs can be considered under two broad headings of 'working plant and equipment' and 'site facilities and equipment'.

Working plant and equipment

The term 'working plant and equipment' is used to describe contractor's plant etc. used for the permanent and temporary works and which is usually costed into the unit rates and prices for the work. Such plant will usually include items such as excavators and dump trucks, concrete fl oats, compressors and welding sets, etc.

But care should be taken as some categories of plant will sometimes be priced into unit rates and in other instances will be in the general 'site facilities and equipment' or preliminaries costs. For instance, cranes used for a specific lift, to place a piece of permanent plant or equipment, might be priced in the unit rates whereas other cranes used for multiple purposes may be priced in the general facilities. This principle can extend to many categories of plant and equipment and a careful analysis is required to establish how and where the plant and equipment costs have been incorporated in the tender.

One of the general 'principles' of the effect of time on plant costs, when the plant is employed on unit rate work, is that the costs do not vary directly with the time expended.

A simple example is that of an excavator employed on the digging of trenches. If, as a result of changes, the excavator has to work longer hours, the average unit costs do not vary directly. The cost of the machine, assuming it is hired or depreciated by the hour, will be the same as will the fuel and lubricant cost. The cost of the driver may vary, however, if the extended hours result in premium time working. In such circumstances the result of extending the working hours from eight to 10 per day may be as follows:

Original cost per hour (plain time working only)	£
Excavator depreciation/hire	30.00
Fuel/lubricants	5.00
Operator	12.00
Total	47.00

Revised cost per hour (10 hours' working per day)	£
Excavator depreciation/hire $10 \times £30.00 =$	300.00
Fuel/lubricants $10 \times £5.00 =$	50.00
Operator $10 \times £12.00 =$	120.00
Operator premium time $2 \times £6.00 =$	12.00
Total =	482.00
Per hour =	48.20

It is only the operator costs that are varied by the premium time working; excavators do not get paid overtime! When the effect of the premium time is spread over the full 10-hour working day, then the increase in the average rate per hour is only some 2.5% despite an increase of 25% in the length of the working day. If the extended day is required to do the same or less work than the tender expectation, then the unit rates will increase, but if the extended day is required to undertake increased amounts of work, then there may be no increase in the unit rates or even a decrease if the total amount of work increases by more than the 2.5% increase in the average hourly cost.

If the hourly average production remains constant, as would be expected in the absence of other factors, then an increase in working time of 25% has produced an effect on the unit cost of production of only 2.5%. This may seem an obvious point but in the analysis of time effects on cost, the simple fact that the two do not necessarily vary in the same proportions is often overlooked or ignored.

In other circumstances changes in time may result in disproportionately high costs. This is particularly so where high capital cost equipment is being used for works paid or priced on a unit rate basis. For instance, works such as dredging require equipment with extremely high capital and running costs if sea-going suction dredgers are employed. If time is extended without corresponding increases in the volume of dredging required, then unit costs will rise rapidly. It is therefore vital that the make-up of the tender costs and pricing is analyzed properly before attempting to undertake any evaluation of the effect of prolongation and delay. Not only must the make-up of the unit rates be understood but also the approach to pricing, in terms of where particular plant is priced, must be available to enable any change evaluation to be undertaken on a consistent basis, avoiding any misleading assumptions.

Facilities and equipment

The term 'site facilities and equipment' is used to describe plant and equipment used generally on the site, not for particular construction activities, and usually priced into the overheads or 'preliminaries' section of the tender.

Such plant and equipment will often include scaffolding and access equipment, general cranes and site concrete batching plants as well as site offices, messing and welfare and safety facilities. One of the important aspects of the costing and pricing of such facilities and equipment is that the costs of the relevant plant or equipment rarely change in a smooth curve in proportion to changes in time or resources. The more common experience is that such costs, while they may vary a

little in response to any time and resource changes, tend to incur substantial changes in costs as 'steps' when critical points are reached.

The easiest example is that of messing facilities, the basic cost of which may vary in direct proportion to time but whose cost will vary in 'steps' with the need to service a greater number in the workforce, it being a characteristic of such facilities that a given size of facility will service a resource up to a certain level, after which an increase in facility size and cost is incurred which will then remain the same until a further maximum capacity is exceeded. For instance, if messing facilities costing £500 per week are provided which will accommodate a workforce of up to, say, 100, but numbers above that will require an additional facility at a cost of £250 per week enabling a further 50 to be accommodated, then an increase in resources from 90 persons to 120 persons will incur the 'step' cost of £250 per week as the resource level exceeds the original 100 capacity. Similar types of variation in costs can be experienced with plant costs such as cranes, where a tower crane may be servicing the general lifting and distribution needs. If the capacity of the tower crane is exceeded other mobile cranes may be required to supplement capacity resulting in steps in the cost of the distribution service.

As with the working plant and equipment the first requirement is to understand how the costs are incurred, what triggers changes in costs and at what point.

3.5.11 Duty to mitigate

The effect of insurance

One of the ways in which a commercial organisation can seek to protect itself against loss, or at least minimize the impact if a particular event should occur, is to take out insurance against the eventuality. Construction companies are of course no exception and carry substantial insurances to cover various aspects of their assets and activities. It is sometimes argued therefore that if a loss that the contractor is seeking to recover under a construction contract is potentially covered by an insurance policy, then the recovery should be by insurance and not through the contract.

4. Evaluation of the direct consequences of change

Claims for additional payment will usually involve either a request for an adjustment of the contract rates and prices, or the reimbursement of a cost based amount as a consequence of other events, or a combination of the two.

The unit rates and prices are often described as the 'direct' cost of the works as each rate or price relates to an individual item or operation included in the works.

Most contracts for construction work will incorporate, in one form or another, unit rates for measured items of the works. In a fully designed and traditionally tendered contract there will often be a bill of quantities defining the works for pricing and setting out the measured units, usually in accordance with a published standard method of measurement or a set of measurement rules contained in the contract documentation. For other contracts, including design and build projects where the contractor has responsibility for designing and defining the full extent of the works in accordance with a brief set out as the employer's requirements, there will often not be a full bill of quantities but an analysis of the contract sum is generally provided to form a basis for valuation of the works and any adjustments that may be necessary as a result of changes in the employer's requirements. This analysis may include a bill of quantities or a schedule of rates for use in the evaluation of any instructed changes to the works.

The total of the unit rate items generally represents the value of the physical construction works, permanent and temporary, to be undertaken. There is, however, usually some overlap with the pricing of the contractor's on and off-site overheads, management, supervision and ancillary service charges. These latter sums are often substantially contained in the preliminaries or 'indirects' section of the contract pricing, possibly subdivided into lump sums and time-related items.

In practice there can be some difficulty in accurately defining the extent to which the unit rates contain management and other costs over and above the cost of the relevant labor, plant and materials, etc. Practice differs between different contracting organizations but it is common to find that working supervision, that is the cost of working foremen, gangers and the like, are included in the unit rates, and that there is a uniform percentage addition to the unit rates for general overhead, with the remainder of the management, overhead and site support costs contained in the preliminaries or 'indirects'.

The problems of scale

The problems of scale have to be addressed by identifying the most appropriate level at which to apply the analysis and testing techniques such as the 'but for' test discussed in Chapter 6. If analysis at the individual unit rate level can be shown to

be unrealistic or impossible then a higher level of analysis such as a trade activity or section of the works may be appropriate.

It should, however, always be the case that the selection of the appropriate level of analysis should be for the pragmatic and common sense reasons discussed in section 6.1 and not merely because it is hoped it will disguise any contractor liability issues that might be revealed by a more detailed level of analysis.

5.1 Unit rates and prices

Design and build / schedule of rates

While there is no detailed measurement available to both parties in such instances there is usually a detailed measurement undertaken by the tendering contractors in order to produce their tender for the works. In design and build or design and construct type contracts it will be necessary to ensure that the contract sum analysis is in such detail as to cover all significant units of work likely to occur and that the pricing applied is reflected in the tender submitted. This is obviously not as straightforward as it is in the contract with a full priced bill of quantities available to both parties, and will require some element of judgment.

Status of contract rates and prices

Whatever the type of contract, the rates and prices submitted by the contractor should reflect, when taken in total, the whole of his obligations under the contract. However, it is important to understand that, while the rates and prices contained in the contractor's tender are deemed to include the whole of his obligations under the contract, they will only apply to the contract works and authorized variations under the contract.

Errors in rates and prices

There is a significant difference between the potential effects of an error in pricing in a "lump sum" contract where the rates and prices are used only to value variations to the works, and remeasurement contracts where the actual scope of the work is measured in its entirety and valued at the quoted rates and prices.

With a lump sum type of contract, such as the JCT Standard Form, the rates and prices are purely for the valuation of variations and changes as the contract scope is not to be remeasured and revalued. In such circumstances it would make nonsense of the tender and contract process if, subsequently, any apparently over-beneficial or -onerous rate could be challenged and changed on the basis that it was an error.

The only possible exception to this position is in circumstances where rectification of an error may be possible. This may be possible where a party discovers an error after entering into a contract and requests agreement from the other party that the contract shall be amended to correct the error. In the absence of such an agreement it may be possible to rely on express terms of the contract for rectification of particular types of error.

In circumstances where the contractor has inserted an erroneously low rate in the contract bills and seeks to avoid its consequences if it is to be used to value additional work it is not possible for the contractor to recover the potential loss under provisions such as clause 26.1 of the JCT Standard Form as 'direct loss and/or expense' as pricing errors are outside the scope of the grounds for which such claims can be made.

5.1.1 The valuation 'fences'

Many contractors view the occurrence of variations, be they of variation to the specification or scope of works, as an opportunity to obtain enhanced rates for the work and thereby improve the commercial position of the contract for them. Such an approach is understandable given the risks that contractors run and in many instances have to carry, and a philosophy of 'making hay' at every opportunity, while understandable, can lead to unnecessary conflicts over the pricing of changes. It has also to be added that the employer's team are often not blameless in such situations, seeking to have varied work undertaken at the minimum, or no, cost rather than the correct price.

There is often little need for such conflict over the pricing of varied work as most, if not all, of the standard forms of contract in regular use have well tested and logical regimes for the pricing of such work. Sadly the same cannot be said of many 'ad hoc' or 'one-off' contracts where the provisions are often not properly developed and considered in the light of all possible future circumstances. The contract regime for pricing variations needs to consider carefully how the contract rates are to be applied, and more importantly how those rates can be changed or varied as the effects of the variation differ.

Change in conditions

Assume that the change in conditions arose from the issue of a variation order to construct further concrete retaining walls but at a part of the site where access to mechanical plant was so restricted as to exclude deliveries of ready-mix concrete lorries from the vicinity and eliminate the use of craneage, and the quantity of concrete in the walls subject to the variation was not sufficient to justify the mobilization and use of a concrete pump.

Assume also that no such restrictions applied to the concrete in the retaining walls which were included in the contract bills.

The change in conditions will affect the placing of the concrete, it may affect the erection of formwork if the contract scope anticipated the use of crane as part of the erection operation, and might similarly affect the placing of the reinforcement if the contract scope had also anticipated the use of crane to place prefabricated reinforcement cages.

To use the rate for concrete as an example, the rate build-up for the contract scope, assuming walls of 150 to 450 mm thickness, might have been:

		£
Concrete	Per m ³	58.00
	Wastage 5%	2.90
Labor	4.25 h @ £15.00	63.75
Plant	Air hose and compressor	4.50
	Per m ³	£129.15

The change in conditions entailing the exclusion of ready-mix lorries from the vicinity might have the effect of increasing the labor content to, say, nine hours per cubic meter, as the concrete has to be transported manually from the nearest delivery position to the point of placement. The manual transportation might also increase the wastage factor by another 2½%. The effect of the change in conditions for the concrete price would therefore be, leaving aside for the moment the issue of potential impact on the crane requirement:

		£
Concrete	Per m ³	58.00
	Wastage 7.5%	4.35
Labor	9 h @ £15.00	135.00
Plant	Air hose and compressor	9.53

	Per m ³	£206.88
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Note that the price for the air hose and compressor has also increased in proportion to the increase in labor time on the assumption that the plant will be dedicated to the concreting operation for the time that the labor is engaged.

This example assumes that the concrete would have been placed from ready-mix delivery lorries direct to the retaining walls for the contract scope.

Where it had been anticipated that plant such as tower cranes would be used for the placement, i.e. using concrete skips to transport and place the concrete, a further potential problem arises in that such items of plant and equipment are often priced in the preliminaries, or site overhead, section of the contract and not in the unit rates and prices. In such circumstances the question arises as to what is the valuation effect of the reduction in usage of the tower crane. The usual answer is that as the crane is being paid for through the preliminaries the contractor still gets his payment and provides the crane for the anticipated period. The overall effect of a single operation such as the loss of usage for a single variation operation will usually not be significant.

Change in character

Now consider the evaluation to be undertaken for a change in character. If, as suggested above, the concrete retaining walls, which are the subject of a variation, are of differing thicknesses and heights in contrast to the concrete scope for such walls, which were of relatively uniform thickness and height, then it is suggested that the rate for the varied work will be a new rate built up to reflect all the elements of the varied work but using the same basic rates for labor, materials and plant as were included in the contract bill rates.

The original rate for formwork to the walls, as envisaged in the contract bills rates, might have been:

			£
Formwork materials	4 uses	£34.00 m ²	8.50
Sundries			1.00
Labor	Make	6 h for 4 uses 1.5 h @ £18.00	27.00

	Repair and remake per 0.50 h @ £10.00		5.00 use
		Per m ²	£41.50

New rate for formwork to walls of varying thicknesses and heights:

			£
Formwork materials	3 uses	£34.00 m ²	11.34
Sundries			1.34
Labor	Make	8 h for 3 uses 2.67 h @ £18.00	48.06
	Repair and remake per 0.75 h @ £10.00		7.50 use
		Per m ²	£68.24

In the latter instance every element of the build-up has been examined and revalued to reflect the character of the varied work, only the basic prices have remained unaltered and it is suggested that this is the correct approach to such valuations.

Valuation of variations in quantity

The influence of the quantity of work can be substantial or negligible depending upon the type of work, the quantities 'before' and 'after', and in some instances the timing of the work. It is impossible to give a definitive list of all the different factors that might need to be taken into account in such circumstances, but the following examples serve to illustrate the range of factors that might be relevant in particular circumstances:

- Reductions in quantity might result in 'small load' charges being levied by suppliers of materials thereby increasing the unit cost of materials.

- Increases in quantity might result in supplies of material having to be brought in from further afield or at greater expense, for instance large increases in the quantities of imported fill material required may result in the exhaustion of local or lowest cost supplies.
- Increases or decreases in quantities might influence the economics of plant employed on the works. This is particularly a problem in contracts where large expensive items of capital equipment are employed in anticipation of a particular volume of work. Such circumstances may, for instance, involve significant fluctuations in quantities of dredged material affecting the economics of mobilized dredging plant, increases in volumes of work resulting in site cramage or other plant being inadequate for the revised works, and in remote locations might involve the importation of labor resources to deal with increased volumes of work.

As an example, consider the case of a large dragline excavator mobilized to site for a particular excavation operation, which it is anticipated in the contract bill of quantities will comprise some 40 000 cubic meters of excavation.

Assume that the contractor priced his unit rate for the relevant excavation thus:

		£
Dragline – mobilization	2 days @ £1,500	3,000.00
Dragline – working	40 000 m ³ @ 750 m ³ per day @ £1,500 per day	80,000.00
Dragline – demobilization	2 days @ £1,500 For 40 000 m ³	3,000.00
		86,000.00
	Per m ³	£2.15

As a result of a redesign and alterations to the required excavation levels, assume that the volume of excavation available for the dragline is reduced to, say, 32 000 m³. In effect, the mobilization and demobilization charges will now be spread over the reduced quantity (£6,000 spread over 32 000 m³, i.e. 18.75 pence per m³), instead of being spread over the original 40 000 m³ (15 pence per m³). The rate would therefore be increased by the difference of 3.75 pence per m³. This of course assumes that any related effect on associated plant such as lorries for carting away

etc., is dealt with under separate items, and prices, for disposal of excavated materials.

Such adjustments should not raise undue difficulty where the costs of plant can be readily established, such as will be the case for hired-in plant.

Adjustment may not be so straightforward where the contractor owns the plant and external charges do not apply. Rates used for mobilization and demobilization might be simply estimates or allowances of the costs that the contractor will incur for use of his own resources. Some items such as transport and associated labor should be possible to establish from daywork charging rates but further difficulties posed by such issues are discussed later in this chapter.

Valuation of omissions

The valuation of omissions from the contract works can sometimes cause some difficulty, particularly where the omissions have an impact on the economics or commercial aspects of other work, or have an impact on the general site services, the preliminaries items.

FIDIC Sub-Clause 12.4 Omissions

“ Whenever the omission of any work forms part (or all) of a Variation, the value of which has not been agreed, if:

- (a) the Contractor will incur (or has incurred) cost which, if the work had not been omitted, would have been deemed to be covered by a sum forming part of the Accepted Contract Amount;*
- (b) the omission of the work will result (or has resulted) in this sum not forming part of the Contract Price; and*
- (c) this cost is not deemed to be included in the evaluation of any substituted work;*

then the Contractor shall give notice to the Engineer accordingly, with supporting particulars. Upon receiving this notice, the Engineer shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine this cost,”

Percentage adjustments in contract valuations

Percentage adjustments commonly occur in the valuation of changes in contract works in two separate guises; the use of threshold percentages of change that must occur as a prior requirement to any adjustment to the contract rates and prices, and the use of percentages of the contract sum or price as the value of the adjustment itself.

Threshold percentages

It is common in many contracts for engineering construction, and occasionally other types of contracts, to state that the contract rates and prices shall apply without amendment unless a stated percentage of change in the volume of work undertaken is experienced. The percentage of change required as a precedent to any amendment to rates is often in the order of 25%, either of increase or reduction in the volume of work. Such provisions are also not unknown in building and civil engineering contracts, where it is possible to find amendments to the JCT Standard Form or ICE Conditions being incorporated in the contract documents to have the same effect, or similar provisions being added into *ad hoc* or one-off contracts.

The desirability of such devices is debatable but is usually intended to prevent argument over the rates and prices when the change in the volume of work is regarded, at least by one party to the contract, to be not significant enough to warrant such changes. That these provisions usually occur in contracts used by large client organizations that are regularly engaged in such contracts supports the contention that they are seen to be a potential safeguard for the employer. They do, however, raise some significant potential problems:

- (1) What are the criteria for judging the change in the volume of work? Is it the change in the contract price, i.e. the total price to be paid for the works? Or is it a change in the amount of resources to be expended on the works?
- (2) Is the amendment to the rates and prices to include preliminaries type items, or is it restricted to only the unit rates? Or does it apply only to the preliminaries, often referred to as ‘indirects’ in such contracts?
- (3) What are the rules to be applied in assessing any amendments to the rates and prices if such are justified? Are the contract rates and prices to be used as a basis for evaluation?

Sadly these matters are often left unanswered, or only partly answered, in many instances, leaving the gaps to be filled by argument between the parties.

Criteria for judging change in volume

It seems obvious to suggest that the criterion for judging a change in the volume of work should be the value of that work, and the work used as a basis for establishing that change in volume should be the work executed at the unit rates and prices, i.e. excluding the preliminaries or indirects element, as it is the volume of the contractor’s site resources that is usually intended to be used in judging a change in the volume of work executed. But adopting value as the criterion can sometimes cause a problem.

If it is the value of the work that is used as the criterion, the intention of the restriction imposed by the percentage threshold may be circumvented by relatively small increases in the volume of high value items. In other circumstances large changes of omission and addition, which cause the nature of the work to change in a manner significant to the contractor, may have the effect of largely cancelling each other out and thereby resulting in a change in value of less than the percentage required to allow a review of the relevant rates and prices.

The intention is presumably to allow the contractor to review his rates and prices in the event that the resource profile of the project differs substantially from that envisaged at the time of tender as a result of ordered changes in the works. If that is so then it would seem reasonable to use a measure of the contractor's resources other than value, if such is available, to judge when and if the threshold level has been achieved. In many contracts containing such clauses the works are largely of a mechanical engineering nature with many of the materials being provided free of charge to the contractor by the client. These contracts also commonly have contract bills of quantities that indicate not only the unit prices for the works but also the unit man-hours.

In such circumstances there is a strong case for using the change in man-hours, being the prime resource provided by the contractor, as the criterion by which the volume of change should be judged.

In other circumstances the parties should consider, before adopting such threshold provisions, how the change is to be measured, and set out the conclusion in the contract to avoid later complications as a result of difficulties such as those discussed above.

Which rates are to be amended?

The intention of such threshold restrictions is often that they should apply only to the adjustment of the preliminaries, or indirects, prices in the event that the threshold for review is exceeded. There is some logic to such an intention as the preliminaries or indirects are where the site supervision and management, and general services, are priced and it is they that are most likely to be affected by substantial fluctuations in the volume of work undertaken at the unit rates and prices in the contract.

If it is intended that the unit rates and prices themselves are to be reviewed if the contract threshold for the change in volume is exceeded, then the contract should make this clear.

Whether all rates are subject to adjustment, or only certain of the rates, the contractor should be aware of the intended regime when pricing the works so he

can ensure that any costs that need to be adjusted if the threshold change occurs are priced in the correct part of the contract.

What rules apply?

It is not uncommon for such clauses simply to provide that the rates and prices, be it for preliminaries type work or the unit rates and prices themselves, can be reviewed if the threshold is exceeded without stating what, if any, rules of valuation apply. In the absence of any express provision to the contrary the review of prices must be by reference to the contract prices so that any adjustments reflect the level of pricing in the contractor's tender.

Percentage adjustments to contract value

Some contracts, particularly in the process plant or mechanical engineering industries, adopt the device of adjustments to the contract price, in the event that work is incomplete or is defective, by a proportion or percentage of the contract price. It is not uncommon for such contracts also to include a cap on the contractor's liability for, for instance, defective work, by use of a percentage restriction.

In many cases the contract may simply provide that the client is not obliged to pay the portion of the contract price that relates to unfinished or defective works.

Percentage for defective or incomplete work etc.

As with many other matters the express terms of the contract will be central to deciding how such provisions are to operate. If the contract simply provides that the relevant proportion, or percentage, of the contract price is not to be paid then there will be ample scope for disagreement as to what represents the relevant proportion where there is no relevant breakdown of the contract sum. It is preferable that the means of measuring such adjustments is set out clearly in the contract, whether by reference to the progress monitoring and reporting regime or by reference to contract requirements for agreement of the state of the works when handed over from the contractor to the employer.

If the contract progress monitoring and reporting system is to be used to establish relevant percentages then it is essential that the system is capable of sustaining such reliance and it is properly operated and kept up to date.

Recording of the relevant completion percentages at the time of handover will also require careful attention to avoid later dispute. It is preferable for the contract to clearly set out whether the percentage or proportion is to be calculated as a whole, over all the works and services provided by the contractor, or whether it is intended that the assessment should be done for separate elements of the contract. If the

latter course is adopted there will of course be further implications for the progress monitoring and reporting, and handover documentation, procedures.

The contract also needs to define the value to which the percentage or proportion is to be applied, usually the 'contract price', i.e. the value of the contract after all adjustments except those which are the subject of the percentage or proportion adjustments.

Such devices can obviate the need for much detailed measurement and pricing of work not executed as contemplated by the contract, and laborious marking up of record drawings with the incomplete elements, which on a major mechanical installation can be a time-consuming and costly job, but if implemented without sufficient prior consideration can cause more disagreement than they save.

Percentage caps on adjustments

Just as percentages are sometimes used to define the amount applicable to a particular circumstance, there are occasions when the amount of adjustments can be limited by a provision in the contract to the effect that certain defined adjustments are limited to a percentage of the contract, or sometimes order, value. For instance, liability for liquidated damages for non-completion by the specified date might be subject to a limit of 10% of the contract sum. Such devices serve to limit liability in circumstances where the potential liability, if unrestricted, would be such as to discourage the contractor or supplier from undertaking the contract, or where an unrestricted liability would mean the inclusion of substantial 'contingency' amounts in the contract.

5.1.5 Quantum meruit

In some circumstances the contractor may be entitled to claim additional payment on the basis of a 'quantum meruit' evaluation. The term 'quantum meruit' literally means 'the amount he deserves' and implies an obligation to pay whatever the work or services provided is worth.

Most claims for additional payment will be anticipated by express provisions in the contract and this type of evaluation should therefore arise only in exceptional circumstances. It has long been established that if a contractor undertakes specific work under a construction contract but is requested to undertake further work outside the scope of the contract he will be entitled to be paid a reasonable sum for the further work undertaken, which being outside the contract is not valued by reference to its terms (*Thorn v. London Corporation* (1876)). Further situations in which 'quantum meruit' might arise are where the contract expressly provides for a payment of a reasonable sum, without detailing that sum or its valuation procedure,

or where the contract requires work to be undertaken but no price is fixed by the contract at all.

The other circumstance that sometimes arises is where the contract provides for the price to be paid for the works but the contractor argues that the contract provisions should be void as a result of the actual conditions or character of the work being so different from that anticipated in the contract that the pricing provisions are to be regarded as void.

The general rule is that, if a quantum meruit is undertaken, then the terms of the contract, if any, which governed the original scope do not have any bearing on the evaluation. The contractor will be entitled to recover a fair commercial rate for the work undertaken. There are no rules for such an assessment but the following factors may be relevant depending on circumstances:

- (1) Evidence in respect of prices in a related or similar contract.
- (2) Evidence of any negotiations between the parties in respect of the applicable price.
- (3) Measurement, or other quantification, of the amount of works undertaken.
- (4) Calculations of the cost of labor, plant and materials required for the works.
- (5) Evidence of the overheads likely to be incurred in respect of the works.
- (6) Evidence as to the level of profit normally anticipated on such work.

From the above it will normally be possible for experienced contractors, quantity surveyors or engineers to arrive at the reasonable value of the works.

There is also the matter of the extent to which a contractor can recover costs, where payment is made on a cost rather than on a measured unit rate basis, in circumstances where rates are not applicable or available and there are suggestions that the contractor has been inefficient or has not managed the works as well as he might. The general rule is that the contractor is not expected to be perfect or to be the best contractor in the circumstances. He is expected to be a reasonably competent contractor experienced in the particular type of work, and as such it can be expected that a certain level of efficiency can be expected which will include an acceptable level of 'inefficiencies'. Providing the contractor has not made errors, or managed the works in a way that demonstrates he is not a reasonably competent contractor, then no adjustment is relevant to the assessment of costs in such circumstances.

5.1.6 Requirement for notices

It should be noted that most contracts will include provisions for notice to be given by a party wishing to initiate a process of valuation for changes to the contract works. The obvious reason for such requirements is that the party in receipt of the

notice, usually the employer or his representative, may wish to take some action in respect of the works for which payment is being claimed, either in respect of the actual works themselves or in respect of records being kept of the works.

If the contractor wishes to contend that a higher rate shall apply, or wishes to dispute a rate fixed by the engineer, then not only does he have to give the necessary notice but also he has to comply with the requirements for records and accounts as summarized above. If the contractor omits to follow these procedures it will be at his own risk as it is expressly stated that he will only be able to recover payment to the extent that the engineer's consideration of the claim has not been prejudiced by the failure to keep records and submit accounts. It is this last provision that is at the essence of the notice requirement. It is only reasonable that the engineer shall be able to verify the records and data relating to the works to ensure that any valuation reflects the true circumstances. Failure to give notice prejudices the engineer, and therefore the employer.

This principle, of lack of notice resulting in recovery only to the extent that evaluation is not prejudiced by the absence of notice, has a general applicability, subject to the specific requirements of a particular contract.

It is not difficult to envisage how records might be necessary, and their absence prejudicial, in evaluating claims for a change in a rate. As an example consider a contract in which a bulk excavation activity is required with large excavators discharging to dump trucks for haulage of the excavated material to a spoil heap some 1500 m from the face of the excavations. At the time of tender the contractor will have estimated not only the rate of excavation that is likely to be achieved by the excavators in the anticipated conditions, but will also have considered the haul distance for the dump trucks and their loaded and unloaded speeds on the site in order to produce a balanced resource that enables the excavators to keep working without having to wait for dump trucks into which they can discharge, while at the same time not 'over trucking' the operation so that dump trucks are left idle queuing to load.

In the event that the engineer instructs that the anticipated site of the spoil heap is unsuitable or not available and instructs another site to be used some 2250 m from the excavation face the contractor is faced with two principal options:

- (1) He can continue with the same team of excavators and dump trucks but accept that due to the increased haul distance the excavators are going to have idle time awaiting trucks into which they can discharge.
- (2) He can increase the number of dump trucks in order to keep the excavators working to full capacity.

The actual course taken will depend upon the circumstances of the project and considerations such as the amount of excavation to be undertaken in whole, and the availability of additional plant among other potential factors.

However, it is likely that the contractor will wish to notify an intention to claim a higher rate if he is dissatisfied with any rate fixed by the engineer as a result of the change in the siting of the spoil heap. Critical to the evaluation, depending upon which option has been adopted, will be records of idle time for the excavators for option 1 above, or records of the increased time spent by additional dump trucks if option 2 has been adopted. Failure to give notice promptly or to keep any records required by the engineer of relevant plant operating and idle times may result in the engineer's claiming he has been prejudiced in assessing the contractor's claim for a higher rate.

This highlights the need for rate fixing, and any subsequent challenges, to be processed as soon as possible, not merely within the time limits expressed in the contract. On most large contracts the works are proceeding at a considerable pace and if the evaluation process is delayed then the possibility of disagreement and dispute as to the consequences of a change increases.

Delayed notification

The provisions in construction contracts for notices are there to avoid, wherever possible, disputes as to the consequences of events on site. If one party to the contract believes that a change or instructed variation has rendered some, or all, of the relevant rates and prices invalid and adjustments are necessary, it is simple good practice to alert the other party to the contract so that records and notes can be kept of any relevant matters to avoid unnecessary argument as to the alleged circumstances and effects of the change or instruction.

Apart from the express requirements for notices incorporated in contracts it makes good commercial sense to have matters recorded jointly as far as possible in the interests of achieving early agreement of any requested adjustments to rates and prices. Cash flow is the lifeblood of the construction contracting business and it is in the interests of the contractor to ensure that early and adequate notice is given. Any belief that some advantage can be achieved by delaying notification and restricting the ability of the other party to make relevant records is more than likely misconceived and it is more likely that the contractor will suffer late agreement and delayed, if not reduced, cash flow as a result of any delay in issuing notices.

5.2 Unit costs

The rates for the detailed construction work are usually broken into units for pricing based on a stated method of measurement. If a standard method of

measurement is not adopted the contract documents should include an explanation of the methodology employed in compiling this section. Failure to adopt an appropriate and relevant standard method of measurement, or to provide a comprehensive description of the method of measurement adopted, will run the risk of later arguments over the 'item coverage' included by the measurement with potential claims that further items should be measured to fill gaps in the coverage between the individual measured items.

The method of measurement, whether one of the standard publications or an *ad hoc* set of rules, will define how the work is to be measured and the 'item coverage' for each item of the detailed measure. As the contract requires the contractor to include in his prices for all his obligations under the contract this will include the supply of labor, plant and equipment, and materials for the works, including any subcontracted elements, but there are variations depending upon the type of contract and the nature of the project.

For instance, in many mechanical engineering and process plant contracts the client may supply substantial elements of the materials required, and *Evaluation of* these and other contracts may require a greater or lesser design input from the contractor.

Generally, leaving aside the less usual aspects of employer-supplied materials and design requirements, the pricing elements will include the following factors.

Labor

- Wages, bonuses, travelling allowances, tool allowances and all payments prescribed by relevant 'working rule agreements', including overtime payments where applicable for work within the site working hours, or where none are stated, the hours anticipated by the contractor.
- Contributions for pensions, sickness, unemployment benefits and National Insurance, etc.
- Contract works, third party and employer's liability insurances (unless included in the contract preliminaries or 'indirects').
- Annual and public holidays with pay.
- Industrial training levies.
- Redundancy payment contributions.
- Obligations under the Contracts of Employment Act etc.
- Site supervision and staff, including timekeepers and clerks, motor vehicles used by supervisors, site offices, hutting and shelters, including time of agents, site foremen and walking gangers working in a supervisory capacity. (The demarcation of site supervision costs between unit rates and preliminaries, or indirects, may vary depending upon the type of contract.)

- Small tools such as picks, shovels, barrows, trowels, ladders, handsaws, buckets, hammers, chisels and all like items including sharpening and replacements.
- Protective clothing and boots.
- Head Office charges and profits.
- Subsistence or lodging allowance for personnel working away from home.
- Welfare and messing facilities (unless included in the contract preliminaries or 'indirects').
- Transport to and from the site (unless included in the contract preliminaries or 'indirects').
- Compliance with all health and safety legislation (unless included in the contract preliminaries or 'indirects').

Plant and equipment

- Provision of owned plant and equipment.
- Provision of hired plant and equipment.
- Maintenance and repairs, including tyres etc., mechanics and fitters' time, etc.
- Cost of fuel, lubricants and grease, etc. including distribution of fuel to working plant on site.
- Contract works third party and employer's liability and motor/plant insurances.
- Road tax and statutory charges, etc. where appropriate.
- Cost of operators' time including all on-costs as listed above for labor.
- Supervision etc. as included for labor.
- Compliance with health and safety legislation and statutory requirements for particular items of plant.
- Head office charges and profit.

Materials

- Cost of supply including carriage and freight charges, etc.
- Unloading and distribution (unless included in contract preliminaries or 'indirects').
- Wastage in carriage, unloading and distribution.
- Wastage and losses in conversion, including bulkage and shrinkage where appropriate.
- Cost of insurances during supply and delivery, etc.

Subcontractors

- Cost of works or supplies from subcontracted companies.

- Cost of attendance on subcontractors, e.g. unloading, distribution of materials, provision of welfare facilities, etc. (unless included in contract preliminaries or ‘indirects’).
- Cost of supervision of subcontracted work including health and safety, etc.

As indicated above, some of the above cost elements may be priced in the contract preliminaries, or indirects, rather than in the unit rates, and care should be taken to ascertain the demarcation between unit rate pricing and contract preliminaries type items in each particular circumstance. Practice may vary between different types of contract and different employer requirements.

The above is not comprehensive and as indicated above may vary with the express requirements of the contract and the project works. It does, however, give a guide to the range of factors that will usually be deemed to be included in the contract rates, and which are therefore fundamental to the understanding of claims for additional payment. The treatment of the individual elements may also vary from company to company particularly with regard to the inclusion of head office overheads and profit within the pricing regime. Some companies may include overhead and profit on all elements, some on labor and plant only, while yet others will price overhead and profit into the contract separately to the unit costs.

5.2.1 Labor costs

Most of the individual elements contained within the make-up of the labor costs are self-explanatory, but there are some that may cause a little confusion when considering claims for additional payment.

Gang rates

It is usual practice when pricing the unit rates in a bill of quantities or schedule of rates for the estimator to use a composite rate for pricing many of the individual items, rather than the rate for a craftsman or laborer alone.

This practice reflects practice on site, where craftsmen and laborers rarely work in isolation but are to a greater or lesser extent deployed in teams. An obvious instance is that of bricklayers who commonly work in teams of two bricklayers and one laborer or four bricklayers and two laborers, with the laborer(s) mixing and transporting the mortar and distributing the bricks to the point of use so that the bricklayers can keep working. Such a ‘two and one’ gang would be priced as:

Bricklayers	per hour 2 x £18.00	36.00
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Laborer	per hour 1 x £15.00	15.00
		£51.00
Cost per bricklayer hour		£25.50

In effect, half an hour of laborer cost has been added to the hourly rate of the bricklayer so that when brickwork items are priced using bricklayer 'norms' or constants, the appropriate allowance for laborer time is also included.

This principle may be extended to other trades such as carpenters and joiners, where it might be considered that a laborer will be required to unload and distribute materials for the carpenters and joiners, at the ratio of perhaps one laborer to every eight carpenters and joiners, depending upon the type of work and circumstances.

In that case the calculation would be:

Carpenters/Joiners	per hour 8 x £18.00	144.00
Laborer	per hour	15.00
		£159.00
Cost per carpenter/joiner hour		£19.875

In this instance the effect is to add an eighth of an hour of laborer cost to the cost of each craftsman hour.

The way in which such laborer time is included in a particular contract may vary. It can be included in gang rates as above. Alternatively, the unloading and distribution, plus clearing away of rubbish and other general activities in support of the trades teams, may be priced as 'service gangs'. In the latter case the cost of the service gang may not appear in the rates and prices for the individual items but might be included in the preliminaries, or indirects, section of the pricing against items describing the contractor's general obligations.

It is therefore necessary to understand, when considering claims for additional payment and the adjustment of rates and prices, just where the costs of the contract obligations have been included in the rates and prices in the contract.

Supervision

The extent to which the rates and prices include supervision of the trades workforce is also an area where practice may vary, especially in relation to the

categories of supervisory staff that might be included in the rates rather than priced in the management items in a preliminaries or indirects section.

The common practice is for 'working' supervision to be included in the unit rates and prices, and supervision by personnel engaged solely in 'management' to be priced in preliminaries or indirects sections. In practice the definition of the two categories of supervisory personnel can become blurred, with consequent difficulties in determining who is included in the unit rates and who is not.

The term 'working supervision' usually covers trade foremen and gangers, working with the trade and laborer teams in the field and responsible for their day to day organisation, including obtaining information and material supplies and raising queries with the site management team. Such foremen and gangers may well also be engaged in assisting with the works themselves, depending upon the type of contract and the contractor's supervisory scheme.

The actual demarcation between the supervisory element included in the unit rates and prices and that included in the preliminaries section may, as in the case of service labor costs, vary from contract to contract and between different contractors depending upon the type of works and the contractor's policy.

5.2.2 Use of norms in evaluation

In compiling the unit rates in a tender the contractor will usually utilize a set of 'norms', or standard productivity outputs, to assess the unit costs for labor and plant. These norms will most often be sets of data compiled by the contractor's staff from their own experience, or from data recorded on similar projects undertaken by the contractor. It is most unusual to find a contractor using published books of norms or pricing information to compile his tender.

The overriding principle when consulting such sources of information in connection with any particular contract is that they should not be regarded as being directly applicable, without careful consideration of the basis of the published data as compared with the circumstances of the particular project.

In particular it is important to understand how the published data addresses a number of issues:

- (1) What is the basis on which the norms have been established? Is this by reference to a relevant British Standard or some other criterion?
- (2) How do the norms deal with supervision? Is it included or excluded? If included, to what extent?
- (3) Do the norms make any allowance for lost time in the working week, such as clocking time, time lost between assembly point and workface at the beginning and end of shifts and at meal breaks, etc.?

- (4) Can it be confirmed that the norms exclude other lost time factors that may affect the works, such as inclement weather losses, training and induction time, periodic leave time and travelling time, etc.

5.2.3 Plant costs

Many of the comments made in respect of the application of norms for labor activities apply equally to productivity data for plant and equipment.

It is equally important to ensure that productivity data for plant and equipment is adjusted to the particular circumstances of a project as it is for labor productivity norms.

In many instances, particularly on large-scale civil engineering or similar works, the contractor will resort to the use of an analysis of anticipated productivity using the type of information sources discussed in section 3.5.5.

Rather than refer to productivity norms, or constants, the expected production levels will be forecast by the establishment of an anticipated method statement and assessment of the production against time that can be expected using the plant and equipment incorporated in the method statement. It is not unusual for such exercises to include ‘what if’ scenarios for testing the method statement, or alternative method statements, to ascertain the production levels for possible alternative methods. The final data from these exercises will then underpin the calculation of rates and prices rather than simple reference to a set of output norms.

Adjustment of unit outputs for plant and equipment may therefore entail some understanding of the method statement and deployment of such plant and equipment, rather than simple reference to standard output data. If standard outputs are used they will be subject to the same considerations as labor constants with reference to their applicability to the particular circumstances under examination.

A matter that might cause greater difficulty in respect of plant and equipment is that of the rates and prices to be used for each item in an analysis, e.g. what is the correct rate per hour/day/week for a particular piece of plant?

Plant and equipment cost rates

When examining unit rates and the plant and equipment element within such rates a decision has to be made as to what are the allowable rates to be employed in making any adjustments. These will usually have to reflect the level of pricing in the contract, i.e. they will have to be consistent with the pricing in the contract, even where there are no readily available rates for comparison.

In most instances the detailed build-up to the contract rates and prices will not be readily available to others outside the contractor’s organisation. In such

circumstances there are different sources of rates that could be applied to plant and equipment in the search for a basis for analysis, including:

- (1) Daywork rates for plant, either from a contract schedule of daywork rates or from published sources such as the CECA Schedule.
- (2) Rates established by reference to quotations or invoices from plant and equipment hire companies.
- (3) Internal 'hire' rates or charging rates that represent charges made within the contractor's organisation for plant and equipment owned by the contractor.

The first of these alternatives, the daywork rates, will not usually be applicable for the adjustment of unit rates as they are intended for the valuation of work instructed to be executed on a daywork basis and undertaken incidental to the contract works. The rates will include elements that may be included or excluded within the measured unit rates. For instance, the CECA Daywork Schedule applies only to the contractor's own plant already on site and does not include fuel distribution in the rates. Adjustment of unit rates will usually encompass plant from any source and include the distribution of fuel to it as required.

The second of the above alternatives may or may not be relevant to individual circumstances, depending for instance if contractors do not normally have such plant or equipment themselves or where such plant and equipment is hired in as a normal practice in the industry. However, when adjusting measured unit rates it is the normal cost of owning and operating the relevant plant and equipment that will be relevant to the process. This then suggests that the third category of rates set out above for plant and equipment should be used but consideration will need to be given as to whether or not the rates are reasonable and reflect the contract pricing regime. It will usually be bad practice to simply proffer or accept rates without being reasonably certain that they only include costs for those elements that should be included in such rates. This then raises the issue of what elements should be included.

It should, however, be noted that this does not give a rate for even these items that is devoid of opinion or judgment. For instance, if considering the appropriate daily charge for a large trailer suction dredger, opinion will be relevant in considering a number of the inputs, including:

- Over how many years is the dredger's capital cost to be depreciated?
- At what intervals will major plant on the vessel such as the main engines and dredge pumps require overhaul or replacement?
- What is the rate of wear on the vessel's equipment generally? Will the rate differ depending upon the actual conditions and location of service?

- Is any allowance to be made at the end of the depreciation period for residual value? If so, is it on a sale or scrapping basis?

These, and many other, issues will need to be considered in judging the reasonableness of any rates proffered by the contractor or plant owner. The final decision will be made in the absence of any available comparable hire rates etc. and will depend upon the perceived reasonableness of the rate and the amount and detail of substantiation supplied, judged against the requirements for the rate being assessed and any commercial information in the contract.

So, for a dredger the following information might give a basis for an appropriate charge rate:

Annual capital depreciation (from company accounts) £750,000.00
 Annual allowance for overhaul and maintenance of major equipment £225,000.00
 £975,000.00 Divided by, say 322 average working days per year £3,027.95 per day
 To this would need to be added crew costs, fuel and consumables and any sundry costs.

If it were considered that the conditions on a particular contract would cause increases, or decreases, to the charges in the company accounts then suitable adjustments could be made. The reasoning behind the figures taken from the accounts should be available so the capital depreciation might be made up of a purchase cost of £25,000,000 with an anticipated lifetime with the company of 20 years before being sold on for £10,000,000. The annual maintenance and overhaul costs should be capable of substantiation from accounts for earlier years.

It is likely that such a level of enquiry and substantiation of cost would only be appropriate for large and expensive items of equipment where no other cost reference data is available.

External hire charges

The use of external hire charge invoices to establish the cost of an item of plant is usually quite straightforward where the hire company providing the plant is separate and distinct from the contractor using and paying for the plant. Complications can arise, however, when there are elements of common ownership between the hire company and the contractor:

A situation that is not uncommon. The potential problems can take on two different forms:

- The rates charged for the plant may not reflect the true cost of the plant but may be contrived to transfer money between companies for taxation or other purposes. In instances where there is a suspicion that such charges are being

artificially inflated to transfer money to a related plant hire company the only recourse is to establish the current market rates for comparable items of plant and adjust the charges accordingly.

- The second problem that can arise is that where, although the charges themselves are just and reasonable, credits or transfers are agreed between the related companies for matters that are not directly related to the contract.

5.2.4 Material costs

The inclusion within unit rates for the material element will usually be quite a straightforward exercise and will be based upon the purchase cost of the material, based upon quotations or invoices from suppliers, plus allowances for a number of other factors, including:

(1) *Wastage*: The actual amount of wastage may vary depending upon the type of material and usage but will usually include losses in transportation for bulk materials, losses in unloading and distribution, and conversion waste, i.e. losses incurred in converting the materials to the finished product.

(2) *Unloading, handling and distribution costs*: These will usually be included in the unit rates but in some civil engineering contracts, for instance those for pipeline construction, handling and distribution of the line pipe may be included in the contract bills as separate items. Where the unit rates require inclusion of such costs they will include labor and equipment for the task, although some major items such as tower cranes may be included in the preliminaries section of the contract charging regime. It is also not unusual, as mentioned elsewhere, to find that many building contractors include the cost of service gangs for the unloading and distribution of materials on large projects in the preliminaries charges.

(3) *Storage*: In some instances storage of material, on or off site, may be required and unless such a requirement only arises as a result of some default by the employer then the cost of such storage will generally be deemed to be included in the unit rates.

(4) *Bulking and shrinkage*: It is important to note that due allowance will often be required in unit rates for some items, particularly in respect of earthworks and fill items, for bulking or compaction of the material. The obvious example is that of imported stone or hardcore used for fill, which will reduce in volume, as compared with the transported volume, when placed and compacted. This can be particularly relevant to consideration of unit rates for the placing of fill material stockpiled from excavations on the same project. The usual method of measurement is that of net volume for both excavation and fill requirement, i.e. the contract measurement

denotes the net volume of excavation and fill. If, for instance, these volumes are the same then it might be considered that no imported fill will be required. In practice this is not so; losses in transportation and the reduction in volume resulting from mechanical compaction of the fill may require import of fill to make up any shortfall. Unless the contract terms allow payment for this importation, which is not usual, the cost of the importation to make up such losses will be at the contractor's risk for inclusion in the unit rate.

(5) *Overhead and profit*: The contractor will be assumed to have included an element of overhead and profit in this and the other elements of unit rates unless the contract requires otherwise.

Analysis of the unit rate will be required, when considering adjustments, to identify the material element and to confirm that all the elements, such as the above, required by the contract provisions have been made.

5.2.5 Overhead and profit

Unless the contract requires that the unit rates are to be exclusive of overhead and profit, with such matters addressed elsewhere, the unit rates will generally be deemed to be inclusive of overhead, both on site and off site, and profit. The extent to which such matters are actually included within the unit rates can vary considerably depending upon the policy of the contractor and type of project.

It is not unusual for a contractor to price the unit rates as net of profit, and sometimes net of overhead. The reason for doing this at tender stage is to allow the net estimated cost of the works to be determined prior to determining the amount of overhead and profit the contractor wishes to add to the total cost when converting the estimate to a tender. The amount of overhead and/or profit ultimately added to the total cost may not be a simple matter of applying calculated rates for overheads from the contractor's management accounts to the projected cost, and then adding a profit element based on required future return, as other factors may play a significant part in the final decision as to what level of addition is made. These factors can include:

- *The market*: this may be the market for the particular type of contract, or the more general market for construction services and the economy at large. Perceptions of the level of alternative work available in the near or later future may affect the amount of overhead and profit priced into the contract. In good times, when alternative work is seen as being plentiful, the inclusions may be relatively high, whereas, when times are hard overhead additions may be reduced and profit eliminated completely!

- *Availability of resources*: the contractor may have a surplus, or a paucity, of the required resources for the contract being tendered. Either situation will tend to influence how the contractor includes overhead and profit in his tender evaluation.
- *Perceptions of the client*: in some instances the contractor may consider some clients more desirable than others, or the contract may be for a client with whom the contractor has established an ongoing relationship, either formally or otherwise. In such cases, consideration of the client can be a factor in deciding the precise level of overhead and profit inclusion. This can sometimes also extend to consideration of the client's consultants or representatives for the contract.

If the contract requires overhead and profit to be included in the unit rates and prices the contractor will often 'spread' the calculated sums for these elements over the unit costs. This may, however, not be done evenly as the contractor may consider that there are advantages in adding a greater proportion to some elements rather than others. For instance, a greater proportion might be included on the rates and prices for work early in the contract period to assist in maximizing the contractor's cash flow. Alternatively a greater proportion might be added to elements that the contractor believes to be liable to increases in measurement when the work is undertaken. There are obvious dangers in such approaches and it is usually assumed that all unit rates and prices include an equal allowance for overheads and profit unless there is some requirement in the contract for different elements to be priced on different bases.

5.3 Subcontractor and supplier costs

The use of subcontractors is long established in the construction industry and in recent years the extent of work subcontracted by the main, or prime, contractor has increased considerably. At one time the common practice was for the main contractor to undertake much, if not all, the structural work with his own workforce and to sublet specialist works such as the mechanical, electrical, plumbing and roofing works, etc. to others. The increase in subcontracting means that it is now not uncommon to find the bulk of the works sublet, with the main contractor providing management and ancillary services and only undertaking minor works as part of the project.

There is nothing intrinsically wrong with a policy of subcontracting, and it can be supported on the grounds that increasing specialization, by having separate contractors for all the major trades and elements, brings greater efficiency. Many contracts place restrictions on the main contractor's ability to sublet the whole or parts of the works but this is outside the remit of this text and the discussion assumes that subcontracting is authorized. The effect of authorized subcontracting

does need some consideration when examining and analyzing the rates and prices in the contract.

5.3.1 Subcontractors

In most construction contracts there are two broad categories of subcontractor, the 'nominated' or 'named' subcontractor where some degree of selection is exercised by the employer and his representatives, and the 'domestic' subcontractor who is selected and controlled entirely by the main contractor.

Nominated or named subcontractors

Tenders for works by nominated subcontractors will usually be obtained by the employer's consultants and selection of the subcontractor to be employed will be made on behalf of the employer by his team. The contract will usually allow the main contractor to price a 'mark-up' on the subcontractor's price and to price any attendances or services required to be provided by the main contractor for the works of the subcontractor.

In the case of named subcontractors the main contractor will usually have to obtain tenders from a list of potential subcontractors included for the specific section of the works in the tender documentation. Once tenders are received they are treated as the main contractor's domestic subcontractors.

This process results in a reasonably transparent regime of pricing and, where appropriate, the subcontractor may provide a priced bill of quantities or schedule of rates. The unit prices so provided can then be analyzed and adjusted in much the same way as the rates and prices in the main contract, with the mark-up and attendances adjusted accordingly. Difficulties can arise if subcontract tenders are provided and accepted without sufficient breaking down of the total sums. See the following section on package equipment suppliers.

Similarly, when considering additional payments for matters such as extensions of time or breaches of the contract, the ability to assess the content of the measured element of the subcontract works will be vital as part of the analysis.

Domestic subcontractors

Under most forms of contract the domestic subcontractor, that is a subcontractor selected and controlled by the main contractor with only approval from the employer for the principle of subcontracting the work, performs the work as part of the main contractor's organisation and there is no separate consideration of the subcontractor by the employer. To all intents and purposes the subcontracted works remain those of the main contractor.

This does not pose any difficulty in principle as far as control of the works may be concerned but can create some tensions when considering the adjustment of unit rates and prices under the contract.

When tendering for the works the main contractor will usually obtain prices from potential subcontractors to use in compiling his tender. A common practice is for the subcontractor to provide a total price for the subcontract works, defined by extracts from the tender documentation, rather than submit detailed rates and prices in response to every enquiry. This practice is adopted to save abortive work in supplying detailed quotations for every enquiry when only a proportion will be successful and need the full detail of the pricing behind the total sum. Only when the main contractor has been advised his tender is under active consideration will he usually request a fully detailed quotation from the subcontractor. This practice may of course vary depending upon the type of contract and tendering process adopted for a particular project, and some contractors may insist on the return of fully detailed quotations from subcontractors on all occasions to minimize the possibility of errors or misunderstanding in the basis of the works priced.

There is of course scope for many variations on the above routine and the most complained of variation, by subcontractors, is that where a subcontractor's price is used by the main contractor in compiling a tender but, upon being advised that his tender is under consideration, the contractor invites further tenders from other potential subcontractors in the hope of finding a lower price than the one used in his tender calculations. Such situations sometimes result in what are known as 'reverse auctions' and there have been concerns that the increased use of tendering by electronic means might increase the incidence of such auctions. Alternatively the subcontractor whose price has been used may be asked for a discount on his price to ensure he is retained for the contract.

The above is, of necessity, only a very brief summary of some of the many vagaries of the tendering process but it serves to illustrate that the calculation of unit rates and prices for work which the main contractor anticipates being sublet will often be the result of a bidding process, rather than the detailed calculation and analysis of the appropriate rates by the main contractor. The result is that the main contractor may often not have a detailed analysis of the work content of unit rates for sublet works in terms of labor, material, plant and equipment, overheads and profit content. He will only know the relevant subcontract rate and how that compares with the rate in the main contract. The main contract rate itself might be based on a rate submitted earlier by the same or another subcontractor.

When adjusting unit rates and prices in the main contract, where a subcontractor executes the work, the correct approach is to treat the rates and prices as being

those of the main contractor and analyze them as such. Any regard to the subcontract rates and prices, if available, should be for information only and to assist with the analysis of the main contract rates as far as possible. However, the issue of ‘buying margins’, i.e. the difference between the prices in the contract and the amounts spent with subcontractors, may become relevant where cost-based claims for delay and disruption to the works are to be considered.

In practice the question of duplication of additions or allowances for overhead and profit may arise, with either two-stage mark-ups being requested to cater for the additions required by the main and subcontractor, or a larger than normal addition being requested to allow payment of the two from the one mark-up. It is implicit in the scheme of most standard construction contracts that such duplication should be avoided. The contract rates and prices apply to the works regardless of whether they are executed by the contractor’s own workforce or by subcontractors. Some *ad hoc* contracts expressly stipulate that only the main contractor’s costs will be taken into account in determining rates and prices, leaving the contractor to buy subcontract works within the rates and prices at his own risk. This probably does no more than make explicit what is implicit in other forms of contract but it is good practice to try to define terms so that grey areas of definition are not exploited by the unscrupulous or overlooked by the naïve.

5.3.2 Package equipment suppliers

One of the most difficult areas to address can be changes in package equipment provided as part of the contract works, where the rates and prices in the contract can be substantial lump sums with little or no breakdown of the sum against the component parts of the equipment, or the processes required to deliver it to the project. Such equipment as compression packages or chemical or water injection packages in the energy and process industries, and large heating and ventilation plant in the building industries, is usually obtained from specialist suppliers and subcontractors who may, or may not, be involved with the installation of the equipment on site, although it is very unusual for there not to be at least some involvement in commissioning the equipment.

Tenders are usually obtained from the supplier on the basis of specification.

This is either by reference to standard manufactured units produced by the supplier or by means of a performance specification setting out the input and output requirements for the package together with any other relevant matters such as environmental conditions and storage capacities, etc. The final price for the equipment can include a wide range of engineering, manufacturing and ancillary matters, including:

- Engineering design, either complete design or detailed design depending upon the circumstances of the particular equipment and order.
- Manufacture of the equipment at the supplier's works.
- Works testing of the equipment to ensure manufacturing defects are eliminated. This may be a supplier-only process or may involve the client's or third party inspection personnel.
- Dismantling of large equipment into component parts for transportation to site, often referred to as 'piece small' packaging for transport.
- Insurance of the equipment in transit. This may be on a number of different bases depending upon the terms of the order and may be at the cost of the contractor or client.
- Shipping and transportation. This may vary from a relatively simple journey for a lorry from the supplier's factory to the site, or may involve shipping by sea with road transport at either end. In extreme cases air transport may be required if timing is of the essence.
- Reassembly at site, if necessary, and installation into the permanent works.
- Testing and commissioning of the equipment in its final position. This may of course not be completed until other related works have been completed on the project.

It is not difficult to appreciate the difficulties that can arise if changes occur in the requirements for a piece of package equipment which incorporates all of the above, and possibly other items in the supply, without any breakdown or analysis of the price. This is further compounded if it is considered that the change may occur, not in the specification of a particular component in terms of 'omit type A and substitute type B', but in the performance specification of the equipment itself so that the parameters are changed without definition of the physical changes required to achieve the required effect.

If the change is particularized in terms of the former of the two possibilities above, i.e. the substitution of one component by another, then the process of evaluating the required adjustment to the price should be reasonably straightforward, colored only by the difficulty of establishing the reasonable cost of the omitted and substituted components if there is no market data for such items. In such circumstances the process of evaluation is often one of the supplier quoting his proposed prices and the reasonableness of those prices being assessed against an objective assessment of the relative changes in the component.

Sometimes the change may simply be in the size of a system or part of a system comprised within the equipment. In such circumstances it should be possible to make a reasoned assessment of the change based upon the price for the original equipment and any available comparisons, bearing in mind that the variation in price will usually not be in direct proportion to the change in size or capacity.

5. EVALUATION OF THE TIME CONSEQUENCES OF CHANGE

In Chapter 1, the following chain of analysis was discussed:

Duty – Breach – Cause – Effect – Damage

This sequence requires that the person making the claim must establish the *duty* that was owed by someone, usually under the contract, for, for instance, supplying information or issuing an instruction. They must then establish that the person who was under that duty was in *breach* of his duty by establishing in what way the duty was not performed, for instance not performed at all, or performed late, etc. The *cause* of the breach should be established, although in practice this may not be as easy as it at first might seem. For instance, if drawings are supplied late the recipient may not know for certain, or at all, why they are late. For the purposes of this text the *effect* is crucial as this is the detailed evidence of the consequences of the breach of duty.

From this it should be possible to establish the *damages* that have been incurred as a result of the breach. Typically the effects will be described as the changes in the contractor's purchases, resources and working methods, etc. experienced as a result of the breach with the damages being the financial consequences of such changes.

The causal link

It is central to any claim for additional payment that the breach complained of must have caused the loss claimed as damages. This seems a simple statement but in practical terms it causes many of the most difficult problems in construction contract claims.

In construction terms a similar analogy might be the late issue of foundation drawings on a contract where the contractor is subsequently late in constructing the foundations. If the contractor in fact could not obtain the plant for the foundation excavation until the day before he commenced the work, have the late drawing issues caused any delay? The question is 'but for the late drawings would the foundations have commenced on time? The answer on the above facts is no, and the late drawing issue therefore did not cause the delay.

There are therefore three potential tests:

- (1) The 'but for' test.
- (2) The pragmatic test.
- (3) The common sense test.

The factor most likely to cause complications in the assessment of causation is that of an act or event that intervenes, being the act of the claimant or a third party, and breaks the chain of causation. The courts have again adopted a common sense approach to the occurrence of intervening acts and events and will determine the issue on the facts of the case rather than by applying predetermined tests. In order to break the chain of causation the court will require something to have occurred that is ‘unreasonable or extraneous or extrinsic’ (*The Sivand* [1998] 2 Lloyds Rep 97 102).

In construction contracts there may be multiple, or even a multitude, of potential acts or events with impacts on the progress of the works. Some, or all, of these acts and events and their impacts may well occur simultaneously or in a manner causing overlap of events and impacts, commonly referred to as ‘concurrent delays’ in the context of the analysis of delaying events. In such circumstances it can be very difficult to determine which acts or events had crucial impacts, and which were secondary or inconsequential.

This has led to the production of various competing, or sometimes complementary, systems of analyzing events impacting on progress to determine the critical ones.

In October 2002 the Society of Construction Law (SCL) Delay and Disruption Protocol was published in order to review competing methods and provide guidance on suitable approaches to the required analysis.

The SCL Delay and Disruption Protocol

As this text is concerned with the evaluation of claims in quantum terms, rather than the establishment of liability, a discussion of many of the Protocol’s principles and recommendations is outside the boundaries of this book.

However, there are a number of issues directly affecting the assessment of quantum where the views expressed in the Protocol are very relevant, in particular in respect of the ‘core principles’ included in the Protocol in respect of ‘float’ in programmes and ‘concurrent delay’.

The Protocol states, in paragraph 8 of ‘Core Principles relating to Delay and Compensation’, that a contractor should be able to recover costs incurred as a result of an employer delay providing the employer delay prevents the contractor from completing the works by his planned completion date, even if this planned completion date is earlier than the contract completion date.

The Protocol qualifies this position by stating that the contractor’s intention to complete before the contract completion date should be known to the employer at the time the contract is entered into, and the intention must be realistic and

achievable. In essence the Protocol is stating that the contractor can suffer an employer delay, which, because of float in the programme, does not affect the completion date but still enables the contractor to recover any loss and expense incurred.

There are two points to be made in respect of this position as set out in the Protocol. Firstly, it is obviously correct that a contractor can suffer delay to various activities within a contract which, while that delay causes him to incur costs, the completion date is not affected because the affected activities are not on the critical path of activities for the project, i.e. they do not lie on the longest sequential path of activities through the project. If the employer causes such delay then, subject to any contract provisions, it is also obviously reasonable for the contractor to recover such losses.

However, the Protocol suggests that the same reasoning applies to employer delays that are critical, in that they extend the period for the execution of the works, but do not affect the completion date because of 'end float', i.e. float time between the contractor's intended completion of activities and the contract completion date. In such circumstances the quantum of the contractor's potential losses is likely to be greater as in the former case he would incur only costs related to the extension of the delayed activities but not to the management of the whole project, whereas in the latter case, where the effect is to extend the intended period of contract activities, then the contractor is likely to claim that he has had to retain the whole project management and support services for the period of the extended activities.

This raises the second point in the Protocol's position, the advisability of an employer entering into a contract in the knowledge that the contractor intends to complete the works prior to the contract completion date. In practice such a situation is unlikely to occur frequently as most employers require their contracts to be completed as soon as possible. If, for whatever reason, the employer is minded to enter into a contract in the knowledge that the contractor intends to complete his works before the contract completion date then it would be very prudent for the employer to provide in the contract for the eventuality that employer delays cause the contractor's works to be extended without affecting the completion date. In particular, the extent to which the contractor can recover project and off-site overheads in respect of such delays should be expressly provided for, as the absence of such provision is likely to result in disagreement and dispute if left for settlement after the event. The extent to which the contractor would incur costs in any event between the intended completion of his activities and the contract completion date would need to be considered as, subject to the provisions of the contract, it is likely that the contractor would still remain responsible for the works until the contract completion date, thereby incurring at

least some of the project costs in respect of such matters as insurances etc. In circumstances where the employer was not aware of the 'end float' the contractor would be deemed to have included his management and support costs for the full period of the project to the stated completion date.

In the absence of any express agreement or term in the contract the contractor would be most unlikely to recover his costs in such a situation.

Paragraph 10 of the Protocol 'Core Principles Relating to Delay and compensation' then goes on to consider the problem of concurrent delay and its effect on the contractor's entitlement to compensation for prolongation. This principle deals with the situation where the contractor incurs additional costs as a result of both employer delay and contractor delay, and states that the contractor should only be able to recover loss and expense to the extent that it is possible to identify costs incurred as a result of the employer delay separately from those caused by the contractor delay.

This is reasonably obvious and accords with recent pronouncements in the English courts where the principle that expense that would have been incurred in any event as a result of contractor delay cannot be recovered as a result of concurrent employer delay.

Prolongation

One of the most common claims in respect of construction contracts is that for additional payment as a result of delays to the contract works resulting in a delay to the contract completion date. There is a considerable volume of literature on the subject of how the entitlement to an extension to the time for completion might be established, and further guidance is available from the Society of Construction Law's Protocol on Delay and Disruption, but the aspect of interest here is the evaluation of the additional payment to be made once an entitlement has been established.

The mechanism of the ICE Conditions recognizes that an extension of time does not, of itself, necessarily incur any additional payment, but that the payment should be related to the circumstances that gave rise to the need to extend the completion date. This recognition, while not always explicit in contract terms and conditions, is very relevant to the assessment of additional prolongation payments in many instances.

The common approach by some contractors that an extension to the contract completion date automatically entitles them to an addition to the contract preliminaries charges, often claimed pro rata to the periods of the original contract

and the extension of time, is not realistic and is not generally supported by the standard forms of contract.

Time-related costs

Where time-related costs are relevant to the calculation of additional payments for an extension to the contract completion date there are a number of matters that need to be borne in mind when making the assessment:

- (1) Costs that are incurred because of the extension of the period of activities giving rise to the extension to the completion date should be distinguished, and separately identified, from costs that have been incurred due to the change in volumes of the work in the relevant activities.
- (2) The time at which the costs that form the claim for additional payment were incurred needs to be accurately identified. It is rare for the additional costs to be incurred wholly, or even at all, during the extended period of the contract, i.e. the period between the original contract completion date and the actual completion date. It is important to be able to identify the periods when the events occurred that gave rise to the extension of time, and base the assessment of additional payment on those periods. For instance, a completion date might be extended from 28 February to 21 March as a result of difficulties in early excavation works. The relevant period for the assessment of costs will be the period of the early excavation works and not the period between 28 February and 21 March.
- (3) Where the cost of plant and equipment are to be included, reasonable rates for externally hired equipment are easily dealt with by applying the hire rates incurred, provided they are not unreasonable. However, for owned, or 'internally hired' items, cost rates can be more difficult to establish. Generally, this should be in line with the discussion in Chapter 5. However, one or two authorities are worthy of consideration here and this now follows.

Additional activity costs

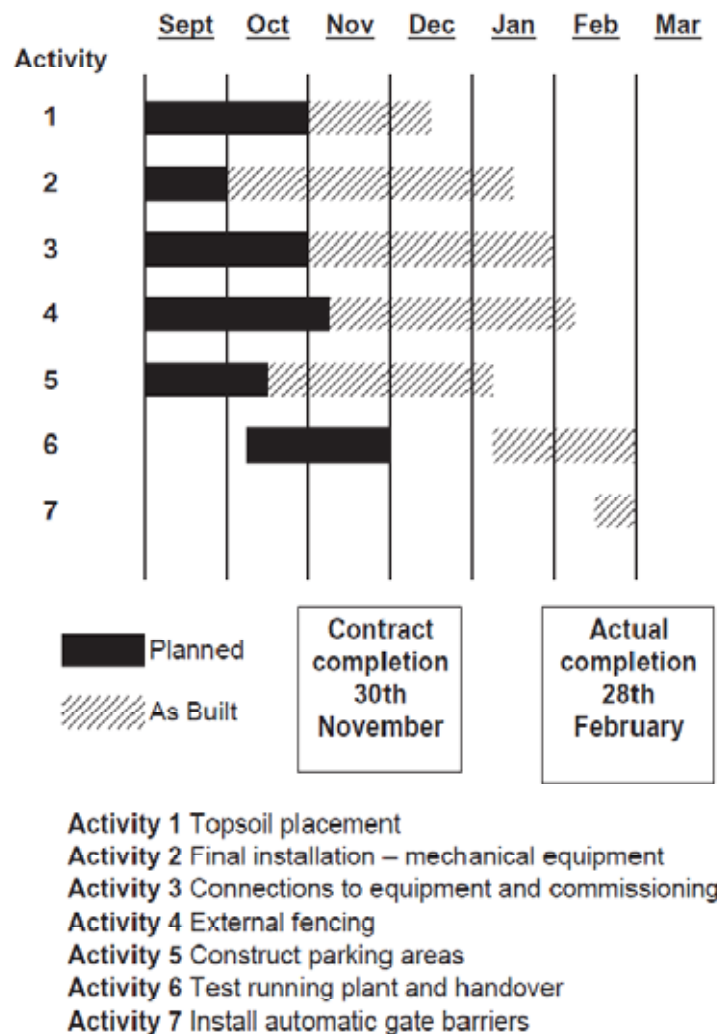
The crux of the quantum for time-related costs is generally the calculation of additional costs incurred as a result of the extension of time for activities affected by the events that give rise to entitlement. As mentioned above it is important that the costs are related to the relevant events, and most forms of contract will require that to be the case. However, there are two complicating factors that need to be carefully considered:

- (1) It may be that there are other activities being undertaken on site concurrently with the activities that are relevant for prolongation costs.

These activities may themselves have been delayed by matters for which the employer does not have responsibility under the terms of the contract, i.e. there could be concurrent delay as discussed in Chapter 3.

- (2) There may, in some instances, be costs incurred as a result of multiple events, the effects of which are not readily distinguishable, i.e. there could be a 'global' element of cost incurred as a result of these events.

The approach to claims which have a global element is often much misunderstood and the principles of this aspect are therefore discussed in greater detail later in this chapter. The practical approach to the quantification of such costs, and contractor concurrent delay costs and costs related to late instructions may however be demonstrated by taking a simple example, as illustrated by the sample programme chart excerpt in Figure 6.1.



In Figure 6.1, to illustrate the various matters that may arise in evaluating the costs of prolongation, it is assumed the seven activities have been delayed beyond the contract completion date of 30 November for the reasons shown below, resulting in an extended completion date of 28 February. The assumed entitlement under the contract for each activity is also explained.

- *Activity 1: Top soil placement and grading.* This has been delayed by earlier exceptionally inclement weather. This is a ground for an extension to the completion date under the contract, but without recompense of any additional costs incurred.
- *Activity 2: Final installation of mechanical equipment.* This has been delayed by the late receipt of performance data required from the employer. This is a ground for an extension to the completion date with compensation.
- *Activity 3: Electrical connections and mechanical commissioning.* This has been delayed as a result of the delay to the preceding activity (final installation of mechanical equipment).
- *Activity 4: External fencing.* This has been delayed by problems with the contractor's own subcontractor for which no extension of time or compensation is provided under the contract.
- *Activity 5: Construct parking areas.* This has been extended by a variation to the amount of parking space required, for which the contractor is entitled to an extension of time with compensation of additional cost.
- *Activity 6: Test run plant and handover.* This has been delayed because of the delays in the preceding Activities 1 to 5.
- *Activity 7: Install automatic gate barriers.* This is a late instruction issued and executed in February, for which the contractor is entitled to an extension of time with recompense of additional costs.

From the above it will appear that the contractor can expect an extension to the contract completion date to the actual completion date of 28 February, providing it can be shown that the extended periods of activities 2, 3 and 6 are the reasonable result of the matters for which the employer is liable without any compounding factors for which the contractor is responsible.

The extension of time in this instance would rely on the above activities, although there are concurrent delays to activities 1, 4, 5 and 7.

The delay to activity 1 is due to delays caused by exceptionally inclement weather, which it is stated above does not give any entitlement to recovery of costs. In setting out the quantum of a claim against the employer the contractor will therefore have to exclude any cost element relating to the plant, equipment and

labor engaged on this activity. He will also have to exclude the cost of any supervision time and ancillary costs in respect of this activity.

The same will apply to activity 4, as the delay in this case is one for which the contractor's subcontractor is liable. It is assumed that this creates no liability on the employer but whether the contractor is entitled to recover any additional costs he has incurred in respect of this activity from the subcontractor will depend upon the terms of the subcontract and the facts of the matter.

Activity 5 is a delay for which the contractor can recover costs although it is concurrent with other employer liability delays and is therefore not essential to the establishment of the extension to the contract completion date.

Activity 7 is similar to activity 5, the employer is liable and the contractor can recover related costs but the activity is not essential to the establishment of the extension of completion date entitlement. Had this item been the only one for which the employer was responsible, and all the other delays had been the contractor's responsibility, then it would have only established an entitlement to an extension of time to the contract completion date for the necessary period to execute the instruction for the new automatic barriers.

For instance, if the instruction, ordering, delivery and installation had all taken, say, five weeks without any undue procrastination on the part of the contractor, then the completion date of 30 November would have been extended by five weeks, plus any period required to cater for programmed holidays over the Christmas and New Year period. The fact that the instruction had in fact been issued in, say, mid February, would not entitle the contractor to calculate his additional time from that date under the 'dotting on' principle established in the case of *Balfour Beatty Building Ltd v. Chestermount Properties Ltd* (1993) 62 BLR 12.

The type of costs that may be recovered in respect of the activity delays in addition to the contractor's management costs and overhead charges for the appropriate period of the prolongation, where these are the employer's liability, will include the following if they pass the testing discussed earlier, i.e. they would not have been incurred 'but for' the cause of delay cited.

Activity 2: Final installation of mechanical equipment

- Any increase in the supplied cost of the equipment caused by the delay. For instance, if ordering and delivery of some equipment is delayed until after an annual revision of prices by the supplier, where the equipment would have been ordered and supplied before such a price rise without the information delay, then the increase in the price will be recoverable.

- It is possible that the total period of installation may have had to be undertaken over an extended, as well as delayed, period thereby causing a reduction in productivity for the labor engaged on the activity. It will be necessary to show that no alternative work could have reasonably been used to fill any gaps but in principle the reduction in productivity caused by an extended period will be recoverable.
- If the delay to the activity necessitates undertaking work after wage rates have been increased, where they would have been undertaken prior to such increases without the delay, then the net cost of such increases will be recoverable.
- Any increased delivery or transport costs incurred because equipment is delivered later or in smaller shipments than would otherwise have been the case will also be recoverable.
- If it is necessary to retain specific supervision for this activity on site for the extended period then the additional cost of that supervision will be recoverable. In this instance it may be that a site mechanical engineer, or engineers, was based on site for the purpose of supervising the installation of the equipment. If so, the net employment cost will be recoverable.

Activity 3: Electrical connections and mechanical commissioning

- The same sort of factors as were considered for activity 2 will need to be reviewed but in addition there may be a site electrical engineer, or engineers, retained by the delay to this activity and, if so, that cost will also be recoverable.

Activity 5: Construct parking areas

- This delay is caused by an increase in the scope of the activity as a result of an instruction for additional parking areas. If it is assumed that the additional work is paid for under the contract at the contract rates then it is possible that all additional activity costs are recovered through the contract variation provisions. However, the matters of supervision and engineering, for instance the involvement of setting out engineers, may need to be considered if these are not covered by the measured rates.

Activity 6: Test run plant and handover

- This has been delayed due to the late running preceding activities. As the activity has been 'shunted' rather than extended it is unlikely that reductions in productivity levels will be relevant. However, the retention of the mechanical and electrical engineer(s) on site for further extended periods will probably generate further recoverable costs.

Activity 7: Install automatic gate barriers

- It is assumed that the cost of this activity will be recovered under the contract variation provisions.
- However, it is possible that some site supervision for the labor engaged on this activity might have been retained on site after the completion of the preceding activities and may not be covered by the calculations of recovery under the variation provisions. If so, the cost of that supervision will be recoverable in addition.

It is not possible to set out an exhaustive list of items that may be relevant to calculation of additional activity costs as these will vary depending upon the terms of the particular contract, the contract pricing and variation valuation rules and the particular circumstances on site. There are, however, some common topics that need to be considered further.

Establishing reductions in productivity

This is one of the perennially difficult issues to face anyone undertaking the quantification of claims on construction contracts and is considered in some detail in the section on the costing of disruption later in this chapter.

Off-site overheads and costs

This is also a topic that is often subject to a wide range of opinion and approaches and it is also considered in detail, with a separate section on formula approaches to this subject, later in this chapter.

Costs of holidays encountered as a result of prolongation

In the example considered above the contract completion date was extended from 30 November to 28 February, thereby extending the period of the works through the holiday period of Christmas and the New Year. As the building and civil engineering industries now generally close down for a two week holiday during this period, with notable exceptions where the holiday period is used as the reason to undertake work, for instance on the railways, it is almost certain that such an extension of time would result in the contractor's incurring costs in respect of the holiday period.

Where the contractor incurs such costs in retaining staff and supervision for the activities that have been extended for reasons that are the employer's responsibility he will, subject to the terms of the contract, be entitled to recovery of those costs. However, a doubt may arise where the activities are those, such as activity 5 'construction of parking areas' in the above example, which have been valued under the contract variation valuation rules.

Recovery of costs for general site management and support

An often vexed question arises as to the extent to which the contractor can recover the costs of the general management of the site, and the general site facilities such as temporary offices, stores, general transport, etc. The approach often adopted by contractors in the past was simply to calculate the cost of these items per week by dividing the contract sums for their provision by the contract period, and then to multiply that sum by the period of the extension to the completion date sought or granted. This approach is flawed under most of the standard forms of contract, as these allow the contractor to recover the actual cost or loss incurred as a result of delays for which the employer has responsibility but not for those that are the contractor's liability.

In the sample programme used to illustrate these points, activity 1 is a delay for which an extension of time is available but without recompense of additional cost. The contractor would therefore have to accept not only the additional activity costs for this delay but also accept the additional general subcontractor to activity 4, for which it is assumed no liability falls on the employer, extends the period of the contractor's responsibility for delay to early February. The contractor will therefore only be able to recover additional cost or loss for general management and site set-up for the period after the conclusion of activity 4 in early February until the actual completion of the works on the extended date of 28 February.

In all the above comment it should be borne in mind that the sample programme is a simple graphical illustration of how some apparent problems may arise in the establishment of quantum for an extension to the contract completion date. In practice the issues on a major contract may be much more complex and delays resulting in extensions to the programme may well have occurred throughout the programme rather than simply in the final activities used to illustrate the points. The only way to resolve such issues is the adoption of careful and well researched delay analysis based on methodologies such as those set out in the Society of Construction Law Protocol on Delay and Disruption.

6.2.2 Loss of profit and opportunity costs

The treatment of overheads and profit in assessing payments for extensions to the contract period are considered later in this chapter but it is often the case that contractors will wish to include in their assessment of costs to be claimed in such circumstances a sum for 'loss of profit' arising from diminution of turnover as a result of the extended contract period. The basis for such a claim is that the contract income has been spread over a longer period thereby reducing his return from the project. Whether this is in fact so will need to be established on the facts of each particular case, taking into account the additional revenue generated by the

events giving rise to the extended contract period, and any other sums paid in addition to the original contract sum. For such a claim to succeed the contractor will need to demonstrate that, at the time the turnover was reduced, he could have used the income profitably. The claim would not necessarily fail because the contract on which the turnover reduction was experienced was not profitable, but the contractor will need to show what he would have done with the lost income.

It is possible that, even if the contractor's business was making a loss at the time the turnover reduction occurred; such a claim might still be viable if it is possible to demonstrate that the reduction in turnover increased the loss made by the business.

6.2.3 Liquidated and ascertained damages

Most standard, and many non-standard, forms of contract for construction works include a provision for the deduction of damages at a preset rate if the contract completion date is not met. The rate is usually set at an amount per day or week, with provision for weekly rates to apply to 'parts thereof'. The expression 'liquidated' simply means that the rate is fixed and agreed.

The deduction of liquidated damages will usually occur when the contractor has failed to complete by the contract completion date, or any authorized extension to that date, and the period of the overrun beyond the contract date is not covered by any granted extension of time. In most instances the liquidated damages will be an exhaustive remedy, i.e. they will be the total of the amount that the employer is entitled to deduct as compensation for the late completion of the contract.

The rate is intended to be an estimate of the loss that would be suffered by the employer in the event that completion of the works is delayed. The practical problem with this situation is that in many instances the damages, rather than being an excessive amount, are in fact often only a portion of the loss likely to be suffered as a result of late completion. The reason is simply that a proper estimate of the likely loss would result in such a high rate of damages that contractors would not accept it as part of the contract. For the same reason some contracts, particularly in the heavy mechanical and process industries, include a cap on the total amount of damages that may be deducted for unauthorized delay.

It is important that the contract clearly defines the date from which the damages are to be calculated, and any provisions for adjustments to that date. If the contract has provisions for the contract to be completed in parts or sections then the amount of damages relating to each part, and the dates from which damages commence for each part or section, also need to be clearly defined.

Duplication of recovery

Whenever costs are being assessed for additional payments as a consequence of prolongation of the works, or as a result of disruption to the progress of the works, it is essential that the evaluation takes into account any duplication of the sums to be paid with other amounts that may have been recovered elsewhere in the contract final account through variation payments and daywork accounts, etc.

The obvious areas where such duplication might occur are in the amounts paid for supervision, management costs, preliminaries items and head office charges. In particular the following areas of potential duplication should be addressed:

- The inclusion of supervision and/or management and head office costs in the labor, or other, rates used to price variations on a cost basis.
- Similar inclusions in the measured unit rates used to price variations on a measure and value basis under the contract valuation rules.
- The inclusion of additional preliminaries items in the variation account where such adjustments are allowed by the contract valuation rules, e.g. JCT Standard Form 1998 clause 13.5.3.3.
- The inclusion of supervision, management, head office and other charges in the additions to prime cost allowed under the contract for works executed on a daywork basis.

The extent of inclusion in the measured rates of labor, plant and materials rates used in a variation account for supervision etc. may be defined by the rules of measurement adopted for the particular contract or by the contract conditions themselves. For instance the Standard Method of Measurement of Building Works, seventh edition, includes in its General Rules at item 4.6 a statement of what is deemed to be included in each measured item, including labor and all costs in connection with labor, and establishment charges, overhead charges and profit.

The problem that can arise in practice is determining the extent and level of inclusion of supervision in measured rates or labor rates. As previously mentioned, it is common practice for contractors to include only working supervision, i.e. working foremen and gangers, etc., in such rates and to price the general site management and engineers, etc. in the preliminaries section.

Only a careful analysis of the rates will establish the extent of inclusion, but in many instances this duplication will be significant, particularly where the reason for any prolongation or disruption is the occurrence of substantial additions and/or variations to the works.

6.3 Disruption

Disruption may be part of a claim for prolongation costs, or may occur where there is no extension to the overall contract period. The term ‘disruption’ generally infers that the contractor’s intended sequence and/or duration of construction activities have been rendered impossible, wholly or in part, by extraneous factors such that it has incurred loss of productivity of labor, and/or plant and/or supervision. Whether such factors are also relevant to the consideration of prolongation will depend on individual circumstances, and the relation of the affected activities to the critical path through the project programme.

The quantification of losses resulting from disruption to the contractor’s works is possibly the most difficult area for anyone engaged in clearly identifying any additional payment that might be due. Before considering the often thorny issue of how to deal with disruption and to evaluate its financial consequences, it may be worth pausing to consider the dictionary definitions of the word ‘disruption’. Typical definitions are as follows:

- ‘To throw into turmoil or disorder’
- ‘To interrupt the progress of’
- ‘To break or split apart’.

Such dictionary definitions give a key to the issues that have to be considered in evaluating the financial consequences of disruption.

The difficulties faced when dealing with disruption claims, whether for the party making the claim or the party receiving and reviewing the claim, include the following:

- Establishing cause and effect.
- Allocation of losses to causes.
- The keeping of records.
- Multiple causes particularly where also involving mixed liability.
- Subcontracting and particularly its effects upon:
 - The extent of records available.
 - The effect on the level of sophistication of the records.
 - The question of whether sums have been paid reasonably.
 - The relative ease with which subcontractors can sometimes obtain money for disruption through the use of adjudication.

It is often the case that claims for disruption are made and considered without due consideration of the contract and the legal basis upon which the claim should be considered. In this regard, there are several alternatives.

In making a claim for disruption a claimant needs to satisfy certain basic principles. Firstly he has the burden of proof to establish the following:

- That an event entitling him to make a claim for disruption, be it either a 'relevant matter' under the express provisions of the contract and/or a breach of contract, has occurred.
- That the party against whom he is making the claim is factually liable for that event.
- That the party against whom he is making the claim is legally liable for that event.
- That the event has caused him to incur loss.
- The quantum of the loss.

Furthermore, the recipient of the claim must be made aware of the case against him in sufficient detail and clarity so as to enable him to respond to that claim. The burden involved in satisfying these requirements can be particularly burdensome when trying to evaluate disruption claims.

Disruption to the contractor's works may arise from a number of sources, including the impact of:

- Ordered variations to the quantity or specification of the original works.
- Ordered additions or omissions to the scope of the works.
- Late information being supplied to the contractor from the design team or specialists.
- Unforeseen physical conditions or obstructions on the site.
- Exceptionally inclement weather.
- Strikes, lockouts, civil disorder or war, etc.
- Difficulties or delays in obtaining the required labor, plant and/or materials.
- Delays by subcontractors, whether nominated, named or domestic.
- The opening up of works for inspection.

This list is not exhaustive but gives the prime examples of the potential sources of disruption to the works, and it is not difficult to see that in most contracts some of these causes will be the contractor's liability while others will be the employer's. Where a number of causes occur on a project, with a mix of liability between the contractor and employer, it is not difficult to anticipate the source of problems in accurately separating and identifying the effects of the various causes. Such situations are common on major projects.

The situation is further complicated when one considers that the effects of the various causes of disruption may manifest themselves in different ways, for instance the effect of any of the above potential causes may be to:

- Require the whole, or a section, of the works to be temporarily suspended.
- Result in a reduction in labor productivity for a section or the whole works.
- Result in certain activities having to be completed on an intermittent basis rather than on a continuous working basis.
- Require the contractor to change the intended sequences of operations and activities for the works.
- Require return visits to working areas to carry out and complete activities.
- Lead to stacking of trades involving increased concurrent working and congestion of working areas.
- Result in restricted access to work areas.
- Create uncertainty as to the scope and detail of work to be carried out.
- Require the contractor to extend his working hours.
- Require the contractor to increase resources, be they labor, plant or supervision resources.
- Lead to changes in personnel.
- Result in work being carried out under different environmental and weather conditions to those planned and priced for.
- Cause a combination of the above effects.

If multiple causes result in multiple effects the compounding factor at work on the site organisation and efficiency can readily be imagined. The difficulty lies in applying some degree of reasonable analysis and calculation to the process so as to allow the effects to be identified to the causes with a degree of reliability, employing logical testing such as the ‘but for’ and pragmatic approaches considered earlier.

There may be instances where the separation of effects is totally impossible, resulting in the desire to produce a ‘composite’ or ‘global’ claim, i.e. one where the effects are not identified to individual causes. Such claims have caused no small degree of controversy in the past and the subject is therefore dealt with in some detail later in this chapter.

6.3.1 Direct costs

There are various potential methods for evaluating the loss of productivity associated with disruption. The method, or methods, adopted depend on such issues as the documentation available, the stage at which the evaluation is attempted and even express agreement within the contract as to how such evaluation is to be carried out. Thus, for example, it has been noted above how the variations clauses of certain construction contracts provide provisions under which disruption might, in certain circumstances, be valued as part of the variation. In addition to the potential benefits of valuing disruption through adjustment for

variations, due to the less contentious nature of this approach, it also has a potential benefit in the ease with which the valuation can be made. Variations, including where appropriate the effects of disruption, fall generally to be valued on a 'value' basis, that is generally by reference to prices already set and agreed in the contract, for example the bills of quantities. Thus, for example, a variation that is reasonably assessed as making an activity 50% more difficult to carry out could be the subject of a 50% pro rata adjustment to elements such as labor and plant costs of the allowances in the bills of quantities rates. Clearly such an approach, if it gives rise to a reasonable valuation as required by the express clause of the contract, can make valuation much simpler. The need to establish actual costs, expense or loss, with the all too common difficulties of records and allocation, can be avoided. Of course this is only if the circumstances and provisions of the contract make such a value-based approach applicable.

However, where there is a need to evaluate disruption claims other than by value, evaluation methods usually require one or a combination of following:

- Record sheets.
- Witness statements.
- Measured mile comparisons.
- Planned against actual comparisons.
- The application of disruption factors.

The direct costs incurred as a result of disruption are the labor, plant, materials and on-site supervision and support costs caused by the factors considered above but not covered by the valuation of the work at the contract rates and prices. These are the same items as were considered in the context of unit rates for the work and the same basic considerations apply.

The starting point for any such assessment of additional cost is often the contractor's tender calculations, with the intention of demonstrating that the disrupting factors have caused the contractor to incur costs at levels greater than those anticipated in the tender calculations and thereby incorporated in the contract price. At its extreme this method of assessment merely presents the contractor's actual cost for items that are alleged to have been subject to the effects of disruption, and then deducts the relevant tender or final account sums. This is often referred to as the 'costs less receipts' approach, for the obvious reason that the contractor is attempting to recover all his costs in excess of the sums received through the contract.

The potential problem of using the contractor's tender calculations as the starting point for the assessment of additional costs was discussed in Chapter 4, and it is the reasonable costs that would have been included in the tender by a competent experienced contractor and incorporated in the unit rates and prices for the works based on the full import of the contract documentation at time of tender that should provide a starting point. The assessment of additional cost must be capable of demonstrating that it is not allowing the contractor to recover inadequacies in the tender calculations as part of the process, or to recover costs incurred as a result of factors outside the claimed cause(s). If the actual tender calculations are adopted it should be with the proviso that it is possible to demonstrate that they meet the competent contractor test described above.

Records-based analysis

The preferred method of productivity analysis should be a records-based approach relying on factual analysis. Such an approach requires the keeping of contemporaneous records as discussed in Chapter 5. The records need to be concurrent with the event and meet any specified requirements of the contractor, engineer or architect where appropriate. Where records are being kept as requested by the contractor, engineer or architect, or other contract administrator, they should be verified and signed by them, or their appointed representative, as appropriate. Such agreement of records does not of course signify acceptance of liability but reduces the scope for future dispute when trying to agree the implications and financial consequences of the recorded work.

The 'measured mile'

One of the most effective means of demonstrating the outputs that should be achievable and that those levels of productivity are compatible with the forecasts and assumptions in the tendered unit rates and prices for labor or plant and equipment, is that of the 'measured mile' approach. The 'measured mile' is simply a section of the work, similar or identical to that which it is claimed has suffered disruption, which has been undertaken and recorded under the contract conditions, i.e. without the effect of the alleged disrupting events. This division of the work into disrupted and undisrupted parts for comparison can be carried out on a location or time period basis.

Examples by location might be chainage or embedded structure on a roads project or by floor of a building or individual property on housing projects.

Division by time period might be monthly or before or after a particular date, or between dates. The choice between these alternatives will depend on how the disruption has impacted the project (for example has it hit some apartments but not

others?) and how records have been kept (for example is it possible to separate out resources by apartment?). If comprehensive and detailed allocation records are available, then comparison by location should be possible. However, it often happens that they are not. One advantage of comparison by time is that they can more often be detailed, by reference to interim valuations and cost reports.

While this may be the ideal, it may well be that the impact of the alleged causes of the disruption affected all the relevant activities throughout their duration and so the possibility of an undisrupted 'test' section of work does not occur.

If the 'measured mile' approach is feasible and there are sections of work unaffected by the alleged causes of disruption then much will depend upon the quality of records kept of the undisrupted work. It is not uncommon to find that, once causes of disruption have been identified, the contractor has instituted a system of record keeping providing comprehensive records of the circumstances and resources utilized on the disrupted work. Certainly, if the contractor does not institute such a record-keeping regime his omission may seriously prejudice his prospects of compiling a viable claim for compensation.

In contrast, records of work not subject to the alleged disruption factors may not have such good records. The prime reason for this difference is usually one of chronology. The undisrupted work often proceeds ahead of the incidence of the disrupting factors and therefore at a period when the potential requirement for detailed records is not appreciated or anticipated.

If, as sometimes happens, the disrupted work occurs at an earlier time than the undisrupted work, for instance when the cause of the disruption is overcome thereby removing the impact on the relevant activities, then the later work can be recorded and used to demonstrate what should have been possible had the earlier disruption not occurred. The obvious danger that needs to be considered in such circumstances is that the contractor may attempt to achieve exceptional outputs on the later undisrupted work in order to inflate the difference in output with the earlier disrupted section of work. Only an objective examination of the work methods and resources will be able to determine if such exaggeration of the output difference has in fact occurred.

Where a 'measured mile' comparison is possible it will be essential that like is compared with like, and any irrelevant influences having an impact on one section of work and not the other are identified and their impact removed, for example, where the compared sections are separated by time periods, that one section was carried out in a period of less clement weather conditions. Another factor might be comparison with a period affected by 'the learning curve'. If it is not possible to remove any such imbalance in the circumstances of the compared sections, the

'measured mile' will not be appropriate as an approach to establishing the extent of disruption and the compensation applicable. The sections need to be representative and particularly should be large enough to ensure that a meaningful comparison is being made.

Measured mile calculations are usually carried out by converting the comparative periods' disrupted and undisrupted productivities into units. These can include:

- Earned value achieved per pound spent.
- Earned value achieved per labor hour expended.
- Earned value achieved per plant hour expended.
- Quantity achieved per pound spent.
- Quantity achieved per labor hour expended.
- Quantity achieved per plant hour expended.

A simple example of a comparison might be:

Concrete gang recorded as placing 310 m ³ per working week prior to disruption	
Cost of concrete gang per week	£2,000.00
Cost per m ³ placed	£6.45
Output during disrupted period 260 m ³ per working week	
Cost per m ³	£7.69

The cost of disruption to the concrete gang is therefore an apparent increase in the labor cost of concrete placed during the disrupted phase of working of £1.24 per m₃. Further adjustments may be necessary for the plant and equipment elements of the operation.

There are, however, two aspects of this calculation that often cause some difficulty:

- (1) What if it can be established that the contractor had allowed in his tender for different levels of productivity to that established by the 'measured mile' recorded pre-disruption, either higher or lower? For example the contractor's pricing might have been based on 290 or 350 m₃ per week per gang rather than the 310 actual performance recorded by the 'measured mile'. The answer has to be that it is the effect on the contractor's actual operation that is measurable and is to be compensated. If the contractor had priced for a higher output than that demonstrated by the 'measured mile' he has to stand the loss represented by that difference as an estimating or tendering error. If he had anticipated a lower output than was being

achieved in the 'measured mile' he should not be penalized by having the tender output substituted for the measured mile output. The contractor is entitled to be put back in the position he would have been in but for the disruption.

- (2) The other, sometimes controversial, aspect of such calculations is that where the engineer or architect, or their representatives, allege that the contractor has not overcome the disrupting factors as well as they might or have been inefficient in their working. The response to such objections has to be that, providing the contractor has not demonstrated incompetence or taken measures that no reasonable contractor would contemplate, it is not reasonable to object to actual performance in the light of difficulties that are not the liability of the contractor.

Calculating productivity

Earned value is a crude means of assessing the productivity of a resource such as site labor. If at tender stage it is anticipated that, for particular operations that are the subject of discussion, 12 000 man-hours of labor resource are anticipated to be required, and the value of the particular operations at the tender prices is, say, £725,000 then a crude assessment of the value earned by each man-hour expended is:

$$£725,000/12\ 000\ \text{hours} = £60.42\ \text{per hour}$$

There are, however, some difficulties with such a crude indicator of productivity. Firstly, it takes no account of the mix of trades and labor input in the 12 000 hours. Secondly, it takes no account of the impact of the cost of plant, equipment and materials for the permanent works in the value of £725,000.

It is not difficult to anticipate that differences in the labor mix, plant and equipment input or the value of materials for the permanent works could quickly distort such an analysis when it is rerun with the site labor hours and valuation figures to produce a comparable earned value figure for the actual work.

For instance, the actual site hours for the operations being analyzed may be 14 260 and the value earned as included in the final account £683,000. This would indicate an earned value for each hour spent on these operations on site of:

$$£683,000/14\ 260 = £47.90\ \text{per hour}$$

In this case the earned value per hour is apparently some 20.72% less than anticipated at the time of tender. The calculation could, however, ignore the impact of, for instance, the contractor's using a greater proportion of unskilled, or semi-skilled, labor in the site workforce than anticipated at the time of tender. This may have a potential impact both on the average cost per hour of the employed labor

and on the output that could be anticipated in any event, although this might not necessarily be so depending upon the circumstances of the particular work being analyzed.

Similarly, variations in the composition of the value side of the analysis, such as instructions from the employer, or the remeasurement of the actual work against the tender anticipation, will potentially distort the analysis.

The sensible conclusion is that methods such as earned value can usually only be regarded as 'broad brush' approaches.

This is not to say that techniques such as the earned value analysis should be totally discarded as they may be useful as an indicator of potential problem areas. However, there has to be a means of addressing the impact of resources, but that impact has to be addressed in a manner that allows a true comparison, with any distorting factors taken out, so that like can be compared with like.

Factors affecting productivity

In assessing the disruption that has been caused to labor, a common historical approach was to take the total labor cost and apply an assessment, for example that 'say 25% was lost due to disruption'. Such a broad and global assessment is unlikely to stand scrutiny. It has been explained above how loss of productivity can arise out of disruption through a number of effects.

One way to apply some degree of calculation to the resulting lost productivity is to apply factors assessed as reasonable for such effects, taking each in turn. This at least adds some particularization and science to what otherwise may be far too broad a calculation to stand scrutiny. These factors might be applied in a 'bottom up' approach to the evaluation of disruption (see below) and particularly where disruption is calculated on a 'value' basis as part of the valuation of variations (see above).

Excessive overtime etc.

The cost of overtime working can be calculated from the nationally agreed rates of payment for construction operatives, and the non-productive element, i.e. the additional cost of working at premium overtime rates, as opposed to the plain time 'ordinary hours' working, can be separated from the total cost.

The assumption is that there is no additional production achieved for this non-productive element of payment and this is usually a reasonable assumption.

Indeed it can be argued that where substantial overtime working is introduced the output during the 'plain time' working hours may also be reduced due to the increased demands on the workforce. In practice it is often difficult, if not

impossible, to identify such an effect separately to the effects of the disruption alleged to be affecting the work in question. But the effect may be demonstrable in circumstances where substantial additional shifts, or six- or seven-day working in lieu of five-day working, are introduced.

This area of the effect of overtime working on productivity on construction sites is one that has particularly been the subject of statistical analyses dating back over the last 30 years. These studies consider such factors as working of longer days, weekends and the cumulative impact of these over a number of weeks. The statistics derived from such analyses are often combined with the direct cost of the premium overtime rates paid to calculate an overall effect of working overtime. That overtime might, for example, be claimed to be the result of instructed or induced acceleration, or the result of the contractor's need to mitigate his own delays. Thus contractors' calculations can be made to show that the combined effect of premium time payments and inefficiency said to result from the working of a ten-hour seven-day week is a combined loss of 50%. Alternatively, from an employer's viewpoint, if it can be shown that the working of overtime was not a matter for which it was responsible, then part of a larger loss said to have been caused by several disruption factors might be extracted based upon statistics for that level of overtime working. In this regard claims made by contractors that they have been instructed or induced to accelerate are often, at least in part, countered by evidence that the contractor actually always planned to work a degree of overtime, or that whether it was planned and priced for or not, his original programme and resources would have always required it. Alternatively, the overtime was being worked already, even before acceleration was allegedly instructed or induced. Such issues need careful consideration of the facts in each case as well as consideration of the appropriateness and use of such statistical studies.

Introduction of additional resources

The difficulty with the introduction of additional resources into a calculation for compensation for disruption is that the reasonable assertion can be made that additional resources will be productive at the same level as the tendered resources and so will be compensated by payment for the work executed at the contract rates.

The counter to this argument is the obvious one of the law of diminishing returns, i.e. if you increase labor resources beyond the optimum level for any particular operation then those resources will be productive at a rate that decreases as the resource is increased. There is usually a minimum, maximum and optimum range of resources for the project works bearing in mind all the constraints placed on any particular contract. Increases above, and decreases below, the optimum will affect

productivity levels and as the maximum is approached the problems of congestion and servicing of a workforce at the upper end of the usable range will usually mean that production levels reduce. This almost inevitably will lead to discussion of the tender resource level, the optimum level required and the extent to which the additional resource has been effective and productive. It is not unusual to find that such discussions are centered around analysis of labor productivity based on 'earned value'.

This is another area that has been the subject of a number of statistical analyses in the last few decades. These analyses consider not only such factors as overmanning and undermanning against optimum gang sizes, but also the effect of site congestion and overcrowding. Changes in gang size, congestion and overcrowding can be the result not only of the introduction Evaluation of the time consequences of change 209 of additional resources but also increases in the overlapping of work and trades due to delays to some early activities.

Again such statistical analyses need careful use, to establish that they are appropriate, relevant and suitably applied. Similarly, the same considerations of contractual responsibility for the effects of additional resources apply, as applied to overtime working considered above. To what extent was the introduction of additional resources or overcrowding the responsibility both actually and contractually of either of the parties?

Changes in the labor or plant mix

As is apparent from the above discussion on the use of 'earned value' calculations to assess changes in productivity, and the impact of introducing additional resources, it is always necessary when comparing outputs and productivity to ensure that the comparison is being made on a like-for-like basis. Any changes in the make-up of resources between one side of the analysis and the other have the potential to distort the end result. For this reason the approach may sometimes be amended to one of 'earned value per pound spent' rather than 'earned value per man-hour (or machine hour if appropriate). The reasoning behind this approach is to convert the analysis to one of determining how much is earned for each pound spent in the expectation that the amount spent will reflect the level of competence of the resource in terms of the tradesmen/laborer mix. This may cater for some of the distortion that can arise from any changes in the mix of labor (or plant) hours between the starting point and the actual, but considerations of how reasonable the starting point is will still be appropriate and necessary.

Condensing of activities

One of the commonly claimed effects of disruption is the condensing of activities into a shorter time frame. This may be particularly relevant to activities that are not themselves affected by the causes of the disruption but have their start delayed by disruption to preceding activities. In planning terms, the effect is to delay the activity start but with either no corresponding delay to the activity completion or a completion delay of less than that which is applicable to the start.

The effects of such a condensing of activity may commonly include:

- The working of overtime at premium costs to increase the productivity per day, or shift, of the site workforce, or
- The introduction of additional resources to enable completion of the work within the shorter time frame.

Whatever approach is adopted the costs will need to be identified as discussed above and related to the relevant activity and its relationship to the disrupted work. The evaluation of such costs is no different in practice to the evaluation of acceleration generally, as that is in effect what is being achieved. The quantification of acceleration is considered later in section 6.4.

Resequencing activities

As an alternative to condensing activities, or as part of a wider scheme of reorganization to overcome disruption, there may be a need to reconsider the contract programme and replan the sequence of operations and activities to the project completion. In such situations programmed activities may be moved in time without their duration being affected, i.e. they are 'shunted' to a later date to avoid the impact of disrupting factors that may otherwise affect them. Alternatively they may be moved in the sequence of activities and also have their duration changed in the interest of achieving the same, or another agreed, completion date.

In such situations it is necessary to identify separately, as far as possible, the effects of the 'shunting' and the effects of any change in the duration.

Generally the 'shunting' of activities may result in work being increased in cost for factors such as:

- Rates of payment to labor increasing between the original period and the 'shunted' period.
- Work being undertaken in less (or more!) favorable conditions than would have been the case had the original period been maintained. For instance, excavation

work originally planned for August/September but shunted to November/December will suffer both the impact of less favorable weather conditions (on average) and the impact of shorter working days unless measures are introduced to enable work to continue after dark, presumably at additional cost. The effects of weather conditions are considered further below.

- The cost of holiday periods may be encountered in activities that would otherwise not have been so affected. In the above example of excavation work shunted to November/December, the cost of the Christmas/New Year holiday may have been relevant if the shunting had been to December/January.

Whatever the effects on a particular activity the costs will have to be identified to the activity and related to the shunting and/or change of period so that the chain of cause and effect is maintained as far as possible.

Breaks in continuity

It is obvious that if a contractor's continuity of working is broken and he has to pause or even cease activity in an area, and even relocate to another area, returning later, then productivity will be lost. The records-based approach described above is most useful for such breaks in continuity if records are kept contemporaneously. However, where they are not then some method of evaluation is required. In either event, the effect of the learning curve, as an area is returned to and labor has to refamiliarize with the state of progress it was left in and even carry out additional preparation work, should not be ignored. It is likely that a break in activity for a defined period will lead to a loss of productivity of somewhat more than the duration of that break. There are some statistical studies that are available purporting to set out the effect on a whole working day of breaks of different durations in that day. As with all such studies these have to be used with care, if at all.

A common approach on projects that are particularly the subject of breaks in continuity is to set these out in the form of as built programmes with broken activity bars to show periods of activity and inactivity in a particular location. Periods for relocation in each break can then be assessed and added up. To be deducted, however, is the extent of revisits that may have been required in any event. Also essential is of course to establish that the extent of breaks is the result of the disruption said to have been imposed, and not some failure by the contractor himself to manage the works efficiently.

Weather conditions

Depending upon the activities being carried out, different weather conditions (and therefore changes in weather conditions) can have a significant effect on

construction outputs. It has been noted elsewhere in this book that ‘exceptional’ weather conditions are a matter that usually gives rise to an entitlement to extension of time, but not to the reimbursement of associated costs. However, such ‘cost neutral’ weather events are not to be confused with the effects of weather conditions that have only been experienced due to other causes. It has been explained above how the resequencing of activities can lead to work being undertaken in less (or more) favorable conditions than would otherwise have been the case. Alternatively, work can be moved into periods of different conditions by earlier delays, and where those earlier delays are the responsibility of the other contracting party there may be grounds for a claim for any reduction in output associated with the changed weather conditions experienced.

The effect of weather conditions on construction outputs is a further area that has been the subject of several published statistical analyses in recent years. These analyses tend to consider two factors: temperature and humidity.

They provide statistics showing the productivity losses said to be associated with low and high temperatures and high humidity levels. In addition they show the combined effects of both factors.

Particular care is required when considering statistical data on weather conditions, both as to the origin of the statistical data itself and its application. Thus for example an analysis that is based upon research carried out in North America may be considered inappropriate to consideration of work carried out by labor that is used to conditions in very different climates. In addition, comparison of work activities, which are the subject of the studies with the work activities to which it is intended to apply the resulting statistics is essential.

Low temperatures will have a very different effect on labor carrying out hand excavation for underpinning compared with mechanical excavation.

Contractor inefficiency

The common complicating factor in the assessment of disruption and other costs is the allegation of inefficient working by the contractor. Wherever actual resources or costs are used as part of an analysis or claim there is the potential for a defense that the level of such resources or costs is unreasonable because of inefficiencies on the part of the contractor. Such allegations may be specific and specify the resources that have been inefficient and the manner in which that inefficiency occurred, or may be a more general allegation of poor productivity due to matters such as a lack of management, insufficient supporting resources or an inadequately skilled workforce.

It is of course important when making any analysis of productivity or the impact of extraneous events to ensure as far as possible that other potential causes, such as the type of inefficiencies mentioned above, have not had an impact on the analysis. It is good practice to undertake some consideration in this respect irrespective of whether or not specific allegations have been made.

One of the more obvious ways to assess if the actual productivity is not affected by such factors as those mentioned above is to consider the make-up of the workforce, its management and support services, etc. from the point of view of the experienced competent contractor and compare the resulting resource and management profile with that actually deployed. Published data and work norms may provide assistance in establishing common resource mixes and levels of supervision, etc. for the relevant activities. This will not provide a definitive answer but if the results are reasonably compatible with the actual there is a strong likelihood that other factors have caused any changes in the productivity achieved.

It should, however, be borne in mind that many allegations of contractor inefficiency may not be relevant in circumstances where the disruption being quantified has been caused by actions, or inactions, of the employer or his representatives.

Lack of management

Typical of the areas often rose as matters of contractor inefficiency are lack of management, and changes in personnel. It is usually assumed (whether rightly or wrongly) that when a contractor makes an allowance in his preliminaries, or a resourced programme, or a staff organogram for a certain level of management and supervision, that that level is the optimum level he requires to efficiently carry out the work in accordance with his tendered outputs. All too often at least two of these sources can be exaggerated. Where the contractor subsequently provides rather lower levels of management and supervision, any claim by the contractor for the loss of efficiency in the use of labor and plant can usually expect to be faced with a response that at least part of the inefficiency is the result of lack of management and supervision.

On the other hand, an apparent lack of management and supervision, that is a shift in its ratio to the number of operatives and pieces of equipment on site, can sometimes be the result of delay and disruption that has been imposed upon the contractor and for which it is entitled to be reimbursed. Thus debates will ensue as to whether levels were sufficient and if not, whose fault it was.

As to the financial consequences, it is inevitable that if the level of management and supervision on a project is not sufficient then the productivity of the operatives

and plant that they were intended to manage and supervise will be reduced. The question is how to evaluate the financial consequences for labor and plant costs. This is yet another area where historical statistical analyses can be of some use, but again need to be applied with a large degree of circumspection.

Similar considerations apply to changes in personnel; this includes both operatives and management/supervision. Both are subject to the 'learning curve' and 'un-learning curve'. Where a contractor experiences excessive changes in personnel this is usually a matter within his control and therefore his responsibility. However, where projects are subject to excessive delay and/or excessive disruption it is often the case that one of the effects is increased personnel turnover, particularly managerial or supervisory staff.

In a construction market as competitive as that in the UK in 2007, grades from site laborer to site agent are unlikely to be short of options for alternative employment. The issues that arise from this are those of contractual responsibility and evaluation. Evaluating the time lost as a result of the repetition of the 'learning curve' is difficult. Further historical statistical analyses are available, but the use of these is subject to the same qualifications on their use mentioned elsewhere.

Bottom up or top down?

Perhaps the most important consideration in the field of quantifying the effects of disruption, and in other aspects of the quantification of resource based matters, is the starting point for the analysis. Should the analysis commence with the actual amount of resources deployed and costs incurred and determine how they relate to the activities and events on site, the 'top down' approach, or should the analysis start with the planned amount of resources to be deployed and costs anticipated (if established to have been reasonable) and consider adjustment of these in the light of any relevant events, the 'bottom up' approach?

The attraction of starting with the actual resources and costs and determining their relationship to events would seem to be that one is dealing with known resources, and costs, providing adequate records of matters on site have been maintained. The disincentive to starting with the activities and events on site and identifying resources and costs to such matters is that this may be a more complex and involved approach requiring more analysis to build the picture step by step. In the absence of adequate records the latter approach may require considerable further research to establish what the reasonably attributable effects of events may have been. Whatever the relative merits both approaches are commonly encountered in claims for additional payment and therefore some more detailed consideration is appropriate.

The 'top down' approach

There are many variations to this approach to the analysis of resources and costs but the common feature is that the approach commences with actual resources and expenditure and relates it back to activities and events on the project site. The employed resources and costs are allocated to the activities to provide as factual a picture as possible of the way in which the contractor's costs were incurred.

To illustrate a typical example using the costs of resources, assume that the following figures may be extracted for three activities, which are alleged to have been disrupted by events on site. In this example the costs have been used to illustrate the analysis but the same process can be undertaken for individual activities using resource figures such as man-hours, plant hours, etc.

	Tender £	Final A/C £	Cost £
Concrete work	210,000.00	242,000.00	310,000.00
Excavation	160,000.00	170,000.00	190,000.00
Steelwork	95,000.00	85,000.00	100,000.00
Total	465,000.00	497,000.00	600,000.00
Loss on Final A/C Value			135,000.00

It might be alleged that the extent of disruption in these activities is demonstrated by the loss incurred by the contractor, represented by the excess of resources and cost compared with the anticipated tender or actual final account value achieved. Thus the overall degree of disruption to the contractor may be represented as the loss as a proportion of the value achieved:

$$\text{£}103,000/\text{£}497,000 = 20.72\%$$

The contractor may then allege that he has suffered a 21% loss of production as a result of disruption.

The flaw in such an approach is obviously that the alleged productivity loss is simply a product of the final cost figure, which may, or may not, be dictated by the impact of disrupting factors on the site activities. It leaves the defenses discussed

above, particularly those where contractor defaults Evaluation of the time consequences of change 215 and problems are alleged to have contributed to the cost of operations, available to the recipient of such a calculation. The same problem applies if the calculation is presented in an alternative to the financial format by using critical components of the final cost such as man-hours or plant hours.

At the very least, if such an approach is considered to be adopted, the analysis should be taken to the component factors of the total loss so that factors can be established for each part. In the above example, for instance, losses of £68,000 can be identified in the concrete work, £20,000 in the excavation activity, and £15,000 in the steelwork. Factors for each of these components would then be:

Concrete work	$£68,000/£242,000 = 28.01\%$
Excavation	$£20,000/£170,000 = 11.76\%$
Steelwork	$£15,000/£85,000 = 17.64\%$

This shows that the various components of the whole have incurred losses at differing rates to that applicable to the whole and may therefore facilitate some examination of the activities, concentrated on the areas of greatest loss, with some prospect of establishing the reasons for the increase in cost attributable to events. It is likely, however, that only a detailed ‘bottom up’ analysis will identify the reasons for the difference between the incurred costs and the achieved value.

There are many variations on this approach, and the above could obviously be refined by converting the ‘final account value’ to a cost basis so that comparison with the actual activity cost is on a like-for-like basis, but it will always suffer from the deficiencies generated by starting with the outcome and trying to work backwards to the cause. The difficulties of allocating actual outcomes to items of causation, separating out non-claimable matters such as contractor’s inefficiencies and mistakes, and eliminating the tender/ final account value as a source of inaccuracy will always mean that such an approach can only be adopted with considerable care and painstaking effort to eliminate inherent causes of distortion in the calculations.

In most instances the ‘bottom up’ approach is to be preferred.

The ‘bottom up’ approach

This approach starts with the activities and events on site, identifies the alleged causes of additional expenditure giving rise to a claim for additional payment, and then assesses the impact of those events using as a starting point the resources and

costs that would have been anticipated by a competent experienced contractor to undertake the works on the basis of the contract information.

This approach will commonly begin with an analysis of the programme of events, both anticipated and as built, in order to establish the causes and impacts on the timing and resources that should have been anticipated as being sufficient for the works. From this analysis it will be possible to identify the components of the additional cost incurred, be that overtime working, additional resources, condensing of activities or other factors caused by the disruption or measures adopted to counter the causes of disruption.

There is a great deal of available literature on how such analysis should be conducted in detail, much of it concentrating upon planning and programming techniques. When undertaking such analysis it is important to bear in mind that a technique that is relevant and suitable for one type of analysis may not be suitable or so relevant in a different situation. When considering during the course of a project if an event is likely to cause a delay to the contract completion date, and therefore justify the granting of an extension of time, it is necessary to update the contract programme with all information and circumstances known at the time that the event impacts in order to assess what likely effect it will have. This is the 'time/impact' analysis discussed in detail in the SCL Protocol. Such a technique may, however, not be appropriate, or possible, for the analysis of disruption retrospectively when it may well not be possible to recreate the programme situation at the time of the impact of an event. It should also be considered that the technique relevant for forecasting an extension of time might not be suitable for establishing the incidence, or extent, of disruption. The more suitable means of establishing disruption is to compare the anticipated programme, corrected for any deficiencies or omissions, etc., with the as built programme, providing the latter can be established with reasonable accuracy from the available records. A comparison of the two will then enable the identification of the problem areas, and causes, between the two programmes.

This may not be highly sophisticated analysis in terms of programming technique, although it can be painstaking and laborious, but it should enable a reasoned analysis to be established based, most importantly, on the facts of the project. If the 'but for', pragmatic and common sense approaches to analysis discussed at the outset of this chapter are adopted, the result should be a sensible factual analysis of causes and effects.

From that analysis it should be possible to build up a cost that is generated by the activities and events and not by the contractor's level of resources deployed, or costs incurred. The end result will often be one that falls short of the total of actual

resources or costs but that may be for valid reasons such as contractor errors or other matters for which the contractor remains liable.

A comparison with the contractor's cost records and/or the final account is always a good reality check on such exercises and should be undertaken to ensure that the results are compatible with, and reflect to the maximum extent possible, the real world.

6.3.2 Subcontractor costs

There is sometimes an issue in the quantification of claims for additional payment caused by the incorporation of costs and claims from subcontractors and suppliers into the main, or prime, contractor's claim to the employer.

Providing the terms of the subcontract are back to back with those of the main contract as far as the relevant terms for quantification of claims is concerned there should be no real issue. The difficulty is often caused in practice by a lack of willingness on the part of subcontractors to provide a detailed analysis of the compensation they are seeking.

Where genuine issues may arise they will usually be in the areas of supervision and support services with potential overlap or duplication of costs, particularly on large projects. The only solution is to adopt the same rigorous 'bottom up' approach to the subcontractor element of claims as applies to the main contractor's claim.

It should, however, always be considered that there might be some distortion between the basis on which subcontract rates and prices have been procured and the basis of pricing in the main contract, due to the time lapse between the tendering of the main works and the letting of subcontracts. If the main contractor is aware of difficulties or changes that have arisen between the commencement of the works and the letting of a subcontract he will generally try to procure a subcontract package on the basis of the changed circumstances, or that incorporates, the effect of any difficulties that have arisen. If this has happened it may well be that some analysis of subcontract pricing will be required to enable the subcontract costs to be applied on the same basis as the original main contract pricing, i.e. the effect of any 'bought in' changes and difficulties will need to be identified and substantiated, and taken into account in any subsequent analysis.

6.4 Acceleration

Claims arising from acceleration of the works are often fraught with difficulty, not least because the powers to instruct acceleration at the employer's expense are not common in construction contracts and the basis of the claim may therefore be contentious.

The question of additional payment for acceleration commonly arises in two different situations. The first such situation is the 'prospective acceleration' where it may be acknowledged by both parties to the contract that the contract completion date, or extended date, is not likely to be met and the employer may request, or instruct, depending upon the terms of the contract, the contractor to adopt accelerative measures in order to meet the original date, or at least reduce the projected overrun. In such a situation the contractor will have to assess what is possible by adopting such measures as overtime working, increased shift working, the introduction of additional resources and the possible reprogramming of the remaining works. In effect he will be in the position of submitting a tender for the accelerative measures and will usually wish to include some contingency to cover unforeseen complications and costs in putting the accelerative measures into effect.

Whether such a contingency is appropriate or not will depend upon the status of the accelerative measures under the terms of the contract and what applies to the payment for accelerative measures if they are adopted but fail to achieve the required result.

Subject to any express terms of the particular contract, it may be considered that a contingency is appropriate if the accelerative measures can be instructed and required but the payment is only to be made if the required effect on completion of the works is achieved.

The greatest difficulty in 'prospective acceleration' occurs, as is often the case, when the accelerative measures are adopted with an agreed payment but they are only partially successful, i.e. they reduce the projected time to completion but not by the amount desired or required. Such a situation needs to be carefully considered before any agreement, or instruction, for accelerative measures is executed and the status of the payment is agreed and set out for all the possible outcomes. It is in essence a matter of who is to carry the risk for the accelerative measures. If the contractor is taking the risk then the inclusion of a reasonable contingency would seem to be a prudent and acceptable matter.

The second common situation requiring the consideration of payment for accelerative measures is that of 'retrospective acceleration' where a completion date, or other agreed date, is achieved but only by adopting exceptional measures to overcome factors that would otherwise have delayed the date.

The 'retrospective' in this case implies that no prior agreement or instruction for the accelerative measures applies. In such situations the second question posed by the judge as to the source of the decision to institute the measures will be directly relevant. This is often the case where the contractor will apply for payment in respect of 'constructive acceleration' meaning that he has adopted exceptional

measures to overcome delays for which the employer is responsible but, as no extension of time has been granted, he has still had to meet the original dates for completion of the works, or at the very least reduce the impact of the delaying events on the contract completion date.

Quantification of acceleration

With the exception of the possible inclusion of the contingency element for 'prospective acceleration' there should be no difference in the approach to quantification of acceleration payments between the 'prospective' and 'retrospective'. The methodology for the quantification of all acceleration should be very similar to that for the quantification of disruption costs, including an adoption of the 'bottom up' approach wherever possible.

As always in such matters the starting point should be the consideration of the organisation and resources that would have been anticipated to be required by an experienced competent contractor to achieve the works described in the contract documents. If it has then been established that intervening delaying factors for which the employer is liable require accelerative measures, those measures should be identified from the starting point resource, and will usually include matters such as:

- The introduction of additional resources. These will be identified to particular activities and operations on site with the objective of shortening durations.
- The working of additional overtime, or adoption of additional shifts. In either case the additional cost is the premium paid for work outside normal hours, as the assumption is that additional labor will be productive at the same rate as the original. If it were thought that productivity might be reduced as a consequence of additional overtime or shift working, some basis of assessing the reduction in productivity would have to be built into the calculation.
- It may be that the introduction of additional resources, or the instituting of additional shift working, requires further labor (and/or plant) resources that are not readily available in the locality. In such circumstances further costs will be incurred in the importation of labor from remote locations, including transport and possibly accommodation costs. It may also be necessary to pay the imported labor a premium to persuade them to travel to the site location.
- Further plant costs may be incurred by duplicating plant already on site in order to service any additional resources.
- Temporary works costs may increase, for instance in circumstances where it is decided that one of the activities to be accelerated is that of formwork to

reinforced concrete, and additional resources are introduced to increase the area of formwork constructed and in place for the pouring of concrete. The amount of formwork material may be increased with a consequent reduction in the number of reuses achieved on the works. Similarly, increases in site workforce may require an increase in access resources such as scaffolding and equipment hoists, etc.

- In addition to the above, and other such direct works consequences, there will be an increase in the site supervision and possibly site services to cater for any increase in resource, i.e. additional on-site overhead.
- There may also be additional head office costs and charges if such can be identified, e.g. management time etc.

All factors in the build-up to the acceleration cost, such as those above, should be identified to the particular activities with an analysis of what is to be achieved. The quantification then becomes a simple case of pricing the various measures.

Sample acceleration costing

To take a relatively simple example of acceleration, consider a situation where an analysis of the work to be undertaken to completion shows that the works will overrun due to changes in the fixing of steel reinforcement caused by delays in delivery of the relevant bending schedules, for which the employer is liable.

Assume for the purposes of this example that analysis of the remaining works shows that if the amount of formwork is doubled the reinforcement fixing can be increased now that the required bending schedules are available, but the reinforcement will have to be delivered in small quantities to expedite delivery in order to keep the steel fixers working. The increased formwork area can be erected and dismantled by employing a further six carpenters and six additional laborers in addition to the original formwork labor of eight carpenters and eight laborers, although the whole of the enlarged formwork workforce of 14 carpenters and 14 laborers will need to work an additional 10 hours' overtime per week, for the anticipated remaining period of the formwork works of 12 weeks. A further four reinforcing steel fixers are required, but will not need to work any exceptional overtime, although none are available in the locality and they will have to be imported and accommodated for the required eight week projected period required. In order to increase the rate of concrete pouring to take advantage of the increased areas of formwork and rate of steel fixing, a further concrete gang of four operatives will be required for a period of eight weeks but neither they nor the existing concrete resource will need to work any exceptional overtime, and in order to alleviate crane bottlenecks caused by the increased rate of concrete placing, a

mobile crane will be required for four weeks to supplement the site crane resource.

In reality all the above resources would be identified to specific parts of the formwork, reinforcement and concreting activities, such as columns to be erected and poured 'early' and areas of slab formwork and beams, etc. to be included in the accelerative measures, but the above is sufficient to provide a sample build-up of the acceleration costs.

The costing for the above measures would be as follows:

Formwork costs

Additional resource:	£
6 carpenters · 12 weeks · 45 hours · £18.00	58,320.00
6 laborers · 12 weeks · 45 hours · £16.00	51,840.00
Overtime:	
14 carpenters · 10 hours · 12 weeks · £3.60	6,048.00
14 laborers · 10 hours · 12 weeks · £3.15	5,292.00

Steel fixing costs

4 steel fixers · 8 weeks · 45 hours · £18.00	25,920.00
Lodging allowance 4 · 8 weeks · 4 nights @ £26.00	3,328.00
Travel time and fares 4 · 8 weeks @ £90.00	2,880.00
Reinforcing steel, small load charge 32 tones @ £6.75	216.00

Concrete costs

Additional resource:	
4 operatives × 8 weeks × 45 hours × £16.85	24,264.00
Mobile crane 4 weeks @ £1,265.00	5,060.00
Total gross cost of accelerative resources	£183,168.00

Any increased material costs resulting from, for instance, any reduction in the number of uses of formwork achieved will need to be added to the above resource cost. It will then be necessary to deduct from the gross cost of the acceleration resources and related material costs the value paid for the work undertaken by the additional resource, i.e. the contract amount payable for the formwork, steel fixing and concrete, to identify the net amount of the acceleration cost that is additional to the amount paid under the contract.

The practical difficulty that may arise in making the appropriate deduction is the identification of the labor element of the concrete work where the contract rates and prices are composite rates for labor, plant and materials, etc. Some analysis of any composite contract rates will be necessary in such circumstances taking into account the factors relating to unit rates discussed in section 5.2.

In making any deduction, however, the amount deducted should not be the whole of the applicable contract rates and prices but should be net of the overhead and profit element, as the contractor is entitled to retain his overhead and profit return from the contract works.

This is merely a simple example of the type of pricing that is required and would in the real world require related identification of the areas and amounts of permanent and temporary works involved in addition to detailed build-ups of the sums claimed. In many instances the extent of the works to be accelerated and the measures required to achieve the acceleration will be much more extensive than the above example, but the 'bottom up' principle would still apply and require each section of the work to be considered, the objective in terms of time set out together with the measures necessary, and the pricing built up for each section, in the manner demonstrated above.

Profit in acceleration

Whether or not the contractor is entitled to include a profit element in his pricing of acceleration will generally depend upon the terms of the contract and whether the acceleration payment is proffered as a 'prospective' acceleration payment or as compensation for 'retrospective' acceleration. Subject to the express terms of the contract the contractor will usually be entitled to include a profit element where it is an agreement or instruction for future acceleration that is being considered but will not usually be able to include profit for 'retrospective' acceleration where he has taken such measures to overcome employer liability delays without instruction or agreement, and where therefore his claim will be for 'loss and expense' or costs occasioned by delays.

6.6 Overheads and profit

Contractors commonly include amounts for overheads, both on and off site, and profit in the sums they present as claims for compensation for time related changes. It is not uncommon for such inclusions to be proffered on a percentage basis for the off-site overheads, and as a daily or weekly sum calculated pro rata to the contract sum for on-site overheads. Profit, and loss of profit, claims are usually put forward as a percentage addition to the total of the direct costs and site overheads.

The basis for claiming such elements of cost and the most appropriate method of calculation need to be considered in some detail.

6.6.1 Site overheads

It is plainly incorrect to assume that the contractor's costs for any extended period of time will vary proportionately to the sums included in the contract for site overheads, often in a 'preliminaries' section if a bill of quantities has been used. The only exception to this principle will occur where specific rates have been included in the contract to cater for such eventualities. This practice, however, is one that is not usually favored by contractors on the grounds that they cannot accurately price the rates required unless they know the circumstances of the extended period of time, the resources and activities taking place, and the site management and facilities required.

The methodology for pricing the cost of site overheads is the simple, but often painstaking, process of identifying the resource required by reference to the causes of the extended period and pricing accordingly. In many respects this is no different to the 'bottom up' approach to pricing prolongation, disruption and acceleration costs but it may become susceptible in complex situations where there are many different causes of delay to the need to price elements on a global basis. For instance, it may be impossible to allocate the cost of additional trade supervision to each one of a number of causes, other than by adopting a purely arbitrary and artificial apportionment, where the supervision is spread over a number of relevant activities.

It is here that the global approach may be applicable but it will still be necessary to identify the group of activities and causes giving rise to the increased supervision. It will also be necessary to demonstrate that there are no other causes contributing to the cost for which the employer is not liable.

6.6.2 Off-site overheads

Contractors have commonly presented claims for off-site, or head office, overheads as a percentage based on a simple analysis of the company accounts for the period in question. The presentation for such analyses can usually be summarized as being along the lines of:

	£
Total turnover for the financial year	24,000,000.00
Total of costs of construction activities	20,500,000.00
Total of administration and head office costs	2,250,000.00

Gross profit 1,250,000.00

Copies of the summarized accounts may be included to support the analysis, and the off-site overhead is presented as an addition to the site costs, including the site overhead cost, calculated as:

$$£2,250,000/£20,500,000 = 10.97\%$$

This approach is attractive in its relative simplicity but has the major disadvantage that the contractor is recovering monies based on an all-encompassing calculation which assumes that additional overhead is incurred at the same rate as the total overhead for the year. Some consideration of the offsite activities usually encompassed by the administration and head office costs will soon lead to the conclusion that the assumption is not a reasonable one as the costs may include matters such as:

- The contractor's estimating and tendering department, which does not have any further input to the contract after it has been procured.
- The contractor's head office contract management and quantity surveying function, which may, or may not, have any greater involvement in the project as a result of the events and causes of compensation being considered.
- The contractor's human resources and payroll department which may not incur any greater level of expenditure as a result of the events on site, even where further resources are employed on site.

Sample analysis of overheads for recovery

Using the figures from Appendix B to illustrate the process of adjustments that might be required by (1) above, the following amendments to the figures might be made before they are applied as overhead.

Assume that the company whose accounts are being examined includes a major contracts division and a minor contracts division, run as one company with one set of accounts but managed separately. Also assume the 'administration staff' includes the estimating department for the whole company at a figure of £211,000, with related costs in 'other employee costs' of £12,000. Also assume that figures of £182,000 and £10,000 are included in the same categories for the management staff of the separate minor projects division. Also assume that the legal and professional costs include £257,000 for costs incurred in litigation on a major contracts division project not connected with the contract for which the overhead is being considered.

To arrive at an overhead figure applicable to the major contracts division operations the above sums would be deducted from the total overhead:

	£
Total overhead costs from accounts	3,884,000.00
Deduct	
Estimating department costs	223,000.00
Minor projects division staff costs	192,000.00
Litigation costs	257,000.00
	3,212,000.00
<i>Deduct</i>	
Proportion of administration costs (less litigation cost) attributable to estimating and minor projects division.	
$3,627,000 \times 415,000/1,293,000$	1,164,118.00
Major contracts division overhead for distribution	£2,047,882.00

This overhead figure would then be expressed as a percentage of the sales figure for the major contracts division operations under consideration, i.e. excluding the minor projects division. So, if minor projects were responsible for £9,550.00 of the total sales of £43,876.00, the above overhead would apply to sales of £34,326,000 giving a percentage overhead rate of 5.97%.

In practice the adjustments would probably be more detailed and require further explanation and analysis but the above sample calculation serves to illustrate the type of adjustments that are often necessary to convert management accounting information into usable and relevant financial data. Had the figures in Appendix B been used unamended then the overhead of £3,884,000 expressed as a percentage of the total sales of £43,876,000 would have produced an overhead rate of 8.85%.

No account is taken in the above sample calculation for the £465,000 management charge shown in the accounts. This is assumed to be a charge from a group, or parent company, and its inclusion or otherwise would depend upon the actual nature of the charge and its rationale.

Wasted management time

As an alternative to, or as part of, a claim for overheads it is common to see claims for the cost of management time expended in dealing with the problem that is the cause of the claim. Such claims are often resisted by counter-claims that the

claimant would have employed the staff concerned in any event and therefore no additional cost has been incurred.

As far as quantification of the loss is concerned, a charge-out rate for the staff can be used if such exists and can be established; otherwise the claimant is entitled to recover cost of salary plus demonstrable overhead, providing of course there is no duplication with other heads of claim.

As in so many areas of quantum, the keeping of records will be crucial to the viability of such a claim.

6.6.3 Profit

The standard forms of contract do not all allow recovery of a profit element to be included in compensation where that profit is alleged to have been available to the contractor through other contracts on which the contractor would have worked but for the prolongation of his resources on the contract under examination. A loss of profit claim may be submitted as part of a 'direct loss and expense' claim under the JCT Standard Form, but the ICE Conditions definition of cost excludes a profit element. Whether or not such a claim can be maintained will rest on the terms of the particular contract.

However, for any such claim to succeed, the contractor will need to demonstrate that he had other work available for the resources that could reasonably have been expected to earn the profit claimed. It is not sufficient merely to demonstrate that resources have been retained by delay or disruption and thereby claim a profit element on the cost of those resources. This, of course, also implies that the profitability, or otherwise, of the contract on which the resources are retained is not relevant to the claim, nor the appropriate rate of profit.

If the contractor can provide the necessary evidence of work turned away for which the retained resources would have been required then a claim for loss of profit may be sustainable. It will not be sufficient merely to show that tender opportunities have been declined, as there would be no way of knowing whether or not the contractor would have been successful, and if successful, at what level. Some evidence of the turning away of real work with realistic prospects of profit will be required.

The rate of profit would not necessarily be based on the overall profitability, or otherwise, of the contractor's business as a whole if it can be demonstrated that the declined work had real prospects of a different level of profitability. It is, however, quite reasonable that the level of profit should not be excessive for the type of work and prevailing market conditions, following the principle of foreseeability,

and that some discount to the anticipated rate might be expected given that recovery as compensation will remove the risks inherent in any alternative work.

6.6.4 Finance charges

The cost of financing borrowings or capital provision as a result of payments being delayed may commonly be claimed either under the express provisions of the contract, if such a provision is included, or may be included within the definition of damages contained in the contract.

Interest under contract provisions

Some construction contracts include provisions for interest to be paid to a contractor in the event that sums are paid late. Typical of such provisions is that contained in the ICE Conditions at clause 60(7). This clause enables the contractor to claim interest on any amounts that the engineer fails to certify or the employer make payment of in accordance with sub-paragraphs (2), (4) and (6) of clause 60. These subparagraphs deal with monthly payments, the final account and the payment of retention monies. Interestingly, the clause provides for the payment of interest by the employer to the contractor in the event of under-certification but does not provide for payment of interest by the contractor to the employer in any instance of over-certification.

There must therefore be a failure to certify or pay before the entitlement to interest is established. As payment is due on certificates any failure of the employer to make due payment will be easily identified. The matter of failure to certify is potentially less easy to determine, as there may be genuine reasons for the engineer's making a different valuation in a certificate to that contended for by the contractor. This raises the prospect of difficulties in establishing whether an under-certification has occurred and if so precisely when. It also raises the question as to whether or not interest is due if an engineer is subsequently found to have under-certified.

Finance charges as 'loss and expense'

The concept of finance charges is quite separate to, and distinct from, a claim for loss of profit or interest on under-certification or on a judgment or award.

It is based on the premise that the contractor has had to finance the cost of variations, or disruption and/or prolongation of his resources on site from his own capital and financial resources because of matters for which the employer is liable. It is, in effect, a claim for being denied the payment of money that should properly have been paid. In such circumstances the contractual mechanism for the giving of notices of the intention to claim may be crucial to such a claim, and careful

consideration of the notice requirements and periods during which such charges are incurred will be necessary.

It has been said that cash flow is the lifeblood of the construction industry, and it is certainly remarkable how many substantial construction undertakings maintain impressively high turnover figures on relatively small amounts of employed capital. This implies both a great pressure on the capital in the business and usually a reliance on external sources of finance in order to maintain the business. The other side of this scenario is that many critics would point out that most construction companies rely heavily on subcontractors and that is used as a source of maintaining the high turnover figures without employing further capital in the business.

It is certainly relevant to any consideration of finance charges that the sum used as the principal for the calculation should reflect not only any delay or reduction in monies received by the contractor but also any corresponding delay or reduction in payments made by the contractor to subcontractors and suppliers where relevant, i.e. the principal amount used for the calculation should be the net effect on the contractor's cash flow and not merely the gross amount of any reduction in income.

Management charges

In the same way that companies within a group can sometimes be funded centrally and financing charges applied at rates decided by the holding company, it is not unusual to find members of a group structure paying management charges to the centre. It is important that such charges, if they occur, are identified separately to, and not included with, any claim for finance charges.

Management charges may genuinely be a charge for services provided centrally, or may simply be a way of subsidiaries returning profit or contribution to the centre for taxation and other purposes. On occasions these charges may include royalty or license payments, particularly in companies involved in the process plant construction industry.

Such charges are entirely different to any charges made for the provision of financial support by the centre and, if existing, should be identified and excluded from the calculation of charges applicable to finance. They may, of course, be relevant to the calculation of overhead charges where such costs relate to the provision of genuine management services.

6.6.5 Interest

As an alternative to the inclusion of interest as finance charges or other charges under a contract provision it is possible that interest may be claimed as a special category of damages in certain circumstances.

Interest as special damages

The inclusion of interest charges on borrowing or capital as part of the assessment of 'loss and expense' is distinct from the inclusion of interest charges in the assessment of damages, as 'special damages'. The loss and expense assessment arises from a contractual entitlement whereas damages are assessed for breaches of contract. Thus the entitlement in the *Minter* case arose from the contract between the parties and not from the law in relation to the assessment of damages.

The settled law for many years, in relation to damages, had been that interest was not due on an overdue debt unless it could be shown that it was intended interest on the debt should be paid, or unless the payment of interest could be implied from the common course of dealings in the particular trade giving rise to the debt. This is obviously a conflict with the realities of the modern commercial world where practically all businessmen acknowledge that if a person or business is deprived of monies otherwise due then the incurring of interest charges is a likely consequence. Interest still cannot be claimed as part of general damages but can be claimed as part of special damages.

6.7 Formula approaches

The analysis and calculation of overhead figures for claims arising from delays to contract completion dates on an actual basis calls for systematic record keeping and a considerable amount of detailed presentation of accounting information if it is to be successful. Even when all the necessary information for analysis is readily to hand there can be differences of opinion as to the relevance of portions of the figures presented, e.g. where costs for an accounting department are included in the figures there can be argument that only elements (perhaps the payroll section) are affected by any claim for delay. There is therefore a great attraction in the potential adoption of a formula that could be used to calculate the appropriate amount of the overhead charge without recourse to accounting data and the required analysis.

The benefits of a suitable formula would obviously be the elimination of the accounting analysis and records, with a consequent saving in time and cost, and the avoidance of argument as to the relevance of any part of the costs. Sadly, there are, however, considerable problems in the adoption of formulae to calculate possible

levels of overhead recovery as a consequence of the prolongation of a contract period, including:

- The formula will need to be based on the contract data for time and money, i.e. the programme and make-up of the contract sum. Where there are errors or deficiencies in either, but particularly the latter, the level of recovery can be more or less than the 'proper' amount.
- It is difficult, if not impossible, to structure a formula to discount elements of the contract sum that may not be applicable to the extended period of the contract.
- The adoption of a formula will generally require the assumption that the rate of activity, and therefore the rate of overhead cost, is uniform throughout the course of the project. Only in exceptional circumstances will such an assumption be valid.
- Crucially, formulae generally require the assumption that the level of overhead commitment and cost during the period of the prolongation of the contract works is the same as the average commitment and cost during the original contract period as calculated from the contract data. This is again an assumption that will be valid only in exceptional circumstances.

For instance, the works may be delayed at the outset by a late possession of the site but in circumstances that incur a low level of commitment and cost. Alternatively the delay may occur at the height of activity during the construction works when commitment and cost are at their highest.

Notwithstanding the above problems the courts have been tempted by the apparent simplicity of the formula approach and have given some measure of approval at times.

There are various potential formulae that may be considered for the calculation of the overhead element arising from prolongation but the two most commonly encountered in Britain are the Hudson and Emden formulae. A further candidate, the Eichleay formula, is an American formula that takes its name from an American court case and is often quoted or adopted by claimants.

The Hudson formula

This formula takes its name from *Hudson's Building and Engineering Contracts*, in which publication it first appeared in 1970. The formula requires the contract sum to be divided by the contract period, in weeks, to produce a weekly amount of the contract sum per week. This sum is then multiplied by the head office percentage, being the portion of the contract sum that applies to off-site overheads, to produce a weekly head office overhead sum, which is then multiplied by the

period of delay, in weeks, to produce a recoverable sum of head office overhead and profit for the period. *Hudson* made no mention of how the applicable percentage was to be obtained, if it was not quoted in the contract or agreed between the parties, although the tenth edition, in which the formula first appeared, suggested that rates of 3–7% of the total prime cost including prime cost and provisional sums was the range to be expected for competitively tendered projects.

The Hudson formula suffers from most, if not all, of the potential criticisms outlined above and has one further major failing:

- In applying the overhead and profit percentage to the weekly amount of the contract sum the percentage is being applied to a figure *which itself includes an element of overheads and profit*. The recovery being calculated therefore includes some double counting because of this failing. If the Hudson formula is to be applied at all the formula needs correcting to reduce the contract sum used in the formula to a figure net of overhead and profit.

The Emden formula

This formula also takes its name from the legal textbook in which it first appeared, *Emden's Construction Law*. It follows the same path as the Hudson formula with one important difference in that it has a first stage in which the company's total overhead cost and profit is expressed as a percentage of the company's total revenue in the period. The formula is then identical to the Hudson formula with the percentage derived from the first stage being used to calculate the weekly overhead and profit amount recoverable. This has the advantage of defining how the percentage is to be calculated, on the company's actual overhead and profit as a proportion of total revenue, but introduces two distinct complications that detract from the attraction of simplicity in formulae:

- (1) The calculation of the percentage as the first stage requires the production of accounting records and data, presumably for at least one relevant financial year, and therefore the avoidance of time and cost involved in such production of data begins to be eroded.
- (2) Secondly, and more importantly, the overhead and profit have to be identified from the accounting records thereby introducing an opportunity for disagreement as to which items in the accounts are, or are not, truly head office overhead.

The Eichleay formula

This formula takes its name from an American legal case involving the *Eichleay Corporation*, and involves three stages:

- (1) The total contract sum is divided by the company total revenue in the period to produce the proportion of the company revenue attributable to the contract; this 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 contract amount of overhead.
- (3) Finally the daily overhead rate is multiplied by the period of delay in days to produce a recoverable amount.

Eichleay obviously does not include profit in the formula and differs in that respect but it still suffers from the criticisms discussed above and, especially, assumes a uniform rate of spend etc. However, it does have the advantage of relating actual expenditure on overhead to all activities and then relating that expenditure to time.